CHINO BASIN WATERMASTER

NOTICE OF MEETING

<u>Thursday, June 26, 2025</u>

11:00 a.m. – Watermaster Board Meeting

Watermaster's function is to administer and enforce provisions of the Judgment and subsequent orders of the Court, and to develop and implement an Optimum Basin Management Program

CHINO BASIN WATERMASTER
WATERMASTER BOARD MEETING
11:00 a.m. – June 26, 2025
Mr. Jim Curatalo, Chair
Mr. Jeff Pierson, Vice-Chair
Mr. Bob Bowcock, Secretary/Treasurer
At The Offices Of
Chino Basin Watermaster
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

AGENDA

CALL TO ORDER

FLAG SALUTE

ROLL CALL

PUBLIC COMMENTS
This is an opportunity for members of the public to address the Board on any short non-agenda items that are within the subject matter jurisdiction of the Chino Basin Watermaster. No discussion or action can be taken on matters not listed on the agenda, per the Brown Act. Each member of the public who wishes to comment shall be allotted three minutes, and no more than three individuals shall address the same subject.

AGENDA – ADDITIONS/REORDER

SAFETY MINUTE

I. **CONSENT CALENDAR**
All matters listed under the Consent Calendar are considered to be routine and non-controversial and will be acted upon by one motion in the form listed below. There will be no separate discussion on these items prior to voting unless any members, staff, or the public requests specific items be discussed and/or removed from the Consent Calendar for separate action.

A. **MINUTES**
Approve as presented:
Minutes of the Watermaster Board Meeting held May 22, 2025 *(Page1)*

B. **FINANCIAL REPORTS**
Receive and file as presented:
Monthly Financial Report for the Period Ended April 30, 2025 *(Page 8)*

C. **APPLICATION: WATER TRANSACTION – 1,000 AF SANTA ANA RIVER WATER COMPANY TO FONTANA WATER COMPANY** *(Page 24)*
Approve the proposed transaction.

D. **PROFESSIONAL SERVICES AGREEMENT BETWEEN APPLIED COMPUTER TECHNOLOGIES AND CHINO BASIN WATERMASTER** *(Page 31)*
Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

E. **PROFESSIONAL SERVICES AGREEMENT BETWEEN RAUCH COMMUNICATION CONSULTANTS, INC. AND CHINO BASIN WATERMASTER** *(Page 53)*
Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

F. **WEST YOST CONTRACT AMENDMENT FOR FY 2025/26 – UPDATED RATES (INFORMATION ONLY)** *(Page 79)*

II. BUSINESS ITEMS

A. **2024 ANNUAL REPORT OF THE PRADO BASIN HABITAT SUSTAINABILITY PROGRAM** *(Page 87)*
Receive and file as presented.

B. **TURNER BASINS 5-10 PROJECT DESCRIPTION AND INITIAL CONCEPT PLAN** *(Page 271)*
Approve the preparation of a project description and initial concept plan for Turner Basins 5-10 Recharge Project or other alternative(s) as determined.

C. **FISCAL YEAR 2025/26 PROPOSED PAY SCHEDULE** *(Page 276)*
Approve the Fiscal Year 2025/26 Pay Schedule as presented.

D. **SELECTION OF FIRM TO PERFORM PEER REVIEW OF THE 2025 SAFE YIELD REEVALUATION FINAL REPORT** *(Page 280)*
Approve and authorize the General Manager to sign a contract with S.S. Papadopulos & Associates, Inc. (SSP&A), as approved to form by Watermaster legal counsel, to perform Peer Review services in the amount of $95,628 plus up to 15% change order authority.

E. **OPTIMUM BASIN MANAGEMENT PROGRAM (OBMP) ECONOMIC STUDY REQUEST (INFORMATION ONLY)** *(Page 373)*

III. REPORTS/UPDATES

A. **WATERMASTER LEGAL COUNSEL**

1. June 27, 2025, Court Hearing (Appropriative Pool Motion for Costs and Fees; Watermaster Motion for Receipt and Filing of Semi-Annual OBMP Status Report 2024-2; IEUA Motion for Costs and Fees; Watermaster Motion for Extension of Time to Complete Safe Yield Evaluation)
2. Court of Appeal Consolidated Cases No. E080457 and E082127 (City of Ontario appeal re: Fiscal Year 2021-22 and 2022-23 Assessment Packages)
3. Inland Empire Utilities Agency, et al. v. LS-Fontana LLC (C.D. Cal Cases Nos.: 5:25-cv-00809, 5:25-cv-01159)

B. **ENGINEER**
None

C. **GENERAL MANAGER**

1. July Meeting Schedule
2. Chino Basin Watermaster Guidance Documents
3. Watermaster Phone System Changes
4. Legislative Update
5. Other

IV. INFORMATION

A. **RECHARGE INVESTIGATION AND PROJECTS COMMITTEE (PROJECT 23a STATUS)** *(Page 376)*

B. **CHINO BASIN DAY** *(Page 377)*

V. BOARD MEMBER COMMENTS

VI. OTHER BUSINESS

VII. CONFIDENTIAL SESSION - POSSIBLE ACTION

Pursuant to Article II, Section 2.6, of the Watermaster Rules & Regulations, a Confidential Session may be held during the Watermaster Board meeting for the purpose of discussion and possible action.

1. CONFERENCE WITH LEGAL COUNSEL – PENDING LITIGATION: a) Chino Basin Municipal Water District v. City of Ontario et al., 4th District Court of Appeal Case No. E080457 and E082127

VIII. FUTURE MEETINGS AT WATERMASTER

06/26/25	Thu	9:30 a.m.	Watermaster Orientation*
06/26/25	Thu	11:00 a.m.	Watermaster Board
07/10/25	Thu	9:00 a.m.	Appropriative Pool Committee
07/10/25	Thu	11:00 a.m.	Non-Agricultural Pool Committee
07/10/25	Thu	1:30 p.m.	Agricultural Pool Committee
07/17/25	Thu	9:00 a.m.	Advisory Committee
07/17/25	Thu	9:30 a.m.	Recharge Investigations and Projects Committee (RIPComm)
07/24/25	Thu	9:30 a.m.	Watermaster Orientation*
07/24/25	Thu	11:00 a.m.	Watermaster Board

ADJOURNMENT

DRAFT MINUTES
CHINO BASIN WATERMASTER
WATERMASTER BOARD MEETING
May 22, 2025

The Watermaster Board meeting was held at the offices of the Chino Basin Watermaster located at 9641 San Bernardino Road, Rancho Cucamonga, CA, and via Zoom (conference call and web meeting) on May 22, 2025.

WATERMASTER BOARD MEMBERS PRESENT AT WATERMASTER

James Curatalo, Chair	Cucamonga Valley Water District
Jeff Pierson, Vice-Chair	Agricultural Pool – Crops
Brian Geye for Bob Bowcock, Secretary/Treasurer	Non-Agricultural Pool – CalMat Co.
Steve Elie	Inland Empire Utilities Agency
Mike Gardner	Western Municipal Water District
Bob Kuhn	Three Valleys Municipal Water District
Jimmy Medrano	Agricultural Pool – State of CA
Bill Velto	City of Upland
Marty Zvirbulis	Fontana Water Company

WATERMASTER STAFF PRESENT

Todd Corbin	General Manager
Edgar Tellez Foster	Water Resources Mgmt. & Planning Director
Anna Nelson	Director of Administration
Justin Nakano	Water Resources Technical Manager
Frank Yoo	Data Services and Judgment Reporting Manager
Daniela Uriarte	Senior Accountant
Ruby Favela Quintero	Executive Assistant
Alonso Jurado	Water Resources Associate
Kirk Richard Dolar	Administrative Analyst
Erik Vides	Field Operations Specialist

WATERMASTER CONSULTANTS PRESENT AT WATERMASTER

Scott Slater	Brownstein Hyatt Farber Schreck, LLP
Andy Malone	West Yost

WATERMASTER CONSULTANTS PRESENT ON ZOOM

Brad Herrema	Brownstein Hyatt Farber Schreck, LLP
Lucy Hedley	West Yost

OTHERS PRESENT AT WATERMASTER

Bob Feenstra	Agricultural Pool – Dairy
Lewis Callahan	Agricultural Pool – State of CA
Tariq Awan	Agricultural Pool – State of CA
Kati Parker	Chino Basin Water Conservation District
Curtis Burton	City of Chino
Ron Craig	City of Chino Hills
Debra Porada	City of Ontario
Jimmie Moffatt	Cucamonga Valley Water District
Jiwon Seung	Cucamonga Valley Water District
Chris Diggs	City of Pomona
Eduardo Espinoza	Cucamonga Valley Water District
Shawn Harkness	CV Strategies
Meredith Nickkel	Downey Brand
Megan Sims	Fontana Water Company
Justin Castruita	Fontana Union Water Company

Bryan Smith	Jurupa Community Services District
Jesse Pompa	Jurupa Community Services District
Aimee Zhao	Inland Empire Utilities Agency
Eddie Lin	Inland Empire Utilities Agency
John Russ	Inland Empire Utilities Agency
Michelle Licea	Monte Vista Water District
Chris Robles	City of Ontario Resident (Fair Ontario)

OTHERS PRESENT ON ZOOM

Gino Filippi	Agricultural Pool – Crops
Michael Maeda	Agricultural Pool – State of CA
Hye Jin Lee	City of Chino
Alexis Mascarinas	City of Ontario
Nicole deMoet	City of Upland
Mark Gibboney	Cucamonga Valley Water District
Rob Hills	Cucamonga Valley Water District
Derek Hoffman	Fennemore Law
Cris Fealy	Fontana Water Company
Toby Moore	Golden State Water Company
Kevin Alexander	Inland Empire Utilities Agency
Justin Scott-Coe	Monte Vista Irrigation Company
Justin Scott-Coe	Monte Vista Water District
Manny Martinez	Monte Vista Water District
Alyssa Coronado	Santa Ana River Water Company
David De Jesus	Three Valleys Municipal Water District
Jake Loukeh	Western Municipal Water District
Richard Rees	WSP USA

CALL TO ORDER
Chair Curatalo called the Watermaster Board meeting to order at 11:00 a.m.

FLAG SALUTE
(00:00:13) Chair Curatalo led the Board in the flag salute.

ROLL CALL
(00:00:42) Ms. Nelson conducted the roll call and announced that a quorum was present.

PUBLIC COMMENTS
This is an opportunity for members of the public to address the Board on any short non-agenda items that are within the subject matter jurisdiction of the Chino Basin Watermaster. No discussion or action can be taken on matters not listed on the agenda, per the Brown Act. Each member of the public who wishes to comment shall be allotted three minutes, and no more than three individuals shall address the same subject.

(00:01:33) Mr. Chris Robles, founder of Fair Ontario, and a concerned resident of the City of Ontario, commented that he has learned a lot from the Watermaster orientations and has brought two guests to join him.

AGENDA – ADDITIONS/REORDER
None

SAFETY MINUTE
(00:05:28) Mr. Corbin announced that the month of May is Mental Health Awareness month. It is an important reminder that takes us back to the lessons we learned during the Covid pandemic.

I. CONSENT CALENDAR

All matters listed under the Consent Calendar are considered to be routine and non-controversial and will be acted upon by one motion in the form listed below. There will be no separate discussion on these items prior to voting unless any members, staff, or the public requests specific items be discussed and/or removed from the Consent Calendar for separate action.

A. MINUTES

Approve as presented:
Minutes of the Watermaster Board Meeting held April 24, 2025

B. FINANCIAL REPORTS

Receive and file as presented:
Monthly Financial Report for the Reporting Period Ended March 31, 2025

C. CONSIDERATION OF COPIER LEASE AGREEMENT WITH ADVANCED OFFICE

Approve lease 36-month copier lease agreement with Advanced Office as presented and authorize the General Manager to sign the contract.

D. PROCLAMATION IN RECOGNITION OF THE INLAND EMPIRE UTILITIES AGENCY'S 75TH ANNIVERSARY

Adopt the Proclamation in recognition of the history and contributions of the Inland Empire Utilities Agency over the past 75 years.

E. CONSIDERATION OF AUDIT ENGAGEMENT LETTER WITH C.J. BROWN & COMPANY CPAs

Approve the Audit Engagement Letter as presented and authorize signatures as appropriate.

(00:06:39) Chair Curatalo pulled Consent Calendar Item I.D. for further discussion.

(00:06:57)
Motion by Mr. Mike Gardner, seconded by Mr. Bob Kuhn, there being no dissent, the item passed unanimously by voice vote.

Moved to approve the Consent Calendar without Item I.D.

(00:07:15) Mr. Corbin addressed Item I.D. and recognized IEUA's 75th anniversary as a major milestone. The Board took turns commending IEUA for its partnership in the Chino Basin indicating that the region's water supply reliability is strengthened as a result of the collaboration among the two agencies. A discussion ensued.

(00:14:32)
Motion by Mr. Marty Zvirbulis, seconded by Mr. Mike Gardner, there being no dissent, the item passed unanimously by voice vote.

Moved to approve Consent Calendar Item I.D.

II. BUSINESS ITEMS

A. WATERMASTER FISCAL YEAR 2025/26 PROPOSED BUDGET

Adopt the Watermaster Fiscal Year 2025/26 Proposed Budget as presented.

(00:15:08) Mr. Corbin introduced Ms. Uriarte to give a report and presentation. A discussion ensued.

(00:26:21)
Motion by Mr. Bill Velto, seconded by Mr. Marty Zvirbulis, there being no dissent, the item passed unanimously by roll call vote as attached to these minutes.

Moved to approve Business Item II.A. as presented.

B. CONSIDERATION OF THE SCOPE OF WORK FOR THE PEER REVIEW ENGAGEMENT OF THE 2025 SAFE YIELD REEVALUATION TECHNICAL RESULTS

Approve the Scope of Work and direct staff to move forward with solicitation of proposals for the peer review engagement as presented.

(00:27:27) Mr. Corbin gave a report and presentation. A discussion ensued.

(00:36:33)
Motion by Mr. Steve Elie, seconded by Vice-Chair Jeff Pierson, there being no dissent, the item passed unanimously by roll call vote as attached to these minutes.

Moved to approve Business Item II.B. as presented.

III. REPORTS/UPDATES

A. WATERMASTER LEGAL COUNSEL

1. June 13, 2025, Court Hearing (Appropriative Pool Motion for Costs and Fees; Watermaster Motion for Receipt and Filing of Semi-Annual OBMP Status Report 2024-2; IEUA Motion for Costs and Fees; Watermaster Motion for Extension of Time to Complete Safe Yield Evaluation)
2. Court of Appeal Consolidated Cases No. E080457 and E082127 (City of Ontario appeal re: Fiscal Year 2021-22 and 2022-23 Assessment Packages)
3. Inland Empire Utilities Agency, et al v. LS-Fontana LLC (San Bernardino Superior Court Case No. CIVRS2501381); Inland Empire Utilities Agency et al v. LS-Fontana LLC (C.D. Cal Case No.: 5:25-cv-00809)

(00:38:47) Mr. Slater gave a report. A discussion ensued.

B. ENGINEER

1. Annual Report and Meeting for the Prado Basin Habitat Sustainability Committee
2. State of the Basin Report

(00:43:16) Mr. Malone gave a report on Item 1. Mr. Tellez Foster prefaced Item 2 and invited Ms. Hedley of West Yost to showcase the new interactive story map features designed for this year's State of the Basin Report.

C. GENERAL MANAGER

1. MWD – Draft Environmental Impact Report for Pure Water California Project
2. Other

(01:04:32) Mr. Corbin reported that he had received a notice for the Pure Water California Project and indicated that it is also known as the Carson project which is going to recharge recycled water from advanced wastewater treatment facilities at various locations and is contemplated to be spread across different portions of Southern California.

IV. INFORMATION

A. RECHARGE INVESTIGATION AND PROJECTS COMMITTEE (PROJECT 23a STATUS)

(01:05:51) Mr. Corbin informed the Pool that this was an informational item and that there was nothing new to report.

V. BOARD MEMBER COMMENTS

(01:06:03) Mr. Gardner inquired as to when the General Manager performance evaluation was going to take place. A discussion ensued.

VI. OTHER BUSINESS

None

VII. CONFIDENTIAL SESSION - POSSIBLE ACTION

Pursuant to Article II, Section 2.6, of the Watermaster Rules & Regulations, a Confidential Session may be held during the Watermaster Board meeting for the purpose of discussion and possible action.

The Board convened into Confidential Session at 12:08 p.m. to discuss the following:

1. CONFERENCE WITH LEGAL COUNSEL – PENDING LITIGATION: a) Chino Basin Municipal Water District v. City of Ontario et al., 4th District Court of Appeal Case No. E080457 and E082127

Confidential session concluded at 12:45 p.m. and Mr. Slater reported that there was no reportable action.

ADJOURNMENT

Chair Curatalo adjourned the Watermaster Board meeting at 12:45 p.m.

Secretary: ________________________________

Approved: ________________________________

Attachments:
1. 20250522 Roll Call Vote Outcome for Business Item II.A.
2. 20250522 Roll Call Vote Outcome for Business Item II.B.

ATTACHMENT 1

May 22, 2025 Watermaster Board Roll Call Vote Outcome		
Member	**Alternate**	**Business Item II.A.**
Zvirbulis, Marty		Yes
Bowcock, Bob*	Geye, Brian	Yes
Elie, Steve		Yes
Gardner, Mike		Yes
Kuhn, Bob		Yes
Medrano, Jimmy		Yes
Pierson, Jeff, Vice-Chair		Yes
Velto, Bill		Yes
Curatalo, James, Chair		Yes
*Absent	**OUTCOME:**	**Passed Unanimously**

ATTACHMENT 2

May 22, 2025 Watermaster Board Roll Call Vote Outcome		
Member	**Alternate**	**Business Item II.B.**
Bowcock, Bob*	Geye, Brian	Yes
Elie, Steve		Yes
Gardner, Mike		Yes
Kuhn, Bob		Yes
Medrano, Jimmy		Yes
Pierson, Jeff, Vice-Chair		Yes
Velto, Bill		Yes
Zvirbulis, Marty		Yes
Curatalo, James, Chair		Yes
*Absent	**OUTCOME:**	**Passed Unanimously**

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888 www.cbwm.org

STAFF REPORT

DATE: June 2025

TO: Watermaster Committees & Board

SUBJECT: Monthly Financial Reports (For the Reporting Period Ended April 30, 2025)
(Consent Calendar Item I.B.)

Issue: Record of Monthly Financial Reports for the reporting period ended April 30, 2025 [Normal Course of Business]

Recommendation: Receive and file Monthly Financial Reports for the reporting period ended April 30, 2025 as presented.

Financial Impact: None

ACTIONS:
Appropriative Pool – June 12, 2025 [Final]: Received and filed.
Non-Agricultural Pool – June 12, 2025 [Final]: Received and filed without approval.
Agricultural Pool – June 12, 2025 [Final]: Received and filed.
Advisory Committee – June 19, 2025 [Final]: Received and filed.
Watermaster Board – June 26, 2025 [Recommended]: Receive and file.

BACKGROUND

A monthly reporting packet is provided to keep all members apprised of Watermaster revenues, expenditures, and other financial activities. Monthly reports include the following:

1. Cash Disbursements – Summarized report of all payments made during the reporting month.
2. Credit Card Expense Detail – Detail report of all credit card activity during the reporting month.
3. Combining Schedule of Revenues, Expenses & Changes in Net Assets – Detail report of all revenue and expense activity for the fiscal YTD, summarized by pool category.
4. Treasurer's Report – Summary of Watermaster investments holdings and anticipated earnings as of month end.
5. Budget to Actual Report – Detail report of actual revenue and expense activity, shown for reporting month and YTD, comparatively to the adopted budget.
6. Monthly Variance Report & Supplemental Schedules – Supporting schedule providing explanation for major budget variances. Also provides several additional tables detailing pool fund balance, salaries expense, legal expense, and engineering expense.

DISCUSSION

Detailed explanations of major variances and other additional information can be found on the "Monthly Variance Report & Supplemental Schedules."

Watermaster staff will provide additional explanations or respond to any questions on these reports during the meetings as requested.

ATTACHMENT

1. Monthly Financial Reports (April 30, 2025)

ATTACHMENT 1

Chino Basin Watermaster
Cash Disbursements
April 2025

Date	Number	Vendor Name	Description	Amount
04/01/2025	25381	CUCAMONGA VALLEY WATER DISTRICT - UTILITY	Utilities: Water	$ (376.28)
04/01/2025	25382	ESRI	Yearly software and maintenance enterprise agreement	(5,300.00)
04/01/2025	25383	GREAT AMERICA LEASING CORP.	February copy machine lease	(1,527.81)
04/01/2025	25384	IN-SITU, INC.	Water level supplies for desalter facilities	(4,490.56)
04/01/2025	25385	PETTY CASH	Petty cash replenishment	(314.18)
04/01/2025	25386	SAN BERNARDINO COUNTY - DEPT. AIRPORTS	April rent for extensometer site	(190.98)
04/01/2025	25387	SOCALGAS	Utilities: Gas	(172.69)
04/01/2025	25388	STANDARD INSURANCE CO.	April life and disability coverage	(996.23)
04/01/2025	25389	VC3, INC.	March IT services	(4,925.91)
04/01/2025	25390	VERIZON WIRELESS	Internet services for extensometer site	(38.01)
04/01/2025	25391	VISION SERVICE PLAN	April vision insurance coverage	(108.39)
04/03/2025	25392	EIDE BAILLY LLP	January accounting consulting services	(420.00)
04/03/2025	25393	WEST YOST	February engineering services	(149,910.15)
04/04/2025	25394	JOHN J. SCHATZ	December AP legal services	(8,453.00)
04/07/2025	ACH4/7/25	CALPERS	April medical insurance premiums	(18,210.85)
04/10/2025	25395	EGOSCUE LAW GROUP, INC.	March OAP legal services	(15,900.00)
04/14/2025	25396	BAY ALARM COMPANY	May security alarm monitoring service	(188.00)
04/14/2025	25397	BOWCOCK, ROBERT		(500.00)
04/14/2025	25398	ELIE, STEVEN		(375.00)
04/14/2025	25399	FRONTIER COMMUNICATIONS	Landline connection for Bay Alarm system	(154.06)
04/14/2025	25400	GEYE, BRIAN		(250.00)
04/14/2025	25401	HUITSING, JOHN		(375.00)
04/14/2025	25402	LEWIS BRISBOIS BISGAARD & SMITH LLP	March ONAP legal services	(2,915.00)
04/14/2025	25403	RAUCH COMMUNICATION CONSULTANTS, INC.	Final installment for annual report	(1,508.75)
04/14/2025	25404	SOUTHERN CALIFORNIA EDISON	Utilities: Electric	(140.83)
04/14/2025	25405	STATE COMPENSATION INSURANCE FUND	FY 25 worker's compensation insurance	(2,264.91)
04/14/2025	25406	VANGUARD CLEANING SYSTEMS	April janitorial service and March electrostatic spraying	(1,220.00)
04/14/2025	25407	VELTO, BILL		(750.00)
04/14/2025	25408	ZVIRBULIS, MARTIN		(375.00)
04/16/2025	25409	CALIFORNIA BANK & TRUST	Account ending 6198 - See detail attached	(8,872.68)
04/16/2025	25410	ACP PUBLICATIONS & MARKETING	Name plates for D. Uriarte and M. Zvirubulis	(279.07)
04/16/2025	25411	ACWA JOINT POWERS INSURANCE AUTHORITY	May life insurance	(274.43)
04/16/2025	25412	BURRTEC WASTE INDUSTRIES, INC.	Utilities: Waste	(168.62)
04/16/2025	25413	CORELOGIC INFORMATION SOLUTIONS	March geographic package services	(125.00)
04/16/2025	25414	CUCAMONGA VALLEY WATER DISTRICT	May lease	(11,902.91)
04/16/2025	25415	DE HAAN, HENRY		(375.00)
04/16/2025	25417	PITNEY BOWES GLOBAL FINANCIAL SVCS.	Quarterly postage meter lease	(454.87)
04/16/2025	25418	RUBEN LLAMAS		(125.00)
04/16/2025	25419	SOUTHERN CA EDISON	Utilities: Electric	(1,383.85)
04/16/2025	25420	SPECTRUM ENTERPRISE	April internet services	(1,173.60)
04/16/2025	25421	VC3, INC.	Firewall server installation hardware and labor	(8,342.50)
04/16/2025	25422	VERIZON WIRELESS	Internet services for Field Ops tablets	(239.16)
04/16/2025	25423	FILIPPI, GINO		(500.00)
04/28/2025	25424	EIDE BAILLY LLP	April accounting consulting services	(525.00)
04/28/2025	25425	GREAT AMERICA LEASING CORP.	March copy machine lease	(1,527.81)
04/28/2025	25426	IN-SITU, INC.	Water quality meter annual maintenance	(1,451.40)
04/28/2025	25427	INLAND EMPIRE UTILITIES AGENCY	FY 24/25 Q3 Groundwater recharge O&M and FY 23/24 cost share	(508,254.92)
04/28/2025	25428	READY REFRESH	Office water dispenser April lease and deliveries	(116.92)
04/28/2025	25429	SOCALGAS	Utilities: Gas	(124.21)
04/28/2025	25430	STANDARD INSURANCE CO.	May life and disability coverage	(1,040.35)
04/28/2025	25431	VC3, INC.	Adobe subscription for Teams and virtual host warranty renewal	(3,295.94)
04/28/2025	25432	VERIZON WIRELESS	Internet services for extensometer site	(38.01)
04/28/2025	25433	WELL TEC SERVICES	New meter installation and calibration	(54,062.50)
04/28/2025	25434	WESTERN MUNICIPAL WATER DISTRICT		(375.00)
04/28/2025	25435	BROWNSTEIN HYATT FARBER SCHRECK	February legal services	(103,401.26)
04/28/2025	25436	EMPLOYMENTOR, INC.	January-April legal consultation and risk management training	(4,437.50)
04/28/2025	ACH4/28/25	PUBLIC EMPLOYEES' RETIREMENT SYSTEM	Annual Unfunded Accrued Liability-Plan 3299	(12,164.17)
04/28/2025	ACH4/28/25	PUBLIC EMPLOYEES' RETIREMENT SYSTEM	Annual Unfunded Accrued Liability-Plan 27239	(172.92)
			Total for Month $	**(947,556.19)**

Chino Basin Watermaster
Credit Card Expense Detail
April 2025

Date	Number	Description	Expense Account	Amount
04/16/2025	25409	**CALIFORNIA BANK & TRUST**		
		Amazon - Amazon Web Services - February 2025	6056 · Website Services	(287.92)
		Panera Bread - OPS Meeting	6141.1 · Meeting Supplies	(70.90)
		Microsoft Software - Mapping and visualization software subscription	6054 · Computer Software	(15.00)
		REV Subscription - Speech to text transcription services	6112 · Subscriptions/Publications	(29.99)
		Kalaveras - Lunch meeting - T. Corbin, S. Elie	6141.1 · Meeting Supplies	(56.41)
		Kara Korner - Administative meeting - T. Corbin, M. Zvirbulis	6141.1 · Meeting Supplies	(26.01)
		The Back Alley - Lunch meeting - T. Corbin, B. Bowcock	6141.1 · Meeting Supplies	(47.09)
		Kara Korner - Lunch meeting - T. Corbin, B. Kuhn	6141.1 · Meeting Supplies	(24.99)
		Amazon - Toner cartridge	6031.7 · General Office Supplies	(295.69)
		Engrave N' Embroider - Front door CBWM decal	6031.7 · General Office Supplies	(66.08)
		Mind Tools - Leadership and Management Learning Solutions - March 2025	6031.7 · General Office Supplies	(25.75)
		Costco - Meeting snacks and drinks	6312 · Board Meeting Expenses	(183.41)
		Costco - Office supplies	6031.7 · General Office Supplies	(82.06)
		Amazon - Headset	6031.7 · General Office Supplies	(19.40)
		BambooHR - HRIS and Timekeeping System	6061.2 · HRIS System	(230.14)
		Amazon - Get well soon gift card for Ruby	6031.7 · General Office Supplies	(40.00)
		BlueHost - Monthly Software Renewal - Standard VPN Server with cPanel	6056 · Website Services	(91.99)
		Dell Technologies - Laptop and dock station	6055 · Computer Hardware	(2,331.31)
		FromYouFlowers - Get well flowers for Ruby	6031.7 · General Office Supplies	(90.86)
		Mezzaterranean - Board meeting lunch 03/27/2025	6312 · Board Meeting Expenses	(322.00)
		Society for Human Resource Management - 2025 Annual Expo - A. Nelson	6191 · Conferences - General	(3,590.00)
		Society for Human Resource Management - 2025 Annual Expo - Lodging - A. Nelson	6191 · Conferences - General	(366.44)
		Weathertech - F-150 Lighting floor liner	6179 · Vehicle Purchase(s)	(293.13)
		Marriott Burbank Airport - CalPERS HR Benefits Conference - Lodging - A. Nelson	6191 · Conferences - General	(253.81)
		Amazon - Replacement speakers	6031.7 · General Office Supplies	(32.30)
			Total for Month	**$ (8,872.68)**

Chino Basin Watermaster

Combining Schedule of Revenues, Expenses & Changes in Net Assets

For the Period of July 1, 2024 through April 30, 2025

(Unaudited)

				POOL ADMINISTRATION & SPECIAL PROJECTS					
	JUDGMENT ADMIN.	OPTIMUM BASIN MGMT.	TOTAL JUDGMENT ADMIN & OBMP	AP POOL	OAP POOL	ONAP POOL	GROUND WATER REPLENISH.	GRAND TOTALS	ADOPTED BUDGET 2024-2025 WITH CARRYOVER
Administrative Revenues:									
Administrative Assessments	$ 9,834,155	$ -	$ 9,834,155	$ 99,200	$ -	$ 31,000	$ -	$ 9,964,355	$ 9,833,780
Interest Revenue	-	384,234	384,234	16,457	52,253	2,777	4,018	459,739	478,500
Groundwater Replenishment	-	-	-	-	-	-	(87,377)	(87,377)	-
Mutual Agency Project Revenue	191,073	-	191,073	-	-	-	-	191,073	191,070
Miscellaneous Income	1,468	-	1,468	-	-	-	-	1,468	-
Total Administrative Revenues	**10,026,695**	**384,234**	**10,410,930**	**115,657**	**52,253**	**33,777**	**(83,358)**	**10,529,258**	**10,503,350**
Administrative & Project Expenditures:									
Watermaster Administration	2,542,860	-	2,542,860	-	-	-	-	2,542,860	2,528,540
Watermaster Board-Advisory Committee	227,619	-	227,619	-	-	-	-	227,619	422,420
Optimum Basin Mgmt Administration	-	770,002	770,002	-	-	-	-	770,002	1,437,940
OBMP Project Costs	-	3,799,096	3,799,096	-	-	-	-	3,799,096	4,971,020
Pool Legal Services	-	-	-	82,722	127,800	12,859	-	223,381	-
Pool Meeting Compensation	-	-	-	-	18,875	4,750	-	23,625	-
Pool Special Projects	-	-	-	-	9,454	-	-	9,454	-
Pool Administration	-	-	-	-	-	-	-	-	370,660
Debt Service	-	955,086	955,086	-	-	-	-	955,086	772,770
Agricultural Expense Transfer [1]	-	-	-	156,129	(156,129)	-	-	-	-
Replenishment Water Assessments	-	-	-	-	-	-	54,425	54,425	180,234
Total Administrative Expenses	**2,770,480**	**5,524,184**	**8,294,664**	**238,851**	**-**	**17,609**	**54,425**	**8,605,549**	**10,683,584**
Net Ordinary Income	**7,256,216**	**(5,139,950)**	**2,116,266**	**(123,194)**	**52,253**	**16,168**	**(137,783)**	**1,923,709**	**(180,234)**
Other Income/(Expense)									
Refund-Recharge Debt Service	-	-	-	-	-	-	-	-	-
Carryover Budget*	-	-	-	-	-	-	-	-	454,875
Net Other Income/(Expense)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**454,875**
Net Transfers To/(From) Reserves	**$ 7,256,216**	**$ (5,139,950)**	**$ 2,116,266**	**$ (123,194)**	**$ 52,253**	**$ 16,168**	**$ (137,783)**	**$ 1,923,709**	**$ 274,640**
Net Assets, July 1, 2024			8,794,214	555,405	1,404,964	65,733	180,234	11,000,551	
Refund-Excess Operating Reserves			-					-	
Net Assets, End of Period			**10,910,480**	**432,211**	**1,457,217**	**81,901**	**42,451**	**12,924,260**	
Pool Assessments Outstanding				(86,315)	(586,852)	-			
Payments received in FY 25 for prior year assessments				231,381	-	-			
Pool Fund Balance				**$ 577,276**	**$ 870,365**	**$ 81,901**			

[1] Fund balance transfer as agreed to in the Peace Agreement.

*Carryover budget will be updated once the refund for excess operating reserves has been finalized.

Chino Basin Watermaster

Treasurer's Report

April 2025

	Type	Monthly Yield		Cost		Market	% Total
Cash & Investments							
Local Agency Investment Fund (LAIF) *	Investment	4.28%	$	665,832	$	666,398	4.5%
CA CLASS Prime Fund **	Investment	4.39%		13,087,117	$	13,086,802	88.4%
Bank of America	Checking			1,056,327		1,056,327	7.1%
Bank of America	Payroll			-		-	0.0%
Total Cash & Investments			**$**	**14,809,276**	**$**	**14,809,526**	**100.0%**

* The LAIF Market Value factor is updated quarterly in September, December, March, and June.

** The CLASS Prime Fund Net Asset Value factor is updated monthly.

Certification

I certify that (1) all investment actions executed since the last report have been made in full compliance with Chino Basin Watermaster's Investment Policy, and (2) Funds on hand are sufficient to meet all foreseen and planned administrative and project expenditures for the next six months.

Anna Nelson, Director of Administration

Prepared By:
Daniela Uriarte, Senior Accountant

Chino Basin Watermaster

Budget to Actual

For the Period July 1, 2024 to April 30, 2025

(Unaudited)

		April 2024	YTD Actual	FY 25 Adopted Budget with Carryover	$ Over / (Under) Budget	% of Budget
1	**Administration Revenue**					
2	Local Agency Subsidies	$ -	$ 191,073	$ 191,070	$ 3	100%
3	Admin Assessments-Appropriative Pool	-	9,497,193	9,521,030	(23,837)	100%
4	Admin Assessments-Non-Ag Pool	-	336,962	312,750	24,212	108%
5	**Total Administration Revenue**	**-**	**10,025,228**	**10,024,850**	**378**	**100%**
6	**Other Revenue**					
7	Appropriative Pool-Replenishment	-	(103,383)	-	(103,383)	N/A
8	Non-Ag Pool-Replenishment	-	16,006	-	16,006	N/A
9	Interest Income	48,268	384,234	478,500	(94,266)	80%
10	Miscellaneous Income	-	1,468	-	1,468	N/A
11	Carryover Budget	-	-	454,875	(454,875)	0%
12	**Total Other Revenue**	**48,268**	**298,325**	**933,375**	**(635,050)**	**32%**
13	**Total Revenue**	**48,268**	**10,323,553**	**10,958,225**	**(634,672)**	**94%**
14	**Judgment Administration Expense**					
15	Judgment Administration	46,862	367,664	721,010	(353,346)	51%
16	Admin. Salary/Benefit Costs	75,981	1,002,053	1,032,120	(30,067)	97%
17	Office Building Expense	17,416	197,295	234,470	(37,175)	84%
18	Office Supplies & Equip.	2,174	24,414	46,760	(22,346)	52%
19	Postage & Printing Costs	1,528	19,196	32,950	(13,754)	58%
20	Information Services	10,379	120,633	232,530	(111,897)	52%
21	Contract Services	1,385	48,023	111,460	(63,437)	43%
22	Watermaster Legal Services	48,097	687,302	414,060	273,242	166%
23	Insurance	-	38,572	50,950	(12,378)	76%
24	Dues and Subscriptions	30	19,792	25,900	(6,108)	76%
25	Watermaster Administrative Expenses	499	8,053	9,630	(1,577)	84%
26	Field Supplies	229	2,228	3,200	(972)	70%
27	Travel & Transportation	2,411	85,983	104,960	(18,977)	82%
28	Training, Conferences, Seminars	4,565	21,697	49,370	(27,673)	44%
29	Advisory Committee Expenses	7,850	43,663	134,130	(90,467)	33%
30	Watermaster Board Expenses	22,835	183,956	288,290	(104,334)	64%
31	ONAP - WM & Administration	2,586	34,276	120,940	(86,664)	28%
32	OAP - WM & Administration	4,129	49,225	124,220	(74,995)	40%
33	Appropriative Pool- WM & Administration	10,784	119,270	125,500	(6,230)	95%
34	Allocated G&A Expenditures	(32,737)	(302,816)	(540,830)	238,014	56%
35	**Total Judgment Administration Expense**	**227,003**	**2,770,480**	**3,321,620**	**(551,140)**	**83%**
36	**Optimum Basin Management Plan (OBMP)**					
37	Optimum Basin Management Plan	113,084	770,002	1,437,940	(667,938)	54%
38	Groundwater Level Monitoring	46,802	384,862	585,050	(200,188)	66%
39	Program Element (PE)2- Comp Recharge	525,753	1,544,811	1,774,300	(229,489)	87%
40	PE3&5-Water Supply/Desalte	47,058	90,521	122,010	(31,489)	74%
41	PE4- Management Plan	66,836	356,793	412,400	(55,607)	87%
42	PE6&7-CoopEfforts/SaltMgmt	89,231	632,515	669,380	(36,865)	94%
43	PE8&9-StorageMgmt/Conj Use	102,784	486,778	867,050	(380,272)	56%
44	Recharge Improvements	-	955,086	772,770	182,316	124%
45	Administration Expenses Allocated-OBMP	10,310	107,776	232,750	(124,975)	46%
46	Administration Expenses Allocated-PE 1-9	22,427	195,040	308,080	(113,040)	63%
47	**Total OBMP Expense**	**1,024,285**	**5,524,184**	**7,181,730**	**(1,657,546)**	**77%**
48	**Other Expense**					
49	Groundwater Replenishment	-	54,425	180,234	(125,810)	30%
50	Other Expenses	-	-	-	-	N/A
51	**Total Other Expense**	**-**	**54,425**	**180,234**	**(125,810)**	**30%**
52	**Total Expenses**	**1,251,288**	**8,349,089**	**10,683,584**	**(2,334,496)**	**78%**
53	**Increase / (Decrease) to Reserves**	**$ (1,203,020)**	**$ 1,974,464**	**$ 274,640**	**$ 1,699,824**	

Chino Basin Watermaster

Monthly Variance Report & Supplemental Schedules
For the period July 1, 2024 to April 30, 2025
(Unaudited)

Budget to Actual

The Budget to Actual report summarizes the operating and non-operating revenues and expenses of Chino Basin Watermaster for the fiscal year-to-date (YTD). Columns are included for current monthly and YTD activity shown comparatively to the FY 25 adopted budget. The final two columns indicate the amount over or under budget, and the YTD percentage of total budget used. As of April 30th, the target budget percentage is generally 83%.

Revenues

Lines 1-5 Administration Revenue – Includes local agency subsidies and administrative assessment for the Appropriative, Agricultural and Non-Agricultural Pools. Below is a summary of notable account variances at month end:

- Line 2 Local Agency Subsidies includes the annual Dy Year Yield (DYY) administrative fee received. This account is at 100% of budget due to the timing of payment.
- Line 3-4 Administrative Assessments for the Appropriative and Non-Agricultural Pools include annual assessment invoices issued in November of each year. The Non-Agricultural Pool line is over budget due to changes in actual versus projected production.

Lines 6-12 Other Revenue – Includes Pool replenishment assessments, interest income, miscellaneous income, and carryover budget from prior years.

Expenses

Lines 14-35 Judgment Administration Expense – Includes Watermaster general administrative expenses, contract services, insurance, office and other administrative expenses. Below is a summary of notable account variances at month end:

- Line 16 Admin Salary/Benefit Costs includes wages and benefits for Watermaster administrative staff. The account is at 97% of budget due to vacation and severance payouts done in July.
- Line 22 Watermaster Legal Services includes outside legal counsel expenses. The account is over budget due to personnel matters not anticipated in the budget.
- Line 27 Travel & Transportation includes travel and transportation costs related to Watermaster business, not related to conferences and seminars, vehicle fuel, repairs and maintenance, and vehicle purchases. The account is at 80% of budget due to the timing of the new field vehicle purchase.

Lines 36-47 Optimum Basin Management Plan (OBMP) Expense – Includes legal, engineering, groundwater level monitoring, allocated administrative expenses, and other expenses.

Lines 48-51 Other Expense – Includes groundwater replenishment, settlement expenses, and various refunds as appropriate.

Chino Basin Watermaster
Monthly Variance Report & Supplemental Schedules
For the period July 1, 2024 to April 30, 2025
(Unaudited)

Pool Services Fund Accounting

Each Pool has a fund account created to pay their own legal service invoices. The legal services invoices are funded and paid using the fund accounts (8467 for the Overlying Agricultural Pool (OAP), 8567 for the Overlying Non-Agricultural Pool (ONAP), and 8367 for the Appropriate Pool (AP)). Along with the legal services fund account for the OAP (8467), the OAP also has two other fund accounts for Ag Pool Meeting Attendance expenses (8470), and Special Projects expenses (8471). The ONAP also has a meeting compensation fund account (8511). Additionally, the OAP has a reserve fund that is held by Watermaster and spent at the direction of the OAP. The AP also has account 8368 relating to the Tom Harder contract. These fund accounts are replenished at the direction of each Pool, and the legal service invoices are approved by the Pool leadership and when paid by Watermaster, are deducted from the existing fund account balances. If the fund account for any pool reaches zero, no further payments can be paid from the fund and a replenishment action must be initiated by the Pool.

The following tables detail the fund balance accounts as of April 30, 2025 (continued next page):

Fund Balance For Non-Agricultural Pool Account 8567 - Legal Services		
Beginning Balance July 1, 2024:	$	63,483.09
Additions:		
Interest Earnings		2,776.63
Payments received on ONAP Assessment invoices issued 11/26/24		25,000.00
Subtotal Additions:		27,776.63
Reductions:		
Invoices paid July 2024 - April 2025		(12,859.00)
Subtotal Reductions:		(12,859.00)
Available Fund Balance as of Apr. 30, 2025	**$**	**78,400.72**

Fund Balance For Appropriative Pool Account 8367 - Legal Services		
Beginning Balance July 1, 2024:	$	(9,472.87)
Additions:		
Interest Earnings		16,456.90
Payments received on AP Assessment invoices issued 11/18/21		27,343.35
Payments received on AP Assessment invoices issued 4/21/22		39,013.34
Payments received on AP Assessment invoices issued 10/14/22		70,478.86
Payments received on AP Assessment invoices issued 4/19/23		26,262.54
Payments received on AP Assessment invoices issued 10/30/23		68,282.61
Payments received on AP Assessment invoices issued 11/26/24		67,701.53
Payments received for appeal legal expenses 2/28/25		31,498.58
Subtotal Additions:		347,037.71
Reductions:		
Invoices paid July 2024 - April 2025		(82,722.38)
Subtotal Reductions:		(82,722.38)
Available Fund Balance as of Apr. 30, 2025	**$**	**254,842.46**

Fund Balance For Non-Agricultural Pool Account 8511 - Meeting Compensation		
Beginning Balance July 1, 2024:	$	2,250.00
Additions:		
Payments received on ONAP Assessment invoices issued 11/26/24		6,000.00
Subtotal Additions:		6,000.00
Reductions:		
Compensation paid July 2024 - April 2025		(4,750.00)
Subtotal Reductions:		(4,750.00)
Available Fund Balance as of Apr. 30, 2025	**$**	**3,500.00**

Fund Balance For Appropriative Pool Account 8368 - Tom Harder Contract		
Beginning Balance July 1, 2024:	$	20,577.61
Additions:		
Subtotal Additions:		-
Reductions:		
Invoices paid July 2024 - April 2025		-
Subtotal Reductions:		-
Available Fund Balance as of Apr. 30, 2025	**$**	**20,577.61**

Chino Basin Watermaster
Monthly Variance Report & Supplemental Schedules
For the period July 1, 2024 to April 30, 2025
(Unaudited)

Pool Services Fund Accounting – Cont.

Fund Balance for Agricultural Pool **Account 8467 - Legal Services (Held by AP)**		
Beginning Balance July 1, 2024*:	$	388,647.51
Reductions:		
Invoices paid July 2024 - April 2025		(127,800.00)
Subtotal Reductions:		(127,800.00)
Available Fund Balance as of Apr. 30, 2025	**$**	**260,847.51**

*Balance includes payments received totaling $262,832.38 for Settlement Agreement outstanding invoices issued Apr. 15, 2022 and Jun. 17, 2022.

Agricultural Pool Reserve Funds **As shown on the Combining Schedules**		
Beginning Balance July 1, 2024*:	$	818,112.17
Additions:		
YTD Interest earned on Ag Pool Funds FY 25		52,252.64
Transfer of Funds from AP to Special Fund for Legal Service Invoices		127,800.00
Total Additions:		180,052.64
Reductions:		
Legal service invoices paid July 2024 - April 2025		(127,800.00)
Subtotal Reductions:		(127,800.00)
Agricultural Pool Reserve Funds Balance as of Apr. 30, 2025:	**$**	**870,364.81**

*Balance includes payments of $102,245.10 and $42,025.61 received in FY 24 for outstanding invoices issued Sep. 9, 2022 and Apr. 20, 2023 for Ag Pool legal services, respectively.

Fund Balance For Agricultural Pool **Account 8470 - Meeting Compensation (Held by AP)**		
Beginning Balance July 1, 2024:	$	17,694.65
Additions:		
Budget Transfers[1]		30,000.00
Subtotal Additions:		30,000.00
Reductions:		
Compensation paid July 2024 - April 2025		(18,875.00)
Subtotal Reductions:		(18,875.00)
Available Fund Balance as of Apr. 30, 2025	**$**	**28,819.65**

[1] Transfer scheduled in April 16, 2025 per communication with OAP legal counsel.

Fund Balance For Agricultural Pool **Account 8471 - Special Projects (Held by AP)**		
Beginning Balance July 1, 2024:	$	51,643.00
Reductions:		
Invoices paid July 2024 - April 2025		(9,454.00)
Budget Transfers[1]		(30,000.00)
Subtotal Reductions:		(39,454.00)
Available Fund Balance as of Apr. 30, 2025	**$**	**12,189.00**

[1] Transfer scheduled in April 16, 2025 per communication with OAP legal counsel.

Chino Basin Watermaster

Monthly Variance Report & Supplemental Schedules
For the period July 1, 2024 to April 30, 2025
(Unaudited)

Watermaster Salary Expenses

The following table details the Year-To-Date (YTD) Actual Watermaster burdened salary costs compared to the FY 25 adopted budget. The "$ Over Budget" and the "% of Budget" columns are a comparison of the YTD actual to the annual budget. As of April 30th, the target budget percentage is generally 83%.

	Year to Date Actual	FY 24-25 Budget	$ Over / (Under) Budget	% of Budget
WM Salary Expense				
5901.1 · Judgment Admin - Doc. Review	50,624	93,860	(43,236)	53.9%
5901.3 · Judgment Admin - Field Work	1,716	11,860	(10,144)	14.5%
5901.5 · Judgment Admin - General	9,440	81,090	(71,650)	11.6%
5901.7 · Judgment Admin - Meeting	31,996	39,710	(7,714)	80.6%
5901.9 · Judgment Admin - Reporting	3,557	13,890	(10,333)	25.6%
5910 · Judgment Admin - Court Coord./Attendance	7,464	16,970	(9,506)	44.0%
5911 · Judgment Admin - Exhibit G	1,588	6,400	(4,812)	24.8%
5921 · Judgment Admin - Production Monitoring	1,002	5,440	(4,438)	18.4%
5931 · Judgment Admin - Recharge Applications	2,318	-	2,318	100.0%
5941 · Judgment Admin - Reporting	1,648	2,140	(492)	77.0%
5951 · Judgment Admin - Rules & Regs	1,682	11,260	(9,578)	14.9%
5961 · Judgment Admin - Safe Yield	46,485	9,510	36,975	488.8%
5971 · Judgment Admin - Storage Agreements	6,427	13,000	(6,573)	49.4%
5981 · Judgment Admin - Water Accounting/Database	75,884	108,290	(32,406)	70.1%
5991 · Judgment Admin - Water Transactions	4,703	5,330	(627)	88.2%
6011.11 · WM Staff - Overtime	6,786	18,000	(11,214)	37.7%
6011.10 · Admin - Accounting	184,438	278,330	(93,892)	66.3%
6011.15 · Admin - Building Admin	48,305	31,200	17,105	154.8%
6011.20 · Admin - Conference/Seminars	34,015	58,530	(24,516)	58.1%
6011.25 · Admin - Document Review	38,079	2,620	35,459	1453.4%
6011.50 · Admin - General	256,068	362,560	(106,492)	70.6%
6011.60 · Admin - HR	96,882	50,450	46,432	192.0%
6011.70 · Admin - IT	68,519	34,070	34,449	201.1%
6011.80 · Admin - Meeting	85,549	39,760	45,789	215.2%
6011.90 · Admin - Team Building	19,750	41,550	(21,800)	47.5%
6011.95 · Admin - Training (Give/Receive)	27,422	64,160	(36,738)	42.7%
6017· Temporary Services	24,229	26,040	(1,811)	93.0%
6201 · Advisory Committee	23,167	82,850	(59,683)	28.0%
6301 · Watermaster Board	73,855	83,910	(10,056)	88.0%
8301 · Appropriative Pool	91,324	67,280	24,044	135.7%
8401 · Agricultural Pool	26,326	66,000	(39,674)	39.9%
8501 · Non-Agricultural Pool	16,176	62,710	(46,534)	25.8%
6901.1 · OBMP - Document Review	25,991	95,290	(69,299)	27.3%
6901.3 · OBMP - Field Work	1,153	50,870	(49,717)	2.3%
6901.5 · OBMP - General	84,202	81,120	3,082	103.8%
6901.7 · OBMP - Meeting	29,573	80,360	(50,787)	36.8%
6901.9 · OBMP - Reporting	9,188	11,040	(1,852)	83.2%
7104.1 · PE1 - Monitoring Program	163,506	275,490	(111,984)	59.4%
7201 · PE2 - Comprehensive Recharge	64,278	71,750	(7,472)	89.6%
7301 · PE3&5 - Water Supply/Desalter	934	9,510	(8,576)	9.8%
7301.1 · PE5 - Reg. Supply Water Prgm.	840	9,510	(8,671)	8.8%
7401 · PE4 - MZ1 Subsidence Mgmt. Plan	1,759	14,040	(12,281)	12.5%
7501 · PE6 - Coop. Programs/Salt Mgmt.	9,876	9,510	366	103.9%
7501.1 · PE 7 - Salt Nutrient Mgmt. Plan	6,753	9,510	(2,757)	71.0%
7601 · PE8&9 - Storage Mgmt./Recovery	23,804	22,520	1,284	105.7%
Subtotal WM Staff Costs	**1,790,844**	**2,529,290**	**(738,446)**	**71%**
60184.1 · Administrative Leave	-	6,550	(6,550)	0.0%
60185 · Vacation	99,087	90,280	8,807	109.8%
60185.1 · Comp Time	8,069	-	8,069	100.0%
60186 · Sick Leave	39,009	79,450	(40,441)	49.1%
60187 · Holidays	79,737	99,330	(19,593)	80.3%
Subtotal WM Paid Leaves	**225,903**	**275,610**	**(49,707)**	**82%**
Total WM Salary Costs	**2,016,747**	**2,804,900**	**(788,153)**	**71.9%**

Engineering

The following table details the Year-To-Date (YTD) Actual Engineering costs compared to the FY 24 adopted budget. The "$ Over Budget" and the "% of Budget" columns are a comparison of the YTD actual to the annual budget. As of April 30th, the target budget percentage is generally 83%.

	Year to Date Actual	FY 24-25 Budget	$ Over / (Under) Budget	% of Budget
Engineering Services Costs				
5901.8 · Judgment Admin - Meetings-Engineering Services	$ -	$ 37,066	$ (37,066)	0.0%
5906.71 · Judgment Admin - Data Requests-CBWM Staff	45,580	101,048	(55,468)	45.1%
5906.72 · Judgment Admin - Data Requests-Non-CBWM Staff	38,411	37,008	1,403	103.8%
5925 · Judgment Admin - Ag Production & Estimation	22,992	31,096	(8,104)	73.9%
5935 · Judgment Admin - Mat'l Physical Injury Requests	1,488	39,452	(37,965)	3.8%
5945 · Judgment Admin - WM Annual Report Preparation	12,659	16,924	(4,266)	74.8%
5965 · Judgment Admin - Support Data Collection & Mgmt Process	-	39,659	(39,659)	0.0%
6206 · Advisory Committee Meetings-WY Staff	9,042	23,510	(14,468)	38.5%
6306 · Watermaster Board Meetings-WY Staff	21,633	23,510	(1,877)	92.0%
8306 · Appropriative Pool Meetings-WY Staff	16,767	23,510	(6,743)	71.3%
8406 · Agricultural Pool Meetings-WY Staff	11,720	23,510	(11,790)	49.9%
8506 · Non-Agricultural Pool Meetings-WY Staff	6,921	23,510	(16,589)	29.4%
6901.8 · OBMP - Meetings-WY Staff	39,449	37,066	2,383	106.4%
6901.95 · OBMP - Reporting-WY Staff	56,567	62,606	(6,039)	90.4%
6906 · OBMP Engineering Services - Other	59,079	51,440	7,639	114.8%
6906.1 · OBMP Watermaster Model Update	6,552	67,596	(61,044)	9.7%
6906.21 · State of the Basin Report	131,212	195,188	(63,977)	67.2%
7104.3 · Grdwtr Level-Engineering	184,319	254,627	(70,308)	72.4%
7104.8 · Grdwtr Level-Contracted Services	12,992	26,174	(13,183)	49.6%
7104.9 · Grdwtr Level-Capital Equipment	4,896	17,000	(12,104)	28.8%
7202 · PE2-Comp Recharge-Engineering Services	13,340	23,496	(10,156)	56.8%
7202.2 · PE2-Comp Recharge-Engineering Services	150,467	75,944	74,523	198.1%
7302 · PE3&5-PBHSP Monitoring Program	80,402	73,305	7,097	109.7%
7303 · PE3&5-Engineering - Other	3,855	16,180	(12,325)	23.8%
7306 · PE3&5-Engineering - Outside Professionals	-	6,500	(6,500)	0.0%
7402 · PE4-Engineering	209,680	281,239	(71,559)	74.6%
7402.10 · PE4-Northwest MZ1 Area Project	83,007	16,656	66,351	498.4%
7403 · PE4-Eng. Services-Contracted Services-InSar	27,677	39,600	(11,924)	69.9%
7406 · PE4-Engineering Services-Outside Professionals	28,346	38,600	(10,254)	73.4%
7408 · PE4-Engineering Services-Network Equipment	2,963	17,553	(14,590)	16.9%
7502 · PE6&7-Engineering	288,333	398,309	(109,976)	72.4%
7505 · PE6&7-Laboratory Services	48,482	61,242	(12,761)	79.2%
7510 · PE6&7-IEUA Salinity Mgmt. Plan	20,880	-	20,880	100.0%
7511 · PE6&7-SAWBMP Task Force-50% IEUA	3,577	27,067	(23,491)	13.2%
7517 · Surface Water Monitoring Plan-Chino Creek - 50% IEUA	24,140	33,574	(9,434)	71.9%
7520 · Preparation of Water Quality Mgmt. Plan	2,783	130,164	(127,381)	2.1%
7610 · PE8&9-Support 2020 Mgmt. Plan	-	32,584	(32,584)	0.0%
7614 · PE8&9-Support Imp. Safe Yield Court Order	462,974	768,963	(305,989)	60.2%
7615 · PE8&9-Develop 2025 Storage Plan	-	42,632	(42,632)	0.0%
Total Engineering Services Costs	**$ 2,133,182**	**$ 3,215,108**	**$ (1,081,926)**	**66.3%**

Legal

The following table details the YTD Brownstein Hyatt Farber Schreck (BHFS) expenses and costs compared to the FY 24 adopted budget. The "$ Over Budget" and the "% of Budget" columns are a comparison of the YTD actual to the annual budget. As of April 30th, the target budget percentage is generally 83%.

	Year to Date Actual	FY 24-25 Budget	$ Over / (Under) Budget	% of Budget
6070 · Watermaster Legal Services				
6071 · BHFS Legal - Court Coordination	$ 243,918	$ 144,040	$ 99,878	169.3%
6072 · BHFS Legal - Rules & Regulations	5,308	10,495	(5,187)	50.6%
6073 · BHFS Legal - Personnel Matters	295,602	28,150	267,452	1050.1%
6074 · BHFS Legal - Interagency Issues	-	40,536	(40,536)	0.0%
6077 · BHFS Legal - Party Status Maintenance	-	13,590	(13,590)	0.0%
6078 · BHFS Legal - Miscellaneous (Note 1)	142,474	177,240	(34,766)	80.4%
Total 6070 · Watermaster Legal Services	**687,302**	**414,051**	**273,251**	**166.0%**
6275 · BHFS Legal - Advisory Committee	11,454	27,764	(16,310)	41.3%
6375 · BHFS Legal - Board Meeting	58,886	88,704	(29,818)	66.4%
6375.1 · BHFS Legal - Board Workshop(s)	-	29,215	(29,215)	0.0%
8375 · BHFS Legal - Appropriative Pool	11,179	34,705	(23,526)	32.2%
8475 · BHFS Legal - Agricultural Pool	11,179	34,705	(23,526)	32.2%
8575 · BHFS Legal - Non-Ag Pool	11,179	34,705	(23,526)	32.2%
Total BHFS Legal Services	**103,877**	**249,798**	**(145,921)**	**41.6%**
6907.3 · WM Legal Counsel				
6907.31 · Archibald South Plume	-	12,565	(12,565)	0.0%
6907.32 · Chino Airport Plume	-	12,565	(12,565)	0.0%
6907.33 · Desalter/Hydraulic Control	-	38,680	(38,680)	0.0%
6907.34 · Santa Ana River Water Rights	1,972	21,405	(19,433)	9.2%
6907.36 · Santa Ana River Habitat	-	31,280	(31,280)	0.0%
6907.38 · Reg. Water Quality Cntrl Board	5,280	63,200	(57,920)	8.4%
6907.39 · Recharge Master Plan	87,479	14,270	73,209	613.0%
6907.41 · Prado Basin Habitat Sustainability	1,902	10,290	(8,389)	18.5%
6907.44 · SGMA Compliance	1,294	10,290	(8,996)	12.6%
6907.45 · OBMP Update	14,497	177,240	(162,743)	8.2%
6907.47 · 2020 Safe Yield Reset	76,390	80,190	(3,800)	95.3%
6907.48 · Ely Basin Investigation	5,633	64,890	(59,257)	8.7%
6907.49 · San Sevaine Basin Discharge	80,664	110,080	(29,416)	73.3%
6907.90 · WM Legal Counsel - Unanticipated	-	38,885	(38,885)	0.0%
Total 6907 · WM Legal Counsel	**275,110**	**685,830**	**(410,720)**	**40.1%**
Total Brownstein, Hyatt, Farber, Schreck Costs	**$ 1,066,290**	**$ 1,349,679**	**$ (283,389)**	**79.0%**

Chino Basin Watermaster
Monthly Variance Report & Supplemental Schedules
For the period July 1, 2024 to April 30, 2025
(Unaudited)

Optimum Basin Management Plan (OBMP)

The following table details the Year-To-Date (YTD) Actual OBMP costs compared to the FY 24 adopted budget. The "$ Over Budget" and the "% of Budget" columns are a comparison of the YTD actual to the annual budget. As of April 30th, the target budget percentage is generally 83%.

	Year to Date Actual	FY 24-25 Budget	$ Over / (Under) Budget	% of Budget
6900 · Optimum Basin Mgmt Plan				
6901.1 · OBMP - Document Review-WM Staff	$ 25,991	$ 95,294	$ (69,303)	27.3%
6901.3 · OBMP - Field Work-WM Staff	1,153	50,870	(49,717)	2.3%
6901.5 · OBMP - General-WM Staff	84,202	81,120	3,082	103.8%
6901.7 · OBMP - Meeting-WM Staff	29,573	80,360	(50,787)	36.8%
6901.8 · OBMP - Meeting-West Yost	39,449	37,066	2,383	106.4%
6901.9 · OBMP - Reporting-WM Staff	9,188	11,040	(1,852)	83.2%
6901.95 · OBMP - Reporting-West Yost	56,567	62,606	(6,039)	90.4%
Total 6901 · OBMP WM and West Yost Staff	**246,123**	**418,356**	**(172,233)**	**58.8%**
6903 · OBMP - SAWPA				
6903 · OBMP - SAWPA Group	15,984	15,990	(6)	100.0%
Total 6903 · OBMP - SAWPA	**15,984**	**15,990**	**(6)**	**100.0%**
6906 · OBMP Engineering Services				
6906.1 · OBMP - Watermaster Model Update	6,552	67,596	(61,044)	9.7%
6906.21 · State of the Basin Report	131,212	195,188	(63,977)	67.2%
6906 · OBMP Engineering Services - Other	59,079	51,440	7,639	114.8%
Total 6906 · OBMP Engineering Services	**196,842**	**314,224**	**(117,382)**	**62.6%**
6907 · OBMP Legal Fees				
6907.31 · Archibald South Plume	-	12,565	(12,565)	0.0%
6907.32 · Chino Airport Plume	-	12,565	(12,565)	0.0%
6907.33 · Desalter/Hydraulic Control	-	38,680	(38,680)	0.0%
6907.34 · Santa Ana River Water Rights	1,972	21,405	(19,433)	9.2%
6907.36 · Santa Ana River Habitat	-	31,280	(31,280)	0.0%
6907.38 · Reg. Water Quality Cntrl Board	5,280	63,200	(57,920)	8.4%
6907.39 · Recharge Master Plan	87,479	14,270	73,209	613.0%
6907.41 · Prado Basin Habitat Sustainability	1,902	10,290	(8,389)	18.5%
6907.44 · SGMA Compliance	1,294	10,290	(8,996)	12.6%
6907.45 · OBMP Update	14,497	177,240	(162,743)	8.2%
6907.47 · 2020 Safe Yield Reset	76,390	80,190	(3,800)	95.3%
6907.48 · Ely Basin Investigation	5,633	64,890	(59,257)	8.7%
6907.49 · San Sevaine Basin Discharge	80,664	110,080	(29,416)	73.3%
6907.90 · WM Legal Counsel - Unanticipated	-	38,885	(38,885)	0.0%
Total 6907 · OBMP Legal Fees	**275,110**	**685,830**	**(410,720)**	**40.1%**
6909 · OBMP Other Expenses				
6909.6 · OBMP Expenses - Miscellaneous	-	-	-	0.0%
Total 6909 · OBMP Other Expenses	**2,172**	**3,540**	**(1,368)**	**61.4%**
Total 6900 · Optimum Basin Mgmt Plan	**$ 736,231**	**$ 1,437,940**	**$ (701,709)**	**51.2%**

Judgment Administration

The following table details the Year-To-Date (YTD) Actual Judgment Administration costs compared to the FY 24 adopted budget. The "$ Over Budget" and the "% of Budget" columns are a comparison of the YTD actual to the annual budget. As of April 30th, the target budget percentage is generally 83%.

	Year to Date Actual	FY 24-25 Budget	$ Over / (Under) Budget	% of Budget
5901 · Admin-WM Staff				
5901.1 · Admin-Doc. Review-WM Staff	$ 50,624	$ 93,860	$ (43,236)	53.9%
5901.3 · Admin-Field Work-WM Staff	1,716	11,860	(10,144)	14.5%
5901.5 · Admin-General-WM Staff	9,440	81,090	(71,650)	11.6%
5901.7 · Admin-Meeting-WM Staff	31,996	39,710	(7,714)	80.6%
5901.8 · Admin-Meeting - West Yost	-	37,066	(37,066)	0.0%
5901.9 · Admin-Reporting-WM Staff	3,557	13,890	(10,333)	25.6%
Total 5901 · Admin-WM Staff	**97,333**	**277,476**	**(180,143)**	**35.1%**
5900 · Judgment Admin Other Expenses				
5906.71 · Admin-Data Req-CBWM Staff	45,580	101,048	(55,468)	45.1%
5906.72 · Admin-Data Req-Non CBWM Staff	38,411	37,008	1,403	103.8%
5910 · Court Coordination/Attend-WM	7,464	16,970	(9,506)	44.0%
5911 · Exhibit G-WM Staff	1,588	6,400	(4,812)	24.8%
5921 · Production Monitoring-WM Staff	1,002	5,440	(4,438)	18.4%
5925 · Ag Prod & Estimation-West Yost	22,992	31,096	(8,104)	73.9%
5931 · Recharge Applications-WM Staff	2,318	-	2,318	100.0%
5935 · Admin-Mat'l Phy Inj Requests	1,488	39,459	(37,972)	3.8%
5941 · Reporting-WM Staff	1,648	2,140	(492)	77.0%
5945 · WM Annual Report Prep-West Yost	12,659	16,924	(4,266)	74.8%
5951 · Rules & Regs-WM Staff	1,682	11,260	(9,578)	14.9%
5961 · Safe Yield-WM Staff	46,485	9,510	36,975	488.8%
5965 · Support Data Collect-West Yost	-	39,659	(39,659)	0.0%
5971 · Storage Agreements-WM Staff	6,427	13,000	(6,573)	49.4%
5981 · Water Acct/Database-WM Staff	75,884	108,290	(32,406)	70.1%
5991 · Water Transactions-WM Staff	4,703	5,330	(627)	88.2%
Total 5900 · Judgment Admin Other Expenses	**270,330**	**443,534**	**(173,204)**	**60.9%**
Total 5900 · Judgment Administration	**$ 367,664**	**$ 721,010**	**$ (353,346)**	**51.0%**

"Carry Over" Funding:

During the month of July 2023, the "Carry Over" funding was calculated. The Total "Carry Over" funding amount of $2,277,561.54 has been posted to the general ledger accounts. The total amount consisted of $870,226.24 from Engineering Services, $816,709.78 from Capital Improvement Projects, $464,627.66 from OBMP Activities, $111,461.18 from Pool Funding Accounts, and $14,536.68 from Administration Services. More detailed information is provided in the table below.

Carry Over Budget Detail - FY 23/24

Description		Amount	Account	Fiscal Year	Type
Other Office Equipment - Boardroom Upgrades	$	10,037.93	6038	FY 2020/21	ADMIN
Board Workshop Expenses - Misc.		4,498.75	6375.2	FY 2021/22	ADMIN
Meter Installation - New Meter Installation		175,400.00	7540	FY 2018/19	OBMP
Meter Installation - Calibration and Testing		181,650.00	7545	FY 2018/19	OBMP
2022 OBMP Update - Dodson & Asso.		107,577.66	6908.1	FY 2022/23	OBMP
Watermaster Model Update		34,206.75	5906.1	FY 2022/23	ENG
Groundwater Level Monitoring Program		2,700.00	7104.3	FY 2022/23	ENG
PE2 - Comprehensive Recharge - Eng. Services		27,943.64	7202.2	FY 2020/21	ENG
PE2 - Comprehensive Recharge - Eng. Services		18,441.85	7202.2	FY 2021/22	ENG
PE2 - Comprehensive Recharge - Eng. Services		72,788.26	7202.2	FY 2022/23	ENG
SB88-Specs-Ensure Compliance-50% IEUA		54,012.38	7208	FY 2020/21	ENG
OBMP - 2023 RMPU		60,000.00	7210	FY 2022/23	ENG
Integrated Model - Meetings - 50% IEUA Costs		24,617.63	7220	FY 2021/22	ENG
PBHSP - Monitoring, Data Analysis, Reporting		21,000.00	7302	FY 2022/23	ENG
OBMP - Engineering Services		65,208.75	7402	FY 2022/23	ENG
PE4 - Northwest MZ-1 Area Project		23,805.91	7402.1	FY 2021/22	ENG
PE4 - Northwest MZ-1 Area Project		126,194.09	7402.1	FY 2022/23	ENG
PE4/MZ-1: InSAR - Outside Pro		85,000.00	7403	FY 2022/23	ENG
Ground Level Monitoring - Capital Equipment		5,000.00	7408	FY 2022/23	ENG
PE6-7: Coop Efforts/Salt Management:		40,000.00	7502	FY 2022/23	ENG
Groundwater Quality Monitoring Program		16,194.00	7505	FY 2022/23	ENG
Hydraulic Control Mitigation Plan Update-50% IEUA		9,687.25	7508	FY 2021/22	ENG
Hydraulic Control Mitigation Plan Update-50% IEUA		1,016.00	7508	FY 2022/23	ENG
IEUA - Update Recycle Water Permit - Salinity		19,752.23	7510	FY 2021/22	ENG
PE8&9 - Support Imp. 2020 Storage Mgmt. Plan		42,657.50	7610	FY 2020/21	ENG
Support Implementation of the Safe Yield Court Order:		120,000.00	7614	FY 2022/23	ENG
Upper Santa Ana River HCP (TO #7)		15,062.88	7690.7	FY 2014/15	PROJ
Upper Santa Ana River HCP (TO #7)		5,000.00	7690.7	FY 2015/16	PROJ
Lower Day Basin RMPU (TO #2)		238,646.90	7690.8	FY 2016/17	PROJ
Jurupa Basin Berm & Trash Boom		358,000.00	7690.23	FY 2022/23	PROJ
Funds on Hold for Projects/Refund		200,000.00	7690.9	FY 2017/18	PROJ
Agricultural Pool - Legal Services		41,675.63	8467	FY 2022/23	AP
Agricultural Pool - Mtg. Attendance Compensation		950.98	8470	FY 2022/23	OAP
Agricultural Pool - Special Project Funding		10,993.67	8471	FY 2021/22	OAP
Non-Agricultural Pool - Meeting Compensation		875.00	8511	FY 2022/23	ONAP
Non-Agricultural Pool - Legal Services		56,965.90	8567	FY 2022/23	ONAP
Balance at 7/31/23	**$**	**2,277,561.54**			

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888 www.cbwm.org

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Application: Water Transaction – 1,000 AF from Santa Ana River Water Company to Fontana Water Company (Consent Calendar Item I.C.)

Issue: The purchase of 1,000 acre-feet of water from Santa Ana River Water Company by Fontana Water Company. This purchase is made from Santa Ana River Water Company's Annual Production Right. [Within WM Duties and Powers]

Recommendation: Approve the proposed transaction.

Financial Impact: None.

ACTIONS:
Appropriative Pool – May 8, 2025 [Final]: Provided advice and assistance.
Non-Agricultural Pool – May 8, 2025 [Final]: Provided advice and assistance.
Agricultural Pool – May 8, 2025 [Final]: Provided advice and assistance.
Advisory Committee – June 19, 2025 [Final]: Provided advice and assistance.
Watermaster Board – June 26, 2025 [Recommended]: Approval.

BACKGROUND

On July 13, 2000, the Court approved the Peace Agreement, the Implementation Plan, and the goals and objectives identified in the OBMP Phase I Report and ordered Watermaster to proceed in a manner consistent with the Peace Agreement. Under the Peace Agreement, Watermaster approval is required for applications to store, recapture, recharge, or transfer water, as well as for applications for credits or reimbursements, and storage and recovery programs.

Where there is no Material Physical Injury, Watermaster must approve the transaction. Where the request for Watermaster approval is submitted by a Party to the Judgment, there is a rebuttable presumption, under the Section 5.2 of the Peace Agreement, that most of the transactions do not result in Material Physical Injury to a Party to the Judgment or the Basin (Storage and Recovery Programs do not have this presumption).

The date of this application is April 14, 2025. Notice of the transaction along with the materials submitted by the requestors was transmitted to stakeholders electronically on May 2, 2025.

DISCUSSION

Beyond confirmation of the source of the water to be transferred (Annual Production Right, Supplemental Water, or Excess Carryover), Watermaster will evaluate the eventual disposition of the transferred water (e.g. production, storage, etc.) at the end of the production year and account for the same consistent with the Watermaster Guidance Documents.

Water transactions occur each year and are included as production by the respective entity (if produced) in any relevant analysis conducted by West Yost pursuant to the Peace Agreement and the Rules & Regulations. There is no indication that additional analysis regarding this transaction is necessary at this time. As part of the OBMP Implementation Plan, measurement of groundwater levels and ground level changes are ongoing, and based on current data, there is no indication that the proposed water transaction will cause Material Physical Injury to a Party to the Judgment, or to the Basin.

Pursuant to the Rules & Regulations, “The Application shall not be considered by the Advisory Committee until at least twenty-one (21) days after the last of the three Pool Committee meetings to consider the matter.” Therefore, this application will be presented to the Advisory Committee and Watermaster Board in the month of June 2025.

At the Pool Committee meetings held on May 8, 2025, the Appropriative and Overlying (Agricultural) Pools unanimously recommended Advisory Committee to recommend to the Watermaster Board to approve the proposed transaction; the Overlying (Non-Agricultural) Pool unanimously recommended its representatives to support at Advisory Committee and Watermaster Board subject to changes they deem appropriate. On June 19, 2025, the proposed transaction was presented to the Advisory Committee for consideration. The Advisory Committee unanimously recommended the Watermaster Board to approve the proposed transaction.

ATTACHMENTS
1. Consolidated Forms 3, 4, & 5
2. Notice Forms

CONSOLIDATED WATER TRANSFER FORMS:
FORM 3: APPLICATION FOR SALE OR TRANSFER OF RIGHT TO PRODUCE WATER FROM STORAGE
FORM 4: APPLICATION OR AMENDMENT TO APPLICATION TO RECAPTURE WATER IN STORAGE
FORM 5: APPLICATION TO TRANSFER ANNUAL PRODUCTION RIGHT OR SAFE YIELD

FISCAL YEAR 2024 - 2025

DATE REQUESTED: 4/14/2025 **AMOUNT REQUESTED:** 1,000.00 Acre-Feet

TRANSFER FROM (SELLER / TRANSFEROR):	TRANSFER TO (BUYER / TRANSFEREE):
Santa Ana River Water Company	Fontana Water Company
Name of Party	Name of Party
10530 54th Street	15966 Arrow Route
Street Address	Street Address
Jurupa Valley CA 91752	Fontana CA. 92335
City State Zip Code	City State Zip Code
(951) 685-6503	(909) 822-2201
Telephone	Telephone
	(909) 823-5046
Facsimile	Facsimile

Have any other transfers been approved by Watermaster between these parties covering the same fiscal year? Yes ☐ No ☒

PURPOSE OF TRANSFER:

- ☐ Pump when other sources of supply are curtailed
- ☒ Pump to meet current or future demand over and above production right
- ☐ Pump as necessary to stabilize future assessment amounts
- ☐ Other, explain ______

WATER IS TO BE TRANSFERRED FROM:

- ☐ Annual Production Right (Appropriative Pool) or Operating Safe Yield (Non-Agricultural Pool)
- ☐ Storage
- ☒ Annual Production Right / Operating Safe Yield first, then any additional from Storage
- ☐ Other, explain ______

WATER IS TO BE TRANSFERRED TO:

- ☒ Annual Production Right / Operating Safe Yield (common)
- ☐ Storage (rare)
- ☐ Other, explain ______

IS THE 85/15 RULE EXPECTED TO APPLY? (If yes, all answers below must be "yes.") **Yes ☒ No ☐**

Is the Buyer an 85/15 Party? Yes ☒ No ☐

Is the purpose of the transfer to meet a current demand over and above production right? Yes ☒ No ☐

Is the water being placed into the Buyer's Annual Account? Yes ☒ No ☐

IF WATER IS TO BE TRANSFERRED FROM STORAGE:

Varies	2024-2025
Projected Rate of Recapture	Projected Duration of Recapture

METHOD OF RECAPTURE (e.g. pumping, exchange, etc.):

Pumping

PLACE OF USE OF WATER TO BE RECAPTURED:

Chino Basin Management Zone 3

LOCATION OF RECAPTURE FACILITIES (IF DIFFERENT FROM REGULAR PRODUCTION FACILITIES):

N/A

WATER QUALITY AND WATER LEVELS

Are the Parties aware of any water quality issues that exist in the area? Yes ☒ No ☐

If yes, please explain:

In 2024, perchlorate and nitrate levels ranged as high as 5.2 ppb and 8.6 ppm respectively.

What are the existing water levels in the areas that are likely to be affected?

Static Water Levels ranging from 317 feet (bgs) to 677 feet (bgs) as of February 2025.

MATERIAL PHYSICAL INJURY

Are any of the recapture wells located within Management Zone 1? Yes ☐ No ☒

Is the Applicant aware of any potential Material Physical Injury to a party to the Judgment or the Basin that may be caused by the action covered by the application? Yes ☐ No ☒

If yes, what are the proposed mitigation measures, if any, that might reasonably be imposed to ensure that the action does not result in Material Physical Injury to a party to the Judgment or the Basin?

N/A

SAID TRANSFER SHALL BE CONDITIONED UPON:

(1) Transferee shall exercise said right on behalf of Transferor under the terms of the Judgment, the Peace Agreement, the Peace II Agreement, and the Management Zone 1 Subsidence Management Plan for the period described above. The first water produced in any year shall be that produced pursuant to carry-over rights defined in the Judgment. After production of its carry-over rights, if any, the next (or first if no carry-over rights) water produced by Transferee from the Chino Basin shall be that produced hereunder.

(2) Transferee shall put all waters utilized pursuant to said Transfer to reasonable beneficial use.

(3) Transferee shall pay all Watermaster assessments on account of the water production hereby Transferred.

(4) Any Transferee not already a party must Intervene and become a party to the Judgment.

ADDITIONAL INFORMATION ATTACHED Yes ☐ No ☒

Seller / Transferor Representative Signature	Buyer / Transferee Representative Signature
John Lopez, General Manager	Martin Zvirbulis, Vice President - Water Resources
Seller / Transferor Representative Name (Printed)	Buyer / Transferee Representative Name (Printed)

TO BE COMPLETED BY WATERMASTER STAFF:

DATE OF WATERMASTER NOTICE: May 2, 2025

DATE OF APPROVAL FROM APPROPRIATIVE POOL: May 8, 2025

DATE OF APPROVAL FROM NON-AGRICULTURAL POOL: May 8, 2025

DATE OF APPROVAL FROM AGRICULTURAL POOL: May 8, 2025

HEARING DATE, IF ANY: N/A

DATE OF ADVISORY COMMITTEE APPROVAL: June 19, 2025

DATE OF BOARD APPROVAL: ____________

July 2009

CHINO BASIN WATERMASTER

NOTICE

OF

APPLICATION(S)

RECEIVED FOR

TRANSFER OF WATER

Date of Notice:

May 2, 2025

This notice is to advise interested persons that the attached application(s) will come before the Watermaster Board on or after 30 days from the date of this notice.

APPLICATION FOR TRANSFER OF WATER

The attached staff report will be included in the meeting package at the time the transfer begins the Watermaster process.

NOTICE OF APPLICATION(S) RECEIVED

Date of Application: **April 14, 2025** Date of this notice: **May 02, 2025**

Please take notice that the following Application has been received by Watermaster:

- Notice of Sale or Transfer – The purchase of 1,000 acre-feet of water from Santa Ana River Water Company by Fontana Water Company. This purchase is made from Santa Ana River Water Company's Annual Production Right.

This ***Application*** will first be considered by each of the respective pool committees on the following dates:

Appropriative Pool:	May 08, 2025
Non-Agricultural Pool:	May 08, 2025
Agricultural Pool:	May 08, 2025

This ***Application*** will be scheduled for consideration by the Advisory Committee ***no earlier than thirty days from the date of this notice and a minimum of twenty-one calendar days*** after the last pool committee reviews it***.***

After consideration by the Advisory Committee, the ***Application*** will be considered by the Board.

Unless the ***Application*** is amended, as ***Contests*** must be submitted a minimum of fourteen (14) days prior to the Advisory Committee's consideration of an ***Application,*** parties to the Judgment may file ***Contests*** to the ***Application*** with Watermaster ***within seven calendar days*** of when the last pool committee considers it. Any ***Contest*** must be in writing and state the basis of the ***Contest***.

Watermaster address:

Chino Basin Watermaster
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

Tel: (909) 484-3888
Web: www.cbwm.org
watertransactions@cbwm.org

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888 www.cbwm.org

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Professional Services Agreement Between Applied Computer Technologies and Chino Basin Watermaster (Consent Calendar I.D.)

Issue: Watermaster intends to renew the annual professional services agreement with Applied Computer Technologies to provide continuing software development and database administration services. Applied Computer Technologies has been providing services to Watermaster since 2001. [Normal Course of Business]

Recommendation: Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

Financial Impact: The FY 2025/26 budget (which includes account number 6052.2 in the amount of $91,000) was adopted by the Board on May 22, 2025. The contract expenses of $175/hour have been funded within the FY 2025/26 budget.

ACTIONS:
Watermaster Board – June 26, 2025 [Recommended]: Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

BACKGROUND

In the normal course of business, Chino Basin Watermaster (Watermaster) maintains many databases. The following is a listing of those databases and their functions:

1. Administration Database
   a. Records of all documents we have in storage in the Annex.
   b. Records of all Motions and Resolutions.
   c. Generates annual mailing labels.

2. Assessment Package Database
   a. Creates the annual Assessment Package.
   b. Linked to Production Database.
   c. Tracks Water Transactions, transfers, purchases, etc.

3. Production Database
   a. Tracks production from all parties.
   b. Contains records of parties and their contact information.
   c. Tracks Assignments, Voluntary Agreements, and other transfers.
   d. Records of wells, their owners and users, and the meters.
   e. Generates quarterly/annual production request forms.

4. Tasks Database
   a. Used as the basis for the SharePoint's Task and Obligations.

5. Human Resources Database
   a. HR related employee information.
   b. Job descriptions.

6. Recharge Database
   a. Tracks all recharge by basin and source.
   b. Generates monthly reports for meetings.

Watermaster does not currently have an employee on staff with the special qualifications needed to maintain and develop the number of databases used by Watermaster. Watermaster utilizes specialized consultants when needed to fill in the operational gaps since Watermaster intentionally employs a small number of full-time employees. As a result, Watermaster uses Applied Computer Technologies for software development and database administration services. Applied Computer Technologies provides specialized services such as application development and support, application interface development, SQL database administration, SharePoint programming and support, SSRS report development, system interface development, and other technologies as needed.

Watermaster has received innovative services from Applied Computer Technologies since 2001 and plans to continue the professional working relationship.

DISCUSSION

During the annual budget development cycle, Watermaster staff worked with Applied Computer Technologies to review the ongoing services required, along with developing the upcoming budget and ensure proper funding of the database administration services is included. For FY 2025/26, Watermaster intends to enter another one-year professional services agreement with Applied Computer Technologies (Attachment 1). A formal contract for each fiscal year will memorialize the description of responsibilities, cost, and schedule, and provide legal protection should disputes arise. Additionally, it will aid in clearly identifying this annual budgeted cost.

The software development and SQL database administrator services scope of work for July 1, 2025 to June 30, 2026 are shown in the Scope of Work (Addendum A) – (Attachment 2). As indicated above, the budget of $175/hour for the estimated costs for the FY 2025/26 ongoing services have been included in the Committee approved and Board adopted FY 2025/26 budget.

ATTACHMENTS
1. Professional Services Agreement
2. Scope of Work (Addendum A)

CONSULTING SERVICES AGREEMENT

This Consulting Services Agreement ("Agreement") is entered into by and between the Chino Basin Watermaster (the "Watermaster") and Applied Computer Technologies ("Consultant," and together with the Watermaster, the "Parties"), effective as of the 1st day of July, 2025 (the "Effective Date").

1. Term of Agreement. This Agreement will become effective as of the Effective Date. This Agreement will terminate on June 30, 2026 or prior to that time in accordance with Section 5 of this Agreement. (The period during which this Agreement is in effect, including any extensions agreed upon by the Parties, is referred to as the "Term.")

2. Services. The Watermaster and Consultant agree that, during the Term, Consultant will provide the services set forth in the Scope of Work attached as Addendum A to this Agreement, as it may be modified from time to time in writing (the "Services"). The Parties acknowledge that the Services are outside the normal scope of the Watermaster's Business (as defined below), and that Consultant is customarily engaged in providing such Services to third parties such as the Watermaster. Consultant will coordinate with Todd Corbin as Consultant's Watermaster contact (the "Watermaster Contact").

3. Compensation and Terms of Payment.

    a. Compensation for Services. In compensation for the Services, Watermaster will pay Consultant $175/hour (the "Fees").

    b. Expenses. Consultant will be responsible for any and all expenses that may be incurred in performing the Services, including all direct and indirect costs, insurance (including professional liability insurance), fees and costs for business and professional licenses and credentialing, mileage and overhead, except as otherwise expressly agreed in writing by the Watermaster in advance with respect to particular expenses ("Expenses").

    c. Method of Payment.

        i. Consultant must submit monthly invoices to the Watermaster for Fees and Expenses incurred to that date. The monthly invoices must include an accurate and detailed summary of the Services performed and the billable hours spent on each task, itemization of any reimbursable Expenses, and documentation and receipts acceptable to the Watermaster supporting any such Expenses or Fees.

        ii. The Watermaster Contact will verify the Services, Fees and Expenses detailed on the invoice and will confirm that the Services described therein have been satisfactorily completed and that appropriate documentation has been provided.

        iii. The Watermaster will make a reasonable effort to pay undisputed invoiced amounts within thirty (30) calendar days. The Watermaster will communicate with Consultant regarding any disputed amounts or amounts as to which inadequate documentation has been provided by Consultant.

iv. The Watermaster reserves the right to withhold payment for Fees and Expenses relating to Services that are not completed as scheduled, are completed unsatisfactorily, are behind schedule, are otherwise performed in an inadequate or untimely fashion, or are not properly documented, each as determined by the Watermaster, with such payments to be released and paid to Consultant promptly if and when the Services are determined by the Watermaster to be satisfactorily completed and properly documented. The Watermaster also reserves the right to withhold payment upon termination of this Agreement in the event Consultant threatens not to comply or fails to comply with its obligations (including post-Term obligations) and/or breaches or threatens to breach this Agreement in any material respect, as determined by the Watermaster.

4. Affirmation of Independent Contractor Status.

a. Independent Contractor. The Watermaster and Consultant each expressly understand, agree and intend that Consultant is an independent contractor in the performance of each and every part of this Agreement, and is solely responsible for all costs and expenses arising in connection with the performance of the Services, except as expressly set forth herein. Consultant is responsible for obtaining any business permits or licenses required to enable it to operate as an independent contractor and perform the Services. All Services are to be performed solely at the risk of Consultant, and Consultant agrees to take all precautions necessary for the proper performance of the Services. Consultant is solely responsible for any and all claims, liabilities or damages or debts of any type whatsoever that may arise on account of the activities of Consultant and its agents. Consultant has and retains control of, and supervision over, the performance of its obligations hereunder, including scheduling and day-to-day control over the performance of the Services, and except as expressly provided herein, the Watermaster will have no right to exercise any control whatsoever over the activities or operations of Consultant. Notwithstanding the foregoing, however, Consultant may not subcontract all or any portion of the performance of the Services, assign performance of the Services to any entity(ies) or individual(s), or assign any former employee or contractor of the Watermaster to perform the Services, unless, in any such case, the Watermaster has provided its prior express written approval.

b. Taxes and Related Matters. Consultant will be solely responsible for all tax and other government-imposed responsibilities relating to the performance of the Services, including payment of all applicable federal, state, local and social security taxes, unemployment insurance, workers' compensation and self-employment or other business taxes and licensing fees. Consultant will be solely responsible for payment of all compensation owed to its agents with respect to the Services, including all applicable federal, state and local employment taxes, and will make deductions for all taxes and withholdings required by law. Except as required by applicable law, no federal, state or local taxes of any kind will be withheld or paid by the Watermaster on behalf Consultant and/or its agents. Consultant acknowledges that the compensation paid pursuant to this Agreement will not be considered "wages" for purposes of the Federal Insurance Contributions Act ("FICA"), unemployment or other taxes. Consultant does not (i) provide management services to the Watermaster or (ii) hold a position as a corporate director or a similar position for the Watermaster. Consultant represents to the

Watermaster that it is not subject to the statutory provisions of Section 409A of the Internal Revenue Code of 1986, as amended (the "Code") and any Treasury Regulations and other interpretive guidance issued thereunder (collectively "Section 409A") because Consultant satisfies the requirements of Treasury Regulation 1.409A-1(f)(2) (the exception to the general definition of "service provider" for certain independent contractors). The Watermaster will issue Consultant an IRS Form 1099 with respect to payments made under this Agreement, and Consultant must promptly provide to the Watermaster a completed IRS Form W-9 and other documentation as may be needed from time to time by the Watermaster. Consultant will be responsible for performing all payroll and record-keeping functions required by law. The compensation provided hereunder is not intended to constitute "nonqualified deferred compensation" within the meaning of Section 409A. No provision of this Agreement will be interpreted or construed to transfer any tax, interest, income inclusion, penalty, or other liability arising from or relating to any liability or obligation imposed on Consultant under the Code or any damages relating to or arising therefrom, including without limitation any tax, interest, income inclusion, penalty, other liability, or damages of Consultant arising from or relating to any liability for failure to comply with any applicable tax obligations, including failure to comply with the requirements of Section 409A, from Consultant or any other individual to the Watermaster.

c. <u>No Employee Benefits from the Watermaster</u>. As an independent contractor, neither Consultant nor its agents will be eligible for benefits from the Watermaster or any related entity, including workers' compensation, unemployment insurance, expense reimbursement, health, dental, vision, life or disability insurance, paid holidays, paid sick leave, vacation or other paid time off, pension or 401(k) plans, educational assistance, continuing education reimbursement, or any other employee benefit that may be offered now or in the future.

d. <u>No Third-Party Beneficiaries</u>. This Agreement is between the Watermaster and Consultant, and creates no individual rights for any agents of Consultant. No agent of Consultant will be deemed to be a third-party beneficiary hereunder, nor will any agent of Consultant be deemed to have any employment or contractual relationship with the Watermaster as a result of this Agreement or his, her or its performance of services for Consultant, including the Services contemplated under this Agreement. The Parties acknowledge that all individuals performing Services on behalf of Consultant are solely the employees and/or agents of Consultant. The Watermaster will not be responsible for payments due and owing to any subcontractors or other agents of Consultant; provided, however, that in the event Consultant fails timely to pay any such agents, if the Watermaster deems it appropriate to make payments directly to any such agents on behalf of Consultant, notwithstanding that it may have no legal obligation to do so, Consultant will reimburse the Watermaster therefor, and the Watermaster may offset any amounts due and owing to Consultant by any amounts it has paid to any such agents of Consultant.

5. <u>Termination of Agreement</u>. This Agreement will expire at the end of the Term, unless earlier terminated as follows:

a. <u>Termination upon Written Notice</u>. Either Party may terminate this Agreement during the Term by providing the other Party with thirty (30) days' written notice of such termination or with any shorter notice period upon which the Parties may agree. The Watermaster may, in its sole discretion, provide compensation in lieu of all or a portion of the notice period, regardless of who initiates the termination, prorating the fees as appropriate. Payment in lieu of notice will be calculated by averaging the fees received during the prior three- (3-) month period (or such lesser number of months as this Agreement has been in effect) and pro-rating as appropriate.

b. <u>Termination for Cause by the Watermaster</u>. The Watermaster may terminate this Agreement immediately for "Cause." Cause includes, but is not be limited to, the following, as determined in the Watermaster's sole discretion: (i) failure of Consultant or its agents to comply in any material respect with this Agreement, including failure to perform the Services in a satisfactory manner, breach of any other agreement between the Parties, or violation of any applicable Watermaster policy, procedure or guideline, including the Watermaster's policy against harassment; (ii) serious personal or professional misconduct by Consultant or its agents (including, but not limited to, dishonesty, fraud, misappropriation, criminal activity or gross or willful neglect of duty); (iii) breach or threatened breach of Consultant's duties to the Watermaster (including theft or misuse of Watermaster property or time) by Consultant or its agents; (iv) conduct that threatens public health or safety, or threatens to do immediate or substantial harm to the Watermaster's Business (as defined below), including potentially subjecting the Watermaster to civil or criminal liability; (v) falsification by Consultant or its agents of any business-related document, including invoices, or the making of any materially false or misleading statement by Consultant or its agents to or in connection with the Watermaster; (vi) an investigation that could have an adverse impact on the Watermaster is commenced with respect to Consultant and/or its agents by a regulatory agency or governmental agency; (vii) failure or refusal of Consultant or its agents to submit to legally-permissible drug screening, testing and/or medical examinations; (viii) the professional license(s), and/or qualifications of Consultant and/or its agents deemed necessary by the Watermaster to perform the Services (if applicable) are not maintained or renewed, or are revoked or suspended by an authorized regulatory agency; (ix) any other willful or substantial misconduct, deficiency, failure of performance, breach or default by Consultant or its agents, including failing to provide Services for any reason on multiple occasions when requested by the Watermaster; or (x) in the event of the discontinuance of the Watermaster's business. The Watermaster's exercise of its right to terminate for Cause will be without prejudice to any other remedy to which it may be entitled at law, in equity, or under this Agreement. In the event of termination for Cause by the Watermaster, the only compensation due to Consultant will be payment of Fees incurred up to the date of termination and outstanding reimbursable Expenses, less appropriate offsets and any applicable Penalty (as defined below). In the event the Watermaster terminates this Agreement for Cause, it will be entitled to recover a penalty (the "Penalty") from Consultant in the amount of thirty (30) days' compensation (calculated as set forth below), which Penalty may be deducted from and offset against outstanding compensation due to Consultant.

c. <u>Penalty for Failure to Provide Notice</u>. In the event either Party fails to provide notice of termination as required under this Agreement, the other Party will be entitled to recover a Penalty in the amount of the compensation that would have been due for the length of the notice period that was not provided. By way of example, if the Watermaster failed to provide any notice to Consultant and terminated this Agreement without Cause, then Consultant would be entitled to recover a Penalty from the Watermaster in the amount of thirty (30) days' compensation. The Penalty amount will be calculated by averaging the fees received during the prior three- (3-) month period (or such lesser number of months as this Agreement has been in effect) and pro-rating as appropriate.

6. Obligations of Consultant.

a. Best Abilities; Good Workmanship; Time of the Essence. Consultant understands that time is of the essence with respect to the performance of the Services. Consultant will proceed with diligence and the Services will be performed in accordance with the highest professional workmanship, service and ethical standards in the field and to the satisfaction of the Watermaster. If Consultant's workmanship does not conform to these standards, in the Watermaster's subjective judgment and discretion, and the Watermaster so notifies Consultant, Consultant agrees immediately to take all action necessary to remedy the nonconformance. Any costs incurred by Consultant to correct such nonconformance will be at Consultant's sole expense. To the extent Consultant fails to correct such nonconformance to the Watermaster's satisfaction, or the Watermaster deems Consultant incapable of correcting such nonconformance to the Watermaster's satisfaction, the Watermaster may elect to have a third party (including a subcontractor of Consultant) correct such nonconformance at Consultant's sole expense.

b. Use of Artificial Intelligence. Neither Consultant nor its agents may utilize artificial intelligence (AI), computer-generated preparation of documents or similar technology in performing the Services without, in each particular instance, the prior written consent of the Watermaster.

c. Compliance with Law and Policies. Consultant and its agents will comply with all federal, state and local laws, rules and regulations applicable to them, including the Occupational Safety and Health Act ("OSHA"), non-discrimination laws, immigration law and work authorization requirements, tax and withholding obligations, and wage and hour requirements (including those related to classification of employees and payment of minimum wage and overtime), in the performance of the Services. Consultant will be responsible for providing, at Consultant's expense, and in Consultant's name, all licenses and permits usual or necessary for conducting the Services. Consultant and its agents also will comply with other Watermaster policies that may be applicable to them, as they may be modified from time to time, including the Watermaster's policies against harassment and discrimination.

d. Qualifications. Consultant and its agents understand that the Watermaster may elect to conduct background screening, and drug screening with respect to Consultant and/or its agents, and that satisfactory completion of the same is a material condition of this Agreement. In addition, during the Term, Consultant will continuously maintain in good standing any qualifications necessary to perform the Services (including as set forth on Addendum A), and will cause its agents to do the same. Consultant and its agents must keep all licensure/certification records fully up to date with the Watermaster, including promptly reporting to the Watermaster any revocation, suspensions, restrictions, censures, or investigations.

e. <u>Equipment; Use of Watermaster Technology</u>. In general, Consultant will be responsible for providing its own supplies, equipment and work location(s). However, to facilitate performance of the Services, Consultant and/or its agents may be provided with certain equipment by the Watermaster. In addition, to facilitate performance of the Services and communications with Watermaster representatives, agents and customers, and to ensure appropriate security levels, confidentiality and privacy protection and document retention procedures, Consultant and/or its agents may be provided with (i) a Watermaster email address, (ii) access to select areas of the Watermaster's computer system, data, files and/or premises, and (iii) access authority and login information with respect to select Watermaster accounts. To the extent Consultant and/or its agents are provided with a Watermaster email address, the applicable signature block must be approved by the Watermaster and must clearly indicate Consultant's status with respect to the Watermaster. Consultant and its agents will be subject to applicable Watermaster policies relating to usage of Watermaster equipment and systems, as more particularly set forth on Addendum C. To the extent non-Watermaster equipment, systems, devices and/or accounts are used, Consultant will take all reasonable steps to ensure the security of data on or in such equipment, devices, systems and accounts, including using encryption where appropriate and/or required by applicable law.

f. <u>Insurance</u>. The Watermaster will not procure liability or other insurance on behalf of Consultant or its agents, ***except that*** the Watermaster may procure professional liability insurance coverage on its own behalf with respect to Consultant's performance of the Services. Consultant and its agents will assist the Watermaster in procuring any such insurance by submitting to examinations and signing such applications and other instruments as may be required by the insurance carriers to which application is made for such insurance. Procurement of all appropriate insurance coverage for Consultant and/or its agents is the sole responsibility of Consultant. Promptly upon request, Consultant will provide the Watermaster with certificates of insurance evidencing coverage for workers' compensation, unemployment insurance, Comprehensive General Liability insurance, professional liability insurance and motor vehicle insurance, to include provisions for property damage, personal injury and automobile liability, to the extent applicable to Consultant. Such insurance must be in amounts satisfactory to the Watermaster and may not be reduced or canceled without the Watermaster's written approval of such reduction or cancellation. Any insurance maintained by Consultant and/or its agents will be primary insurance to the full approved limits of liability and, should the Watermaster have other valid insurance, such insurance will be excess insurance only. The Watermaster, however, is not required to, and may or may not, include Consultant and/or its agents as additional insureds under any policy the Watermaster maintains on its own behalf, unless otherwise required by applicable law or the terms of the Watermaster's existing insurance policies.

g. <u>Non-Contravention; No Improper Use of Materials</u>. Consultant represents and warrants that it has all right, power, authority and capacity and is free to enter into this Agreement. Consultant further represents that, by entering into this Agreement, neither Consultant nor its agents will violate or interfere with the rights of any other person or entity. Consultant represents and warrants that neither it nor its agents are subject to any contract, restrictive covenants, non-compete obligations, understandings or other commitments of any kind that will or might prevent, interfere with or impair Consultant's acceptance of this Agreement and/or the performance of the Services. Consultant confirms that it has identified on Addendum B any and all restrictions to which Consultant and its agents who will perform the Services are subject (including restrictive covenants and non-compete obligations) in order to allow the Watermaster the opportunity to assess any such restrictions and their potential impact on the Watermaster and the performance of the Services. Neither Consultant nor its agents will enter into any agreements inconsistent with this Agreement. Consultant further certifies that neither it nor its agents will utilize or disclose any confidential, trade secret or proprietary information of any prior employer or other individual or entity in connection with this Agreement or the performance of the Services, and they will not bring any such information onto the Watermaster's premises or introduce such information onto the Watermaster's equipment or systems.

h. No Conflict of Interest. Consultant confirms that its and its agents undertaking the Services will not pose any actual or present any perceived conflict of interest. Consultant agrees that neither it nor its agents will, during the Term, directly or indirectly, either on their own or for or on behalf of any other individual or entity, perform any services for, sponsor, promote or enter into any employment or engagement that poses an actual conflict, or that may pose a perceived conflict, with the Watermaster's Business without the Watermaster's prior written approval. For purposes of this Agreement, the "Watermaster's Business" is to administer and enforce provisions of the 1978 Judgment and subsequent orders of the Court, and to develop and implement an Optimum Basin Management Program.

i. Non-Disparagement. Consultant agrees that, during the Term and thereafter, neither it nor its agents will, directly or indirectly, take any action or make any statements, written or verbal, including statements on social media sites, that defame, disparage or in any way criticize the personal or business reputation, products, services, practices or conduct of the Watermaster or its officers, directors, employees, agents or other consultants. Consultant further agrees that neither it nor its agents will engage in any conduct, directly or indirectly, that may be detrimental to the Watermaster's mission, reputation, practices or conduct, including failing timely to provide payment to Consultant's agents. Nothing in this Agreement is intended to preclude Consultant or its agents from providing truthful testimony in response to valid legal process or otherwise truthfully cooperating with or reporting to governmental agencies, or from making other legally protected statements or disclosures.

j. Non-Recruitment. Because of the nature of the Confidential Information (as defined below) to which Consultant and its agents will have access in the course of performing the Services, Consultant agrees that neither it nor its agents will, during the Term and for a period of twelve (12) months after the termination of this Agreement for any reason (the "Restricted Period"), in any manner whatsoever, directly or indirectly, attempt to induce any then-current employee, contractor or agent to terminate or otherwise diminish its, his or her relationship with the Watermaster.

k. Confidential Information. In connection with the performance of the Services, Consultant and its agents will have access to information that has been developed by, created by or provided to the Watermaster (including without limitation, information created or developed by Consultant and/or its agents) that has commercial value to the Watermaster's Business, and is not generally known to the public or others, or is otherwise required to be kept confidential by the Watermaster (all of which is referred to as “Confidential Information”).

i. Confidential Information includes any information (whether in paper or electronic form, or contained in the memory of Consultant and/or its agents, or otherwise stored or recorded) that is not generally known and relates to the Watermaster’s Business, if such information has been expressly or implicitly protected by the Watermaster from unrestricted use by persons not associated with the Watermaster. Confidential Information includes, but is not limited to, information contained in or relating to the manner and details of the Watermaster’s operation, organization and management; passwords; concepts; programs; trade secrets; product designs; innovations; source codes and documentation; software; data; protocols; best practices; plans and proposals; processes and techniques; projects; the identities and contact information of, and details regarding the Watermaster’s relationship with, actual and prospective stakeholders, contractors and vendors; fees and charges of the Watermaster; pricing data and related information; applicant and employee personnel information; financial information; and legal and business strategies and plans, as well as any other information marked “confidential,” “proprietary,” “secret” or the like. Confidential Information also includes information of the Watermaster’s affiliates, customers, vendors, consultants, referral sources, contractors, partners, stakeholders, directors, officers, employees and other third parties that was disclosed or entrusted to the Watermaster or to Consultant and/or its agents in the course of business and/or in the course of performing the Services with the expectation of confidentiality.

ii. Consultant agrees that the Confidential Information made available to it and its agents will be used solely for the purpose of performing the Services and will be kept strictly confidential by Consultant and its agents. Consultant agrees that, unless authorized in writing by the Watermaster’s General Manager, neither Consultant nor its agents will, directly or indirectly, disclose or use any Confidential Information for their own benefit or for the benefit of any individual or entity other than the Watermaster, either during the Term or thereafter. In addition, without the Watermaster’s prior written consent, Consultant will not modify, disassemble, reverse engineer or decompile any Confidential Information, or copy, retransmit or otherwise reproduce for, or distribute to third parties any Confidential Information. Nothing contained in this Agreement will require the Watermaster to transmit any Confidential Information to Consultant, or be construed as granting any license or any other rights with respect to the Watermaster’s proprietary rights or Confidential Information.

iii. If, during the Term or at any time thereafter, Consultant or its agents receive a request to disclose any Confidential Information, whether under the terms of a subpoena, court order, or other governmental order or otherwise, Consultant and/or its agents will notify the Watermaster immediately of the details of the request including providing a copy thereof, unless expressly prohibited from doing so by applicable law, and will consult with the Watermaster on the advisability of taking legally available steps to resist or narrow such request. If disclosure of such Confidential Information is required to prevent Consultant and/or its agents from being held in contempt or subject to other penalty, Consultant and/or its agents will furnish only such portion of the Confidential Information as, in the written opinion of legal counsel satisfactory to the Watermaster, Consultant and/or its agents are legally compelled to disclose, and Consultant and its agents will use their best efforts to assist the Watermaster in obtaining an order or other reliable assurance that confidential treatment will be accorded to the disclosed Confidential Information.

l. Ownership; Return of Property and Duties upon Termination. All Confidential Information, reports, recommendations, documents, drawings, plans, presentations, specifications, technical data, databases, charts, files and other information developed by or provided to Consultant and/or its agents in connection with Consultant's affiliation with the Watermaster are and will remain the property of the Watermaster. Upon termination of this Agreement for any reason, or at such earlier time as the Watermaster may request, Consultant and its agents will immediately (i) discontinue any use of the name, logo, trademarks, or slogans of the Watermaster; (ii) discontinue all representations or statements from which it might be inferred that any continuing relationship exists between Consultant and/or its agents and the Watermaster; (iii) provide to the Watermaster reproducible copies (including electronic versions if available, in native format and with all supporting materials such as fonts, graphics and attachments) of all work product prepared or modified by Consultant and/or its agents and not previously provided to the Watermaster, whether completed or not; (iv) return to the Watermaster all tangible and intangible Confidential Information, property, documents and other information of the Watermaster, in whatever form or format, including originals and all copies of documents, drawings, computer printouts, notes, memoranda, specifications, hard drives, flash drives, disks or storage media of any kind, including all copies, summaries and compilations thereof, in the possession, custody or control of Consultant and/or its agents; (v) subject to record retention obligations, promptly and permanently delete any Confidential Information stored in the internal and/or personal email account(s), computer(s), electronic devices, voicemails, storage media and cloud-based storage (including external hard drives, flash drives, and discs) of Consultant and/or its agents, and certify the same to the Watermaster; (vi) provide the Watermaster with any and all passwords, source codes, security codes, administrative access information and/or other information in the possession of Consultant and/or its agents necessary to enable the Watermaster to get the benefit of the Services; and (vii) transition to the Watermaster ownership of any websites, accounts, handles, and the like maintained for, by or on behalf of the Watermaster. All of the foregoing will be at the sole expense of Consultant. No failure of the Watermaster to enforce the disposition of materials under this Section, or to enforce it fully or promptly, will constitute, or be interpreted or construed as, a waiver of any right of the Watermaster under this Agreement, nor will it affect in any way the characterization of any material as Confidential Information or give Consultant any rights or license as to any such Confidential Information of the Watermaster, whether by implication, estoppel, act of law, or any other theory or reason.

m. Cooperation. During the Term and thereafter, Consultant and its agents will fully cooperate in the investigation by the Watermaster of any issues, and the defense of any claims by, against or otherwise involving the Watermaster that might arise that could involve Consultant and/or its agents or information within their knowledge, regardless of whether Consultant and/or its agents personally are named in the action, without additional compensation for such cooperation other than reimbursement of reasonable costs related to such cooperation. Consultant agrees to promptly advise the Watermaster if it learns or suspects that current or former agents of the Watermaster have violated or intend to violate their legal or contractual obligations to the Watermaster, including misuse of Confidential Information.

n. Reasonable Restrictions. Consultant and its agents acknowledge and agree that the requirements set forth in this Section are reasonable in time and scope, and do not unduly burden Consultant and/or its agents.

7. No Authority to Bind the Watermaster; Marketing and Advertising. Neither Consultant nor its agents have any authority, right or ability to bind or commit the Watermaster in any way or incur any debts or liabilities in the name of or on behalf of the Watermaster (including, without limitation, by entering into contracts or agreeing to contract terms) without the express prior written consent of the Watermaster in each individual instance, and will not attempt to do so or imply that it may do so. Consultant and its agents agree not to advertise, promote or represent to any third party that Consultant or its agents are the agents of the Watermaster. Consultant and its agents may represent only that the Parties have an independent contractor relationship pursuant to which Consultant has accepted an opportunity to provide Consultant's customary services to the Watermaster. Consultant and its agents will refrain from using the Watermaster's name in any advertisement, promotion, business card, website, or similar manner without the Watermaster's prior written consent. Consultant and its agents will not add to, delete from or modify any documentation or forms provided by the Watermaster, except with the prior written consent of the Watermaster.

8. Indemnification; Limitation on Liability.

a. By Consultant. Consultant agrees to indemnify, defend (with counsel selected by the Watermaster) and hold harmless the Watermaster and its affiliates, successors, agents, employees, contractors, insurers, officers and directors (the "Watermaster Indemnified Parties") from and against any and all claims, demands, damages, costs, losses, taxes, penalties, assessments, judgments, interest payments, and expenses of whatever kind and nature, to the fullest extent permitted by law, including attorneys' fees and expert witness costs, directly or indirectly arising out of or resulting from or on account of: (i) any claim, demand, and/or determination that the Watermaster is the employer (whether sole, joint and/or common law) of any agent of Consultant performing the Services or otherwise, including any claims brought by Consultant's agents arising from or relating to any purported employment relationship or other affiliation and/or the termination thereof, including claims under the California Fair Employment and Housing Act, the California Family Rights Act, the California Government Code, the California Business and Professions Code, the California Paid Sick Leave Law and related local laws, and the California Labor Code, or similar federal statutes, all as amended, for discrimination, harassment, retaliation, workers' compensation, unemployment benefits, unpaid compensation, benefits, misclassification or failure to make withholdings, and any other obligations owed by Consultant to its agents (including under California Labor Code section 2810.3, if and to the extent applicable); (ii) any claim, demand or charge based upon acts or omissions of Consultant or its agents in relation to the Services (including failure to maintain appropriate credentials or insurance); (iii) any claim for negligence or misconduct against any of the Watermaster Indemnified Parties in connection with the engagement of Consultant and/or arising under or relating to this Agreement, including without limitation any unauthorized effort by Consultant or its agents to bind the Watermaster with respect to third parties or the failure of Consultant or its agents to comply with their obligations under this Agreement; (iv) any claim for injury to or death of any person or for damage to or destruction of property resulting from any act or omission of Consultant or its agents arising under or relating to this Agreement, including any motor vehicle accident; (v) any misappropriation, misuse or theft of Confidential Information, unfair competition, breach of contract (including breach of this Agreement), or other acts or omissions of Consultant or its agents that harm or damage (or threaten to harm or damage) any of the Watermaster Indemnified Parties or their business, goodwill or reputation; (v) any claim arising from omissions or misrepresentations by Consultant in Section 6.f above, including claims by third parties for alleged violations of restrictive covenants by Consultant and/or its agents; and (vi) any claims that any work performed by Consultant infringes or violates any third party's patent, copyright, trade secret or any other intellectual property or proprietary right in each case; including, in each of the subsections above, claims and proceedings brought by the Watermaster. Such obligations will not be construed to negate, abridge, or otherwise reduce other rights or obligations of indemnity that would otherwise exist as to a Watermaster Indemnified Party, and do not limit the Watermaster's rights under any applicable law to seek additional relief. The indemnification obligations of Consultant under this Section will not be subject to any limitation on amount or type of damages, compensation or benefits payable by or for the Watermaster under workers' compensation laws, unemployment statutes, disability or other employee benefit acts, any applicable insurance policy, or any other federal, state or local law or regulation.

b. By the Watermaster. The Watermaster agrees to defend, indemnify and hold Consultant and its officers, directors and agents harmless from and against any and all claims, demands, damages, costs, losses, taxes, penalties, assessments, judgments, interest payments, and expenses of whatever kind and nature, to the fullest extent permitted by law, including attorneys' fees and expert witness costs, directly or indirectly arising out of or resulting from (i) the Watermaster's gross negligence or willful misconduct relating to its performance under this Agreement, and (ii) claims brought against Consultant by a third party as a result of Consultant's activities as authorized by the Watermaster and/or Consultant's activities that are within the course and scope of this Agreement, in each case only to the extent that such losses, costs, claims, demands, judgments or liability are not due in whole or in part to the negligence or wrongful act(s) of Consultant and/or its agents. The Watermaster may, at its option, elect to provide a defense in lieu of indemnifying Consultant for attorneys' fees and related defense costs, subject to applicable conflict of interest considerations. In any proceeding in which defense and/or indemnification will be sought by Consultant, Consultant must give prompt written notice of such proceeding to the Watermaster. As a condition to receiving indemnification, Consultant also must promptly cooperate with all reasonable requests by the Watermaster in connection with the defense of such proceeding. Consultant's right to indemnification does not apply to (i) any proceeding or claims initiated by Consultant or its agents against the Watermaster or any other person or entity, including counterclaims, unless the Watermaster has expressly agreed in writing to waive this provision with respect to the proceeding or claims at issue, (ii) any proceeding initiated by the Watermaster against Consultant and/or its agents, (iii) any proceeding or claims alleging or involving conduct by Consultant and/or its agents that the Watermaster in its sole discretion determines was outside the course and scope of the Services, was in breach of this Agreement, constituted gross misconduct or was a violation of applicable law or the ethical duties of Consultant and/or its agents, or (iv) any situation in which indemnification of Consultant and/or its agents is not authorized or permitted pursuant to applicable law.

c. Limitation on the Watermaster's Liability. The Watermaster will not be liable to Consultant or its agents for any incidental, indirect, special, consequential, punitive or reliance damages of any nature whatsoever, regardless of the foreseeability thereof (including any claim for loss of services, lost profits or lost revenues) arising under or related to this Agreement, whether based on breach of contract, tort, breach of warranty, negligence or any other theory of liability in law or in equity. Notwithstanding anything to the contrary in this Agreement, Consultant's remedy, if any, for any breach of this Agreement, will be solely in damages, and Consultant may look solely to the Watermaster for recovery of such damages. Consultant waives and relinquishes any right Consultant may otherwise have to obtain injunctive or equitable relief against any third party with respect to any dispute arising under this Agreement. Notwithstanding anything to the contrary in this Agreement, the Watermaster's entire liability, and Consultant's ability to recover damages, at law or in equity with respect to any and/or all claims, damages, losses, costs or causes of action arising from or related to this Agreement (other than any action for payment of the Services and invoices related thereto) may not exceed the aggregate dollar amount paid by the Watermaster to Consultant under this Agreement.

9. General Provisions.

a. Entire Agreement. This Agreement, along with other documents incorporated herein, constitutes the entire agreement between the Watermaster and Consultant relating to the subject matter hereof and supersedes all prior oral and written understandings, communications and agreements relating to such subject matter, whether verbal or written, implied or otherwise, provided that Consultant's continuing obligations under prior agreements with the Watermaster, including the Consulting Services Agreements between Consultant and the Watermaster dated as of June 22, 2023 and July 1, 2024 will continue in full force and effect. In the event of a conflict between any provisions appearing in any other writing and in this Agreement, the provisions of this Agreement will be controlling. Unless otherwise agreed by the Parties, all services performed by Consultant for the Watermaster during the Term of this Agreement, whether or not set forth in Addendum A, will be governed by this Agreement.

b. Assignment. This Agreement is not assignable by Consultant, and any purported transfer or assignment is void. This Agreement, or the Watermaster's interest in this Agreement, may be assigned and transferred by the Watermaster, temporarily or permanently, whether expressly, by operation of law or otherwise, and Consultant agrees to perform the Services for the benefit of any such assignee.

c. Nonexclusive Nature of Agreement. This Agreement does not grant Consultant and/or its agents an exclusive privilege or right to supply Services to the Watermaster. Other than as expressly set forth in this Agreement, the Watermaster makes no representations or warranties as to a minimum or maximum procurement of Services. Nothing in this Agreement will be construed as limiting in any manner the ability of Consultant and/or its agents to procure other engagements consistent with their obligations to the Watermaster hereunder, including the post-Term obligations.

d. Use of Name, Likeness and Biography. The Watermaster will have the right (but not the obligation) to make public announcements concerning the affiliation of Consultant and its agents with the Watermaster. The Watermaster will have the right (but not the obligation) to use, publish and broadcast, and to authorize others to do so, the name photograph, likeness and biographical information of Consultant and its agents on any media, now known or later discovered, in connection with the business of the Watermaster.

e. Amendments; Waiver. This Agreement may not be amended except by a writing executed by all of the Parties hereto. No delay or omission by the Watermaster in exercising any right under this Agreement will operate as a waiver of that or any other right. No waiver by either Party of a right or remedy hereunder will be deemed to be a waiver of any other right or remedy or of any subsequent right or remedy of the same kind.

f. Provisions Subject to Applicable Law; Modification; Severability. All provisions of this Agreement will be applicable only to the extent that they do not violate any applicable law. If any term, provision, covenant, paragraph or condition of this Agreement is held to be invalid, illegal, or unenforceable by any court or arbitrator of competent jurisdiction, as to such jurisdiction that provision will be limited ("blue-penciled") to the minimum extent necessary so this Agreement will otherwise remain enforceable in full force and effect. To the extent such provision cannot be so modified, the offending provision will, as to such jurisdiction, be deemed severable from the remainder of this Agreement, and the remaining provisions of this Agreement will be construed to preserve to the maximum permissible extent the intent of the Parties and the purpose of this Agreement.

g. Notices. All notices, demands, consents, waivers, and other communications under this Agreement will be deemed to have been duly given when (i) delivered by hand; (ii) when received by the addressee, if sent by registered mail (return receipt requested), a nationally recognized overnight delivery service (signature requested) or electronic mail, in each case to the addresses or mail addresses set forth below (or to such other addresses as either Party may designate upon written notice):

If to Consultant:

Applied Computer Technologies
Attn: Susan M. Knowlton
417 296th Street East
Roy, Washington 98580
Email: appliedcomputertechnologiesllc@gmail.com

If to the Watermaster:

Chino Basin Watermaster
Attn: Todd Corbin
9641 San Bernardino Road
Rancho Cucamonga, California 91730

Email: tcorbin@cbwm.org

With a copy (which will not constitute notice) to:

Brownstein Hyatt Farber Schreck, LLP
1021 Anacapa Street, 2nd Floor
Santa Barbara, California 93101
Attention: Scott Slater
Email: sslater@bhfs.com

h. Construction. The Section headings in this Agreement are for convenience and reference only, and the words contained therein in no way will be held to explain, modify, amplify or aid in the interpretation, construction, or meaning of the provisions of this Agreement. The word "including" will mean "including but not limited to." The word "agents" includes employees, contractors, subcontractors, agents, owners and other representatives. Both Parties participated in the drafting of this Agreement, and each had the opportunity to consult with counsel of their own choosing in connection therewith. The rule that ambiguities in an agreement will be construed against the drafter does not apply to this Agreement.

i. Force Majeure. Each Party's obligations hereunder will be suspended during the duration of events beyond that Party's reasonable control (including labor strikes, lockouts, enactment of laws or regulations, civil unrest, pandemics, diseases, measures implemented by any governmental authority, and acts of God), provided such Party makes reasonable efforts to perform and resumes performance at the earliest opportunity. If Consultant suspends the Services for a period in excess of five (5) calendar/business days, the Watermaster may elect to terminate this Agreement immediately thereafter by providing written notice thereof, notwithstanding anything to the contrary in Section 5 of this Agreement.

j. Governing Law; Venue; Fees. This Agreement is entered into and will be governed by and construed and enforced in accordance with the laws of the State of California and the United States as applied to agreements among California residents entered into and to be performed entirely within the State of California. Unless waived by the Watermaster in writing for the particular instance, the sole jurisdiction and venue for actions related to the subject matter hereof will be the Court maintaining jurisdiction over the case *Chino Basin Municipal Water District v. City of Chino*, San Bernardino Superior Court Case No. RCV RS 51010. The Parties irrevocably consent to the exclusive jurisdiction of such court (and of the appropriate appellate courts therefrom) in any such action, suit or proceeding. The substantially prevailing Party in any action related to this Agreement, including the breach or enforcement hereof, will be entitled to recover its costs and reasonable attorneys' fees and expenses, including expert witness fees, to the fullest extent permitted by applicable law.

k. Legal and Equitable Remedies. Because Consultant's Services are personal and unique, and because Consultant and its agents will have access to and become acquainted with the Confidential Information (as defined above), the Watermaster will have the right to enforce this Agreement and any of its provisions by injunction, specific performance or other equitable relief, without bond or other security, without prejudice to any other rights and remedies that the Watermaster may have for a breach of this Agreement, and Consultant and its agents waive the claim or defense that the Watermaster has an adequate remedy at law.

l. Authority; Counterparts. Each Party represents and warrants that it has full power and authority to enter into this Agreement. This Agreement may be executed in separate counterparts, each of which will be deemed an original, and both of which taken together will constitute one and the same instrument. A facsimile, pdf, DocuSigned or emailed signature will have the same force and effect as an original signature.

ACKNOWLEDGED AND AGREED:

Applied Computer Technologies		**Chino Basin Watermaster**	
By:	________________________ Susan M. Knowlton	By:	________________________ Todd Corbin
Its:	President	Its:	General Manager

ADDENDUM A: SCOPE OF WORK

Consultant will provide to the Watermaster Software Development and SQL Database Administrator Services, including the following:

- Application Development and Support
- Application Interface Development
- SQL Database Administration
- SharePoint Programming and Support
- SSRS Report Development
- System Interface Development
- Knowledge transfer to new consulting firm
- Other technologies as needed

The exact work to be performed during the Term will be identified in coordination with Watermaster staff, as it may be modified from time to time. The implementation plan will be developed and directed by Consultant.

In addition, Consultant will provide as-needed on-site services at the Watermaster's offices in Rancho Cucamonga to facilitate interaction with Watermaster staff on the status and scope of the project, ongoing needs, and modifications.

ADDENDUM B: DISCLOSURE OF RESTRICTIVE COVENANTS

Consultant hereby discloses all restrictions to which Consultant and/or its agents who may be performing the Services are or may be subject, including restrictive covenants and non-compete obligations, in order to allow the Watermaster the opportunity to assess any such restrictions and their potential impact on the Watermaster and/or the performance of the Services. Consultant understands that such restrictions may be included in, among other things, confidentiality agreements, consulting agreements, employment agreements, separation agreements, employee handbooks, option agreements, and other types of documents. Consultant agrees to provide copies of the applicable restrictive covenants promptly upon request. Consultant further agrees to update this Disclosure promptly upon any changes to the information provided.

Check one:

☐ Neither Consultant nor its agents are subject to any restrictive covenants or non-compete provisions that may impact the performance of the Services.

☐ Consultant and/or its agents are subject to the following restrictive covenants or non-compete provisions that may impact the performance of the Services:

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ADDENDUM C:

HANDBOOK POLICIES APPLICABLE TO CONSULTANT

- 2.5 – Equal Employment Opportunity
- 4.6 – Conflicts of Interest
- 4.7 – Confidential Information and Watermaster Records
- 4.13 – Safety
- 4.17 – Use of Company Computers and Other Equipment
- 4.18 – Harassment and Discrimination
- 4.19 – Inspections, Searches and Monitoring
- 4.20 – Right to Search
- 4.21 – Smoking
- 4.22 – Voicemail, E-Mail and Technology
- 4.23 – Social Media
- Appendix B – Substance Abuse Policy

34052016

Applied Computer Technologies

BUSINESS SOLUTIONS PROVIDER

June 2, 2025

Edgar Tellez Foster
Frank Yoo
Chino Basin Watermaster
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

SUBJECT: Software Development and SQL Database Administrator Services
Scope of Work for Fiscal Year 2025-2026

Dear Edgar,

I am pleased to offer continuing software development and database administrator services for Chino Basin Watermaster for the 2025-2026 fiscal year. The ongoing services to be provided include the following:

- Application Development and Support
- Application Interface Development
- SQL Database Administration
- SharePoint Programming and Support
- SSRS Report Development
- System Interface Development
- Knowledge transfer to new consulting firm
- Other technologies as needed.

The exact work to be performed will be identified in coordination with Watermaster staff. In addition, we will provide on-site services at the Watermaster's offices in Rancho Cucamonga as needed to facilitate interaction with Watermaster staff on the status and scope of the project, ongoing needs, and modifications. The hourly rate for this service is $175 per hour, billed on an as needed basis.

If you have additional questions, please do not hesitate to contact me at 951-265-0433 or by email to appliedcomputertechnologiesllc@gmail.com.

Thank you.

S M. Knowlton

Susan M. Knowlton
President, Applied Computer Technologies

417 296th STREET EAST ~ ROY, WA 98580 ~ 951-265-0433

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888 www.cbwm.org

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Professional Services Agreement Between Rauch Communication Consultants, Inc. and Chino Basin Watermaster (Consent Calendar Item I.E.)

Issue: Watermaster seeks to enter into a contract with Rauch Communication Consultants, Inc. to aid in the creation of the 48th Annual Report (Fiscal Year 2024/25). Rauch Communications Consultants have been providing services to Watermaster since 2002. [Normal Course of Business]

Recommendation: Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

Financial Impact: The contract expenses of $24,475 are funded within the FY 2024/25 budget under account number 6061.3, which was adopted by the Board on May 22, 2025.

ACTIONS:
Watermaster Board – June 26 [Recommended]: Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

BACKGROUND

Paragraph 48 of the Restated Judgment requires that Watermaster file an Annual Report with the Court by January 31 each year. The Restated Judgment states that the Report shall apply to the preceding fiscal year's operation, contain details as to operation of the Pools, contain a certified audit of assessments and expenditures pursuant to the Physical Solution, and review Watermaster activity.

Chino Basin Watermaster (Watermaster) has partnered with Rauch Communication Consultants, Inc. (RCC) since the preparation of the 26th Annual Report in 2002 and plans to continue the engagement for the fiscal year ending June 30, 2025 report. RCC provides additional research, writing, optimizing of photos, graphic design, layout, proofing, printing, and delivery of the annual report.

DISCUSSION

Since the 40th Annual Report, Watermaster has entered into a formal contract with RCC and plans to continue the practice as shown in the Consulting Services Agreement (Attachment 1). Entering into a contract for each Annual Report will help memorialize the description of responsibilities, cost, and schedule, as well as provide legal protection should disputes arise. Additionally, it will aid in clearly identifying this annual budgeted cost.

The cost and proposed scope of work for RCC's services for the 48th Annual Report has been reviewed by staff and is included as Attachment 2. Costs for the 48th Annual Report are included in the approved Fiscal Year 2025/26 budget.

ATTACHMENTS
1. Consulting Services Agreement
2. Proposed Cost and Scope and Detail of Hours

ATTACHMENT 1

CONSULTING SERVICES AGREEMENT

This Consulting Services Agreement ("Agreement") is entered into by and between the Chino Basin Watermaster (the "Watermaster") and Rauch Communication Consultants, Inc. ("Consultant," and, together with the Watermaster, the "Parties"), effective as of the 1st day of July, 2025 (the "Effective Date").

1. Term of Agreement. This Agreement will become effective as of the Effective Date. This Agreement will terminate on June 30, 2026 or prior to that time in accordance with Section 5 of this Agreement. (The period during which this Agreement is in effect, including any extensions agreed upon by the Parties, is referred to as the "Term.")

2. Services. The Watermaster and Consultant agree that, during the Term, Consultant will provide the services set forth in the Scope of Work attached as Addendum A to this Agreement, as it may be modified from time to time in writing. Consultant must provide regular written progress reports to the Watermaster, no less frequently than monthly, and maintain regular contact with the Watermaster for project clarification, guidance and issue resolution. Consultant may from time to time be required to perform other duties that are reasonably related to Consultant's expertise and skills. Collectively, these are referred to as the "Services." The Parties acknowledge that the Services are outside the normal scope of the Watermaster's Business (as defined below), and that Consultant is customarily engaged in providing such Services to third parties such as the Watermaster. Consultant will coordinate with Todd Corbin as Consultant's Watermaster contact (the "Watermaster Contact").

3. Compensation and Terms of Payment.

   a. Compensation for Services. In compensation for the Services, the Watermaster will pay Consultant on a time and materials basis, with a total cost not to exceed $24,475.00 over the Term of the Agreement (the "Fees"). Current rates are as shown on Addendum A.

   b. Expenses. Consultant will be responsible for any and all expenses that may be incurred in performing the Services, including all direct and indirect costs, insurance (including professional liability insurance), fees and costs for business and professional licenses and credentialing, mileage and overhead, except as otherwise expressly agreed in writing by the Watermaster in advance with respect to particular expenses ("Expenses").

   c. Method of Payment.

      i. Consultant must submit monthly invoices to the Watermaster for Fees and Expenses incurred to that date. The monthly invoices must include an accurate and detailed summary of the Services performed and the billable hours spent on each task, itemization of any reimbursable Expenses, and documentation and receipts acceptable to the Watermaster supporting any such Expenses or Fees.

      ii. The Watermaster Contact will verify the Services, Fees and Expenses detailed on the invoice and will confirm that the Services described therein have been satisfactorily completed and that appropriate documentation has been provided.

      iii. The Watermaster will make a reasonable effort to pay undisputed invoiced amounts within thirty (30) calendar days. The Watermaster will communicate with Consultant regarding any disputed amounts or amounts as to which inadequate documentation has been provided by Consultant.

iv. The Watermaster reserves the right to withhold payment for Fees and Expenses relating to Services that are not completed as scheduled, are completed unsatisfactorily, are behind schedule, are otherwise performed in an inadequate or untimely fashion, or are not properly documented, each as determined by the Watermaster, with such payments to be released and paid to Consultant if and when the Services are determined by the Watermaster to be satisfactorily completed and properly documented. The Watermaster also reserves the right to withhold payment upon termination of this Agreement in the event Consultant threatens not to comply or fails to comply with its obligations (including post-Term obligations) and/or breaches or threatens to breach this Agreement in any material respect, as determined by the Watermaster.

4. <u>Affirmation of Independent Contractor Status.</u>

a. <u>Independent Contractor.</u> The Watermaster and Consultant each expressly understand, agree and intend that Consultant is an independent contractor in the performance of each and every part of this Agreement, and is solely responsible for all costs and expenses arising in connection with the performance of the Services, except as expressly set forth herein. Consultant is responsible for obtaining any business permits or licenses required to enable it to operate as an independent contractor and perform the Services. All Services are to be performed solely at the risk of Consultant, and Consultant agrees to take all precautions necessary for the proper performance of the Services. Consultant is solely responsible for any and all claims, liabilities or damages or debts of any type whatsoever that may arise on account of the activities of Consultant and its agents. Consultant has and retains control of, and supervision over, the performance of its obligations hereunder, including scheduling and day-to-day control over the performance of the Services, and except as expressly provided herein, the Watermaster will have no right to exercise any control whatsoever over the activities or operations of Consultant. Notwithstanding the foregoing, however, Consultant may not subcontract all or any portion of the performance of the Services, assign performance of the Services to any entity(ies) or individual(s) other than as listed on Addendum A, or assign any former employee or contractor of the Watermaster to perform the Services, unless, in any such case, the Watermaster has provided its prior express written approval.

b. <u>Taxes and Related Matters.</u> Consultant will be solely responsible for all tax and other government-imposed responsibilities relating to the performance of the Services, including payment of all applicable federal, state, local and social security taxes, unemployment insurance, workers' compensation and self-employment or other business taxes and licensing fees. Consultant will be solely responsible for payment of all compensation owed to its agents with respect to the Services, including all applicable federal, state and local employment taxes, and will make deductions for all taxes and withholdings required by law. Except as required by applicable law, no federal, state or local taxes of any kind will be withheld or paid by the Watermaster on behalf of Consultant and/or its agents. Consultant acknowledges that the compensation paid pursuant to this Agreement will not be considered "wages" for purposes of the Federal Insurance Contributions Act ("FICA"), unemployment or other taxes. Consultant does not (i) provide management services to the Watermaster or (ii) hold a position as a corporate director or a similar position for the Watermaster. Consultant represents to the Watermaster that it is not subject to the statutory provisions of Section 409A of the Internal Revenue Code of 1986, as amended (the "Code") and any Treasury Regulations and other interpretive guidance issued thereunder (collectively "Section 409A") because Consultant satisfies the requirements of Treasury Regulation 1.409A-1(f)(2) (the exception to the general definition of "service provider" for certain independent contractors). The Watermaster will issue Consultant an IRS Form 1099 with respect to payments made under this Agreement, and Consultant must promptly provide to the Watermaster a completed IRS Form W-9 and other documentation as may be needed from time to time by the Watermaster. Consultant will be responsible for performing all payroll and record-keeping functions required by law. The compensation provided hereunder is not intended to constitute "nonqualified deferred compensation" within the meaning of Section 409A. No provision of this Agreement will be interpreted or construed to transfer any tax, interest, income inclusion, penalty, or other liability arising from or relating to any liability or obligation imposed on Consultant under the Code or any damages relating to or arising therefrom, including without limitation any tax, interest, income inclusion, penalty, other liability, or damages of Consultant arising from or relating to any liability for failure to comply with any applicable tax obligations, including failure to comply with the requirements of Section 409A, from Consultant or any other individual to the Watermaster.

c. <u>No Employee Benefits from the Watermaster.</u> As an independent contractor, neither Consultant nor its agents will be eligible for benefits from the Watermaster or any related entity, including workers' compensation, unemployment insurance, expense reimbursement, health, dental, vision, life or disability insurance, paid holidays, paid sick leave, vacation or other paid time off, pension or 401(k) plans, educational assistance, continuing education reimbursement, or any other employee benefit that may be offered now or in the future.

d. <u>No Third-Party Beneficiaries.</u> This Agreement is between the Watermaster and Consultant, and creates no individual rights for any agents of Consultant. No agent of Consultant will be deemed to be a third-party beneficiary hereunder, nor will any agent of Consultant be deemed to have any employment or contractual relationship with the Watermaster as a result of this Agreement or his, her or its performance of services for Consultant, including the Services contemplated under this Agreement. The Parties acknowledge that all individuals performing Services on behalf of Consultant are solely the employees and/or agents of Consultant. The Watermaster will not be responsible for payments due and owing to any subcontractors or other agents of Consultant; provided, however, that in the event Consultant fails timely to pay any such agents, if the Watermaster deems it appropriate to make payments directly to any agents on behalf of Consultant, notwithstanding that it may have no legal obligation to do so, Consultant will reimburse the Watermaster therefor, and the Watermaster may offset any amounts due and owing to Consultant by any amounts it has paid to any such agents of Consultant.

5. <u>Termination of Agreement.</u> This Agreement will expire at the end of the Term, unless

earlier terminated as follows:

a. Termination upon Written Notice. Either Party may terminate this Agreement during the Term by providing the other Party with thirty (30) days' written notice of such termination or with any shorter notice period upon which the Parties may agree. The Watermaster may, in its sole discretion, provide compensation in lieu of all or a portion of the notice period, regardless of who initiates the termination, prorating the fees as appropriate. Payment in lieu of notice will be calculated by averaging the fees received during the prior three (3) month period (or such lesser number of months as this Agreement has been in effect) and pro-rating as appropriate.

b. Termination for Cause by the Watermaster. The Watermaster may terminate this Agreement immediately for "Cause." Cause includes, but is not be limited to, the following, as determined in the Watermaster's sole discretion: (i) failure of Consultant or its agents to comply in any material respect with this Agreement, including failure to perform the Services in a satisfactory manner, breach of any other agreement between the Parties, or violation of any applicable Watermaster policy, procedure or guideline, including the Watermaster's policy against harassment; (ii) serious personal or professional misconduct by Consultant or its agents (including, but not limited to, dishonesty, fraud, misappropriation, criminal activity or gross or willful neglect of duty); (iii) breach or threatened breach of Consultant's duties to the Watermaster (including theft or misuse of Watermaster property or time) by Consultant or its agents; (iv) conduct that threatens public health or safety, or threatens to do immediate or substantial harm to the Watermaster's Business (as defined below), including potentially subjecting the Watermaster to civil or criminal liability; (v) falsification by Consultant or its agents of any business-related document, including invoices, or the making of any materially false or misleading statement by Consultant or its agents to or in connection with the Watermaster; (vi) an investigation that could have an adverse impact on the Watermaster is commenced with respect to Consultant and/or its agents by a regulatory agency or governmental agency; (vii) failure or refusal of Consultant or its agents to submit to legally-permissible drug screening, testing and/or medical examinations; (viii) the professional license(s), and/or qualifications of Consultant and/or its agents deemed necessary by the Watermaster to perform the Services (if applicable) are not maintained or renewed, or are revoked or suspended by an authorized regulatory agency; (ix) any other willful or substantial misconduct, deficiency, failure of performance, breach or default by Consultant or its agents, including failing to provide Services for any reason on multiple occasions when requested by the Watermaster; or (x) in the event of the discontinuance of the Watermaster's business. The Watermaster's exercise of its right to terminate for Cause will be without prejudice to any other remedy to which it may be entitled at law, in equity, or under this Agreement. In the event of termination for Cause by the Watermaster, the only compensation due to Consultant will be payment of Fees incurred up to the date of termination and outstanding reimbursable Expenses, less appropriate offsets and any applicable Penalty (as defined below). In the event the Watermaster terminates this Agreement for Cause, it will be entitled to recover a penalty (the "Penalty") from Consultant in the amount of thirty (30) days' compensation (calculated as set forth below), which Penalty may be deducted from and offset against outstanding compensation due to Consultant.

c. Penalty for Failure to Provide Notice. In the event either Party fails to provide notice of termination as required under this Agreement, the other Party will be entitled to recover a Penalty in the amount of the compensation that would have been due for the length of the notice period that was not provided. By way of example, if the Watermaster failed to provide any notice to Consultant and terminated this Agreement without Cause, then Consultant would be entitled to recover a Penalty from the Watermaster in the amount of thirty (30) days' compensation. The Penalty amount will be calculated by averaging the fees received during the prior three (3) month period (or such lesser number of months as this Agreement has been in effect) and pro-rating as appropriate.

6. Obligations of Consultant.

a. Best Abilities; Good Workmanship; Time of the Essence. Consultant understands that time is of the essence with respect to the performance of the Services. Consultant will proceed with diligence and the Services will be performed in accordance with the highest professional workmanship, service and ethical standards in the field and to the satisfaction of the Watermaster. If Consultant's workmanship does not conform to these standards, in the Watermaster's subjective judgment and absolute discretion, and the Watermaster so notifies Consultant, Consultant agrees immediately to take all action necessary to remedy the nonconformance. Any costs incurred by Consultant to correct such nonconformance will be at Consultant's sole expense. To the extent Consultant fails to correct such nonconformance to the Watermaster's satisfaction, or the Watermaster deems Consultant incapable of correcting such nonconformance to the Watermaster's satisfaction, the Watermaster may elect to have a third party (including a subcontractor of Consultant) correct such nonconformance at Consultant's sole expense.

b. Use of Artificial Intelligence. Neither Consultant nor its agents may utilize artificial intelligence (AI), computer-generated preparation of documents or similar technology in performing the Services without, in each particular instance, the prior written consent of the Watermaster.

c. Compliance with Law and Policies. Consultant and its agents will comply with all federal, state and local laws, rules and regulations applicable to them, including the Occupational Safety and Health Act ("OSHA"), non-discrimination laws, immigration law and work authorization requirements, tax and withholding obligations, and wage and hour requirements (including those related to classification of employees and payment of minimum wage and overtime) in the performance of the Services. Consultant will be responsible for providing, at Consultant's expense and in Consultant's name, all licenses and permits usual or necessary for conducting the Services. Consultant and its agents also will comply with other Watermaster policies that may be applicable to them, as they may be modified from time to time, including the Watermaster's policies against harassment and discrimination.

d. Qualifications. Consultant and its agents understand that the Watermaster may elect to conduct background screening, and drug screening with respect to Consultant and/or its agents, and that satisfactory completion of the same is a material condition of this Agreement. In addition, during the Term, Consultant will continuously maintain in good standing any qualifications necessary to perform the Services, and will cause its agents to do the same. Consultant and its agents must keep all licensure/certification records fully up to date with the Watermaster, including promptly reporting to the Watermaster any revocation, suspensions, restrictions, censures or investigations.

e. Equipment; Use of Watermaster Technology. In general, Consultant will be responsible for providing its own supplies, equipment and work location(s). However, to facilitate performance of the Services, Consultant and/or its agents may be provided with certain equipment by the Watermaster. In addition, to facilitate performance of the Services and communications with Watermaster representatives, agents and customers, and to ensure appropriate security levels, confidentiality and privacy protection and document retention procedures, Consultant and/or its agents may be provided with (i) a Watermaster email address, (ii) access to select areas of the Watermaster's computer system, data, files and/or premises, and (iii) access authority and login information with respect to select Watermaster accounts. To the extent Consultant and/or its agents are provided with a Watermaster email address, the applicable signature block must be approved by the Watermaster and must clearly indicate Consultant's status with respect to the Watermaster. Consultant and its agents will be subject to applicable Watermaster policies relating to usage of Watermaster equipment and systems, as more particularly set forth on Addendum C. To the extent non-Watermaster equipment, devices, systems and/or accounts are used, Consultant will take all reasonable steps to ensure the security of data on or in such equipment, devices, systems and accounts, including using encryption where appropriate and/or required by applicable law.

f. Insurance. The Watermaster will not procure liability or other insurance on behalf of Consultant or its agents, except that the Watermaster may procure professional liability insurance coverage on its own behalf with respect to Consultant's performance of the Services. Consultant and its agents will assist the Watermaster in procuring any such insurance by submitting to examinations and signing such applications and other instruments as may be required by the insurance carriers to which application is made for such insurance. Procurement of all appropriate insurance coverage for Consultant and/or its agents is the sole responsibility of Consultant. Promptly upon request, Consultant will provide the Watermaster with certificates of insurance evidencing coverage for workers' compensation, unemployment insurance, Comprehensive General Liability insurance, professional liability insurance and motor vehicle insurance, to include provisions for property damage, personal injury and automobile liability, to the extent applicable to Consultant. Such insurance must be in amounts satisfactory to the Watermaster and may not be reduced or canceled without the Watermaster's written approval of such reduction or cancellation. Any insurance maintained by Consultant and/or its agents will be primary insurance to the full approved limits of liability and, should the Watermaster have other valid insurance, such insurance will be excess insurance only. The Watermaster, however, is not required to, and may or may not, include Consultant and/or its agents as additional insureds under any policy the Watermaster maintains on its own behalf, unless otherwise required by applicable law or the terms of the Watermaster's existing insurance policies.

g. Non-Contravention; No Improper Use of Materials. Consultant represents and warrants that it has all right, power, authority and capacity and is free to enter into this Agreement. Consultant further represents that, by entering into this

Agreement, neither Consultant nor its agents will violate or interfere with the rights of any other person or entity. Consultant represents and warrants that neither it nor its agents are subject to any contract, restrictive covenants, non-compete obligations, understandings or other commitments of any kind that will or might prevent, interfere with or impair Consultant's acceptance of this Agreement and/or the performance of the Services. Consultant confirms that it has identified on Addendum B any and all restrictions to which Consultant and its agents who will perform the Services are subject (including restrictive covenants and non-compete obligations) in order to allow the Watermaster the opportunity to assess any such restrictions and their potential impact on the Watermaster and the performance of the Services. Neither Consultant nor its agents will enter into any agreements inconsistent with this Agreement. Consultant further certifies that neither it nor its agents will utilize or disclose any confidential, trade secret or proprietary information of any prior employer or other individual or entity in connection with this Agreement or the performance of the Services, and they will not bring any such information onto the Watermaster's premises or introduce such information onto the Watermaster's equipment or systems.

h. No Conflict of Interest. Consultant confirms that its and its agents undertaking the Services will not pose any actual or present any perceived conflict of interest. Consultant agrees that neither it nor its agents will, during the Term, directly or indirectly, either on their own or for or on behalf of any other individual or entity, perform any services for, sponsor, promote or enter into any employment or engagement that poses an actual conflict, or that may pose a perceived conflict, with the Watermaster's Business without the Watermaster's prior written approval. For purposes of this Agreement, the "Watermaster's Business" is to administer and enforce provisions of the 1978 Judgment and subsequent orders of the Court, and to develop and implement an Optimum Basin Management Program.

i. Non-Disparagement. Consultant agrees that, during the Term and thereafter, neither it nor its agents will, directly or indirectly, take any action or make any statements, written or verbal, including statements on social media sites, that defame, disparage or in any way criticize the personal or business reputation, products, services, practices or conduct of the Watermaster or its officers, directors, employees, agents or other consultants. Consultant further agrees that neither it nor its agents will engage in any conduct, directly or indirectly, that may be detrimental to the Watermaster's mission, reputation, practices or conduct, including failing timely to provide payment to Consultant's agents. Nothing in this Agreement is intended to preclude Consultant or its agents from providing truthful testimony in response to valid legal process or otherwise truthfully cooperating with or reporting to governmental agencies, or from making other legally protected statements or disclosures.

j. Non-Recruitment. Because of the nature of the Confidential Information (as defined below) to which Consultant and its agents will have access in the course of performing the Services, Consultant agrees that neither it nor its agents will, during the Term and for a period of twelve (12) months after the termination of this Agreement for any reason (the "Restricted Period"), in any manner whatsoever, directly or indirectly, attempt to induce any then-current employee, contractor or agent to terminate or otherwise diminish its, his or her relationship with the Watermaster.

k. Confidential Information. In connection with the performance of the Services, Consultant and its agents will have access to information that has been developed by, created by or provided to the Watermaster (including without limitation, information created or developed by Consultant and/or its agents) that has commercial value to the Watermaster's Business, and is not generally known to the public or others, or is otherwise required to be kept confidential by the Watermaster (all of which is referred to as "Confidential Information").

i. Confidential Information includes any information (whether in paper or electronic form, or contained in the memory of Consultant and/or its agents, or otherwise stored or recorded) that is not generally known and relates to the Watermaster's Business, if such information has been expressly or implicitly protected by the Watermaster from unrestricted use by persons not associated with the Watermaster. Confidential Information includes, but is not limited to, information contained in or relating to the manner and details of the Watermaster's operation, organization and management; passwords; concepts; programs; trade secrets; product designs; innovations; source codes and documentation; software; data; protocols; best practices; plans and proposals; processes and techniques; projects; the identities and contact information of, and details regarding the Watermaster's relationship with, actual and prospective stakeholders, contractors and vendors; fees and charges of the Watermaster; pricing data and related information; applicant and employee personnel information; financial information; and legal and business strategies and plans, as well as any other information marked "confidential," "proprietary," "secret" or the like. Confidential Information also includes information of the Watermaster's affiliates, customers, vendors, consultants, referral sources, contractors, partners, stakeholders, directors, officers, employees and other third parties that was disclosed or entrusted to the Watermaster or to Consultant and/or its agents in the course of business and/or in the course of performing the Services with the expectation of confidentiality.

ii. Consultant agrees that the Confidential Information made available to it and its agents will be used solely for the purpose of performing the Services and will be kept strictly confidential by Consultant and its agents. Consultant agrees that, unless authorized in writing by the Watermaster's General Manager, neither Consultant nor its agents will, directly or indirectly, disclose or use any Confidential Information for their own benefit or for the benefit of any individual or entity other than the Watermaster, either during the Term or thereafter. In addition, without the Watermaster's prior written consent, Consultant will not modify, disassemble, reverse engineer or decompile any Confidential Information, or copy, retransmit or otherwise reproduce for, or distribute to third parties any Confidential Information. Nothing contained in this Agreement will require the Watermaster to transmit any Confidential Information to Consultant, or be construed as granting any license or any other rights with respect to the Watermaster's proprietary rights or Confidential Information.

iii. If, during the Term or at any time thereafter, Consultant or its agents receive a request to disclose any Confidential Information, whether under the terms of a subpoena, court order, or other governmental order or otherwise, Consultant and/or its agents will notify the Watermaster immediately of the details of the request, including providing a copy thereof, unless expressly precluded from doing so by applicable law, and will consult with the Watermaster on the advisability of taking legally available steps to resist or narrow such request. If disclosure of such Confidential Information is required to prevent Consultant and/or its agents from being held in contempt or subject to other penalty, Consultant and its agents will furnish only such portion of the Confidential Information as, in the written opinion of legal counsel satisfactory to the Watermaster, Consultant and its agents are legally compelled to disclose, and Consultant and its agents will use their best efforts to assist the Watermaster in obtaining an order or other reliable assurance that confidential treatment will be accorded to the disclosed Confidential Information.

I. Ownership; Return of Property and Duties upon Termination. All Confidential Information[1], reports, recommendations, documents, drawings, plans, presentations, specifications, technical data, databases, charts, files and other information developed by or provided to Consultant and/or its agents in connection with Consultant's affiliation with the Watermaster are and will remain the property of the Watermaster. Upon termination of this Agreement for any reason, or at such earlier time as the Watermaster may request, Consultant and its agents will immediately (i) discontinue any use of the name, logo, trademarks, or slogans of the Watermaster; (ii) discontinue all representations or statements from which it might be inferred that any continuing relationship exists between Consultant and/or its agents and the Watermaster; (iii) provide to the Watermaster reproducible copies (including electronic versions if available, in native format and with all supporting materials such as fonts, graphics and attachments) of all work product prepared or modified by Consultant and/or its agents and not previously provided to the Watermaster, whether completed or not; (iv) return to the Watermaster all tangible and intangible Confidential Information, property, documents and information of the Watermaster, in whatever form or format, including originals and all copies of documents, drawings, computer printouts, notes, memoranda, specifications, hard drives, flash drives, disks or storage media of any kind, including all copies, summaries and compilations thereof, in the possession, custody or control of Consultant and/or its agents; (v) subject to record retention obligations, promptly and permanently delete any Confidential Information stored in the internal and/or personal email account(s), computer(s), electronic devices, voicemails, storage media and cloud-based storage (including external hard drives, flash drives, and discs) of Consultant and/or its agents, and certify the same to the Watermaster; (vi) provide the Watermaster with any and all passwords, source codes, security codes, administrative access information and/or other information in the possession of Consultant and/or its agents necessary to enable the Watermaster to get the benefit of the Services; and (vii) transition to the Watermaster ownership of any websites, accounts, handles, and the like maintained for, by or on behalf of the Watermaster. All of the foregoing will be at the sole expense of Consultant. No failure of the Watermaster to enforce the disposition of materials under this Section, or to enforce it fully or promptly, will constitute, or be interpreted or construed as, a waiver of any right of the Watermaster under this Agreement, nor will it affect in any way the characterization of any material as Confidential Information or give Consultant any rights or license as to any such Confidential Information of the Watermaster, whether by implication, estoppel, act of law, or any other theory or reason.

m. Cooperation. During the Term and thereafter, Consultant and its agents will fully cooperate in the investigation by the Watermaster of any issues, and the defense of any claims by, against or otherwise involving the Watermaster that might arise that could involve Consultant and/or its agents or information within their knowledge, regardless of whether Consultant and/or its agents personally are named in the action, without additional compensation for such cooperation other than reimbursement of reasonable costs related to such cooperation. Consultant agrees to promptly advise the Watermaster if it learns or suspects that current or former agents of the Watermaster have violated or intend to violate their legal or contractual obligations to the Watermaster including misuse of Confidential Information.

n. Reasonable Restrictions. Consultant and its agents acknowledge and agree that the requirements set forth in this Section are reasonable in time and scope, and do not unduly burden Consultant and/or its agents.

7. No Authority to Bind the Watermaster; Marketing and Advertising. Neither Consultant nor its agents have any authority, right or ability to bind or commit the Watermaster in any way or incur any debts or liabilities in the name of or on behalf of the Watermaster (including, without limitation, by entering into contracts or agreeing to contract terms) without the express prior written consent of the Watermaster in each individual instance, and will not attempt to do so or imply that it may do so. Consultant and its agents agree not to advertise, promote or represent to any third party that Consultant or its agents are the agents of the Watermaster. Consultant and its agents may represent only that the Parties have an independent contractor relationship pursuant to which Consultant has accepted an opportunity to provide Consultant's customary services to the Watermaster. Consultant and its agents will refrain from using the Watermaster's name in any advertisement, promotion, business card, website, or similar manner without the Watermaster's prior written consent. Consultant and its agents will not add to, delete from or modify any documentation or forms provided by the Watermaster, except with the prior written consent of the Watermaster.

8. Indemnification; Limitation on Liability.

a. By Consultant. Consultant agrees to indemnify, defend (with counsel selected by the Watermaster) and hold harmless the Watermaster and its affiliates, successors, agents, employees, contractors, insurers, officers and directors (the "Watermaster Indemnified Parties") from and against any and all claims, demands, damages, costs, losses, taxes, penalties, assessments, judgments, interest payments, and expenses of whatever kind and nature, to the fullest extent permitted by law, including attorneys' fees and expert witness costs, directly or indirectly arising out of or resulting from or on account of: (i) any claim, demand, and/or determination that the Watermaster is the employer (whether sole, joint and/or common law) of any agent of Consultant performing the Services or otherwise, including any claims brought by Consultant's agents arising from or relating to any purported employment relationship or other affiliation and/or the termination thereof, including claims under the California Fair Employment and Housing Act, the California Family Rights Act, the California Government Code, the California Business and Professions Code, the California Paid Sick Leave Law and related local laws, and the California Labor Code, or similar federal statutes, all as amended, for discrimination, harassment, retaliation, workers' compensation, unemployment benefits, unpaid compensation, benefits, misclassification or failure to make withholdings, and any other obligations owed by Consultant to its agents (including under California Labor Code section 2810.3, if and to the extent applicable); (ii) any claim, demand or charge based upon acts or omissions of Consultant or its agents in relation to the Services (including failure to maintain appropriate credentials or insurance); (iii) any claim for negligence or misconduct against any of the Watermaster Indemnified Parties in connection with the engagement of Consultant and/or arising under or relating to this Agreement, including without limitation any unauthorized effort by Consultant or its agents to bind the Watermaster with respect to third parties or the failure of Consultant or its agents to comply with their obligations under this Agreement; (iv) any claim for injury to or death of any person or for damage to or destruction of property resulting from any act or omission of Consultant or its agents arising under or relating to this Agreement, including any motor vehicle accident; (v) any claim arising from omissions or misrepresentations by Consultant in Section 6.f above, including claims by third parties for alleged violations of restrictive covenants by Consultant and/or its agents; (vi) any misappropriation, misuse or theft of Confidential Information, unfair competition, breach of contract, (including breach of this Agreement), or other acts or omissions of Consultant or its agents that harm or damage (or threaten to harm or damage) any of the Watermaster Indemnified Parties or their business, goodwill or reputation; and (vii) any claims that any work performed by Consultant infringes or violates any third party's patent, copyright, trade secret or any other intellectual property or proprietary right in each case; including, in each subsection above, claims and proceedings brought by the Watermaster. Such obligations will not be construed to negate, abridge, or otherwise reduce other rights or obligations of indemnity that would otherwise exist as to a Watermaster Indemnified Party, and do not limit the Watermaster's rights under any applicable law to seek additional relief. The indemnification obligations of Consultant under this Section will not be subject to any limitation on amount or type of damages, compensation or benefits payable by or for the Watermaster under workers' compensation laws, unemployment statutes, disability or other employee benefit acts, any applicable insurance policy, or any other federal, state or local law or regulation.

b. <u>By the Watermaster.</u> The Watermaster agrees to defend, indemnify and hold Consultant and its officers, directors, and agents harmless from and against any and all claims, demands, damages, costs, losses, taxes, penalties, assessments, judgments, interest payments, and expenses of whatever kind and nature, to the fullest extent permitted by law, including attorneys' fees and expert witness costs, directly or indirectly arising out of or resulting from (i) the Watermaster's gross negligence or willful misconduct relating to its performance under this Agreement, and (ii) claims brought against Consultant by a third party as a result of Consultant's activities as authorized by the Watermaster and/or Consultant's activities that are within the course and scope of this Agreement, in each case only to the extent that such losses, costs, claims, demands, judgments or liability are not due in whole or in part to the negligence or wrongful act(s) of Consultant and/or its agents. The Watermaster may, at its option, elect to provide a defense in lieu of indemnifying Consultant for attorneys' fees and related defense costs, subject to applicable conflict of interest considerations. In any proceeding in which defense and/or indemnification will be sought by Consultant, Consultant must give prompt written notice of such proceeding to the Watermaster. As a condition to receiving indemnification, Consultant also must promptly cooperate with all reasonable requests by the Watermaster in connection with the defense of such proceeding. Consultant's right to indemnification does not apply to (i) any proceeding or claims initiated by Consultant or its agents against the Watermaster or any other person or entity, including counterclaims, unless the Watermaster has expressly agreed in writing to waive this provision with respect to the proceeding or claims at issue, (ii) any proceeding initiated by the Watermaster against Consultant and/or its agents, (iii) any proceeding or claims alleging or involving conduct by Consultant and/or its agents that the Watermaster in its sole discretion determines was outside the course and scope of the Services, was in breach of this Agreement, constituted gross misconduct or was a violation of applicable law or the ethical duties of Consultant and/or its agents, or (iv) any situation in which indemnification of Consultant and/or its agents is not authorized or permitted pursuant to applicable law.

c. Limitation on the Watermaster's Liability. The Watermaster will not be liable to Consultant or its agents for any incidental, indirect, special, consequential, punitive or reliance damages of any nature whatsoever, regardless of the foreseeability thereof (including any claim for loss of services, lost profits or lost revenues) arising under or related to this Agreement, whether based on breach of contract, tort, breach of warranty, negligence or any other theory of liability in law or in equity. Notwithstanding anything to the contrary in this Agreement, Consultant's remedy, if any, for any breach of this Agreement, will be solely in damages, and Consultant may look solely to the Watermaster for recovery of such damages. Consultant waives and relinquishes any right Consultant may otherwise have to obtain injunctive or equitable relief against any third party with respect to any dispute arising under this Agreement. Notwithstanding anything to the contrary in this Agreement, the Watermaster's entire liability, and Consultant's ability to recover damages, at law or in equity with respect to any and/or all claims, damages, losses, costs or causes of action arising from or related to this Agreement (other than any action for payment of the Services and invoices related thereto) may not exceed the aggregate dollar amount paid by the Watermaster to Consultant under this Agreement.

9. General Provisions.

a. Entire Agreement. This Agreement, along with other documents incorporated herein, constitutes the entire agreement between the Watermaster and Consultant relating to the subject matter hereof and supersedes all prior oral and written understandings, communications and agreements relating to such subject matter, whether verbal or written, implied or otherwise; provided that Consultant's continuing obligations under prior agreements with the Watermaster, including the Consulting Services Agreements between Consultant and the Watermaster dated as of June 22, 2023 and June 22, 2024 will continue in full force and effect. In the event of a conflict between any provisions appearing in any other writing and in this Agreement, the provisions of this Agreement will be controlling. Unless otherwise agreed by the Parties, all services performed by Consultant for the Watermaster during the Term of this Agreement, whether or not set forth in Addendum A, will be governed by this Agreement.

b. Assignment. This Agreement is not assignable by Consultant, and any purported transfer or assignment is void. This Agreement, or the Watermaster's interest in this Agreement, may be assigned and transferred by the Watermaster, temporarily or permanently, whether expressly, by operation of law or otherwise, and Consultant agrees to perform the Services for the benefit of any such assignee.

c. Nonexclusive Nature of Agreement. This Agreement does not grant Consultant and/or its agents an exclusive privilege or right to supply Services to the Watermaster. Other than as expressly set forth in this Agreement, the Watermaster makes no representations or warranties as to a minimum or maximum procurement of Services. Nothing in this Agreement will be construed as limiting in any manner the ability of Consultant and/or its agents to procure other engagements consistent with their obligations to the Watermaster hereunder, including the post-Term obligations.

d. Use of Name, Likeness and Biography. The Watermaster will have the right (but not the obligation) to make public announcements concerning the affiliation of Consultant and its agents with the Watermaster. The Watermaster will have the right (but not the obligation) to use, publish and broadcast, and to authorize others to do so, the name, photograph, likeness and biographical information of Consultant and its agents on any media, now known or later discovered, in connection with the business of the Watermaster.

e. Amendments; Waiver. This Agreement may not be amended except by a writing executed by all of the Parties hereto. No delay or omission by the Watermaster in exercising any right under this Agreement will operate as a waiver of that or any other right. No waiver by either Party of a right or remedy hereunder will be deemed to be a waiver of any other right or remedy or of any subsequent right or remedy of the same kind.

f. Provisions Subject to Applicable Law; Modification; Severability. All provisions of this Agreement will be applicable only to the extent that they do not violate any applicable law. If any term, provision, covenant, paragraph or condition of this Agreement is held to be invalid, illegal, or unenforceable by any court or arbitrator of competent jurisdiction, as to such jurisdiction that provision will be limited ("blue-penciled") to the minimum extent necessary so this Agreement will otherwise remain enforceable in full force and effect. To the extent such provision cannot be so modified, the offending provision will, as to such jurisdiction, be deemed severable from the remainder of this Agreement, and the remaining provisions of this Agreement will be construed to preserve to the maximum permissible extent the intent of the Parties and the purpose of this Agreement.

g. Notices. All notices, demands, consents, waivers, and other communications under this Agreement will be deemed to have been duly given when (i) delivered by hand; (ii) when received by the addressee, if sent by registered mail (return receipt requested), a nationally recognized overnight delivery service (signature requested) or electronic mail, in each case to the addresses or mail addresses set forth below (or to such other addresses as either Party may designate upon written notice):

If to Consultant:

Rauch Communication Consultants LLC
Attn: Martin Rauch
936 Old Orchard Road Campbell, CA 95008

Email: martin@rauchcc.com

If to the Watermaster:

Chino Basin Watermaster
Attn: Todd Corbin
9641 San Bernardino Road
Rancho Cucamonga, California 91730
Email: TCorbin@cbwm.org

With a copy (which will not constitute notice) to:

Brownstein Hyatt Farber Schreck, LLP
1021 Anacapa Street, 2nd Floor
Santa Barbara, California 93101
Attention: Scott Slater
Email: sslater@bhfs.com

h. Construction. The Section headings in this Agreement are for convenience and reference only, and the words contained therein in no way will be held to explain, modify, amplify or aid in the interpretation, construction, or meaning of the provisions of this Agreement. The word "including" will mean "including but not limited to." The word "agents" includes employees, contractors, subcontractors, agents, owners and other representatives. Both Parties participated in the drafting of this Agreement, and each had the opportunity to consult with counsel of their own choosing in connection therewith. The rule that ambiguities in an agreement will be construed against the drafter does not apply to this Agreement.

i. Force Majeure. Each Party's obligations hereunder will be suspended during the duration of events beyond that Party's reasonable control (including labor strikes, lockouts, enactment of laws or regulations, civil unrest, pandemics, diseases, measures implemented by any governmental authority, and acts of God), provided such Party makes reasonable efforts to perform and resumes performance at the earliest opportunity. If Consultant suspends the Services for a period in excess of five (5) calendar/business days, the Watermaster may elect to terminate this Agreement immediately thereafter by providing written notice thereof, notwithstanding anything to the contrary in Section 5 of this Agreement.

j. Governing Law; Venue; Fees. This Agreement is entered into and will be governed by and construed and enforced in accordance with the laws of the State of California and the United States as applied to agreements among California residents entered into and to be performed entirely within the State of California. Unless waived by the Watermaster in writing for the particular instance, the sole jurisdiction and venue for actions related to the subject matter hereof will be the Court maintaining jurisdiction over the case *Chino Basin Municipal Water District v. City of Chino*, San Bernardino Superior Court Case No. RCV RS 51010. The Parties irrevocably consent to the exclusive jurisdiction of such court (and of the appropriate appellate courts therefrom) in any such action, suit or proceeding. The substantially prevailing Party in any action related to this Agreement, including the breach or enforcement hereof, will be entitled to recover its costs and reasonable attorneys' fees and expenses, including expert witness fees, to the fullest extent permitted by applicable law.

k. Legal and Equitable Remedies. Because Consultant's Services are personal and unique, and because Consultant and its agents will have access to and become acquainted with the Confidential Information (as defined above), the Watermaster will have the right to enforce this Agreement and any of its provisions by injunction, specific performance or other equitable relief, without bond or other security, without prejudice to any other rights and remedies that the Watermaster may have for a breach of this Agreement, and Consultant and its agents waive the claim or defense that the Watermaster has an adequate remedy at law.

l. Authority; Counterparts. Each Party represents and warrants that it has full power and authority to enter into this Agreement. This Agreement may be executed in separate counterparts, each of which will be deemed an original, and both of which taken together will constitute one and the same instrument. A facsimile, pdf, DocuSigned or emailed signature will have the same force and effect as an original signature.

ACKNOWLEDGED AND AGREED:

Rauch Communication Consultants LLC	**Chino Basin Watermaster**
By: ____________________	By: ____________________
Martin Rauch	Todd Corbin
Its: Principal Consultant	Its: General Manager

ADDENDUM A: SCOPE OF WORK

Consultant will provide Martin Rauch and such other individuals as may be designated from time to time (the "Service Providers") with the approval of the Watermaster, and with the Watermaster having sole and absolute discretion to request removal of any such Service Provider to provide the Services described herein, which include the following:

[See attached]

rauch communication consultants inc.

Phone: 408-374-0977
Email: info@rauchcc.com
Web: www.rauchcc.com
936 Old Orchard Rd. Campbell, CA 95008

Dynamic Public Outreach, Smart Strategic Planning

For local governments, special districts, and the engineering, environmental and law firms that support them.

DATE: June 4, 2025 **NO OF PAGES:** 3

TO: Justin Nakano, Water Resources Technical Manager

FROM: Martin Rauch **RE:** Proposed Costs and Scope + Details of Hours

This document contains our proposed scope of work for the development of the 48th Annual Report. It includes a detailed description of the work, as well as the breakdown of costs by category and hours per person.

The Annual Report development process that has been implemented in the last couple of years has worked smoothly and effectively. We propose to continue the same process as outlined below.

RESEARCH AND OUTLINING OF INFORMATION

<u>Kickoff meeting.</u> RCC will participate with staff and the engineer to review key actions, themes, and messages contained within the staff narrative. It is ideal if the General Manager can participate in the kickoff meeting; if not, we will seek to obtain the General Manager's comments as early in the process as possible.

1. <u>Coordinate with staff to gather information, review questions, etc.</u>
2. <u>Review background documents and develop a detailed outline of actions</u>, from the State of the Basin Report, Status Reports, Agendas and Minutes, and other reports and studies, as well as any other documents suggested by staff.
3. <u>Collect, research, and evaluate photos.</u> RCC will suggest photo needs to CBWM and evaluate photos provided by staff for suitability. RCC will also search its own photo collection as well as royalty-free collections it subscribes to.

WRITING AND EDITING

4. <u>Write the entire document</u>, including the development of headlines, captions, opening letter, pull quotes, etc. Edit the document to ensure the content fits into the book structure and spreads, and effectively communicates Watermaster's key information and messages.
5. <u>Coordinate review and editing with the client</u> in MSWord until we have a solid draft and, then develop an initial version in the design software to establish what fits, the photo needs, the colors, and the look of the document. Finally, and late in the process, a near-final designed version would be prepared for final edits.
6. <u>Dedicated Proof Reading.</u> To ensure quality control, we will continue the use of a dedicated proofreader at a minimum of three points: at the end of the initial writing process just before design; when there is deemed to be a first complete draft before the second designed draft is developed; and of the entire book (including appendices) just before printing.

APPENDICES

7. <u>Update Current Appendices.</u> Rauch Communication Consultants (RCC) has identified final version of

each appendix from the 47th Annual Report, which includes all approved edits and formatting. These files will be located on a secure password-protected RCC server ready to be used as a clean starting point for the 47th Annual Report. RCC will provide all team members with login and editing capabilities at the beginning of the program.

Later in the program, CBWM will advise RCC when all appendix files have been updated. RCC will then produce an unframed PDF draft of the entire appendices for review. CBWM will review and provide any final edits to RCC.

8. RCC will proof, review, and incorporate the appendices into the book with the framework, new header and page number, and separator pages as we have done in the past. RCC will provide minor formatting to ensure pages break appropriately to fill pages as closely as reasonably possible, footers align, font sizes are consistent (where practical), and left-right spreads are maintained as appropriate. Any additional steps would be charged on a time and materials basis.

G0VERNANCE SECTION

9. CBWM will submit the list of members late in the program. RCC will review the list and suggest possible edits, and then CBWM will submit the final Governance list for inclusion in the report. RCC will make any corrections from this round of reviews. Any additional steps would be charged for time and materials.

GRAPHIC DESIGN AND LAYOUT

10. Complete turn-key graphic design and layout. This includes the development of cover options, color and design themes, photo placement, color correction as needed, text layout, and development of graphics, tables, graphs, etc. The final draft would be deemed complete once all the elements, for example, text, captions, headings, graphics, layout, etc., are submitted for approval, reviewed by the client, and any corrections made. After that, any further changes, besides grammatical fixes would be time and materials.

ESTIMATED COST

We propose to complete the project so as not to exceed the time and materials required by $24,475.

COST ESTIMATE DETAILS

48th Annual Report Proposal	Senior Consultant	Graphic Design	Writing, Research	Admin. + Production	Subtotal
	$225	**$105**	**$90**	**$95**	
Hours	7	0	6	0	13
Step 1. Research and coordination	$1,575	$0	$540	$0	$2,115
Hours	40	0	12	2	54
Step 2. Outline, write, edit, proof document	$9,000	$0	$1,080	$190	$10,270
Hours	7	33	0	1	41
Step 3. Graphic design, select and choose photos, frame appendices	$1,575	$3,465	$0	$95	$5,135
Hours	4	31	10	20	65
Step 4. Review, comment and insert appendices with consistent formatting	$900	$3,255	$900	$1,900	$6,955
TOTAL	$13,050	$6,720	$2,520	$2,185	**$24,475**

This is an estimated time and materials cost, not to exceed cost. Overall costs may be less. Costs for individual tasks may vary, but the total will not exceed the estimate without advance agreement in writing (email) from the client. No out-of-scope work will be undertaken without prior email approval from the agency. Out-of-scope work includes new tasks or extra work on existing tasks that exceed the total estimated cost for the project.

Current Rates. Management and Strategic Planning Consulting for the senior consultants is $245 per hour. The outreach and public involvement programs rate for the senior consultants is $225 per hour. Outreach and public involvement programs rate for associate consultants is $115 per hour. The graphic designer and webmaster services rate is $105 per hour. Social media, writing specialist's rate, and project administrator is $90 to $95 per hour.

Travel and Expenses Additional. We expect some costs to purchase photos between $25 and $200 above the labor cost shown above. Subject to the terms of the Professional Public Outreach Service Agreement, basic material expenses, including travel expenses (transportation and lodging), office printing, shipping, and sales tax, are additional and passed on at cost. Car mileage is at the IRS California rate at the time or the actual rental car cost plus fuel. For meetings involving travel, the minimum charge is four hours.

We look forward to continuing to work with you on this important project. Please let me know if you have any questions or if there is anything else, we can do to help.

Sincerely,

____

Martin Rauch, Principal Consultant
Rauch Communication Consultants, Inc.

ADDENDUM B: DISCLOSURE OF RESTRICTIVE COVENANTS

Consultant hereby discloses all restrictions to which Consultant and/or its agents who may be performing the Services are or may be subject, including restrictive covenants and non-compete obligations, in order to allow the Watermaster the opportunity to assess any such restrictions and their potential impact on the Watermaster and/or the performance of the Services. Consultant understands that such restrictions may be included in, among other things, confidentiality agreements, consulting agreements, employment agreements, separation agreements, employee handbooks, option agreements, and other types of documents. Consultant agrees to provide copies of the applicable restrictive covenants promptly upon request. Consultant further agrees to update this Disclosure promptly upon any changes to the information provided.

Check one:

☐ Neither Consultant nor its agents are subject to any restrictive covenants or non-compete provisions that may impact the performance of the Services.

☐ Consultant and/or its agents are subject to the following restrictive covenants or non-compete provisions that may impact the performance of the Services:

____

____

____

____

____

____

ADDENDUM C: POLICIES APPLICABLE TO CONSULTANT

- 2.5 – Equal Employment Opportunity
- 4.6 – Conflicts of Interest
- 4.7 – Confidential Information and Watermaster Records
- 4.13 – Safety
- 4.17 – Use of Company Computers and Other Equipment
- 4.18 – Harassment and Discrimination
- 4.19 – Inspections, Searches and Monitoring
- 4.20 – Right to Search
- 4.21 – Smoking
- 4.22 – Voicemail, E-Mail and Technology
- 4.23 – Social Media
- Appendix B – Substance Abuse Policy

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ESTIMATED COST

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COST ESTIMATE DETAILS

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We look forward to continuing to work with you on this important project. Please let me know if you have any questions or if there is anything else, we can do to help.

Sincerely,

Martin Rauch, Principal Consultant
Rauch Communication Consultants, Inc.

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888 www.cbwm.org

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: West Yost Contract Amendment for FY 2025/26 (Updated Rates) (Consent Calendar Item I.F.)

Issue: The current contract with West Yost & Associates, Inc. (West Yost) allows for a 5% increase in the first year. [Normal Course of Business]

Recommendation: Information Only

Financial Impact: None. The approved FY 2025/26 budget reflects the updated billing rates.

ACTIONS:
Watermaster Board – June 26, 2025 [Recommended]: Information Only.

BACKGROUND

Watermaster contracts with West Yost Associates, Inc. for engineering services related to enforcement of the Judgment and implementation of the Optimum Basin Management Program (OBMP). West Yost's scope includes among other items, support with Watermaster's reporting requirements, periodic calculation of the safe yield of Chino Basin, assistance with the ongoing monitoring program (water levels, ground levels, water quality, production, Prado Basin habitat, etc.), studies (e.g. salinity study), attendance at various meetings, and development of management plans (OBMP, Recharge, Ground Level Movement, etc.).

The current contract with West Yost, approved by the Board in June 2024, allows for a 5% increase in the first year. West Yost has been providing valuable services to Watermaster, and it is essential to ensure that their billing rates are updated to reflect the current market conditions. The proposed billing rates for FY 2025/26 and FY 2024/25 can be found in Attachment 1.

DISCUSSION

Watermaster staff have conducted an analysis of the proposed billing rates for FY 2025/26 and confirmed that the proposed changes align with the provision in the current contract that allows for a 5% increase in the first year. Attachment 2 to this report includes an analysis performed by staff confirming that the proposed changes are in line with this provision.

ATTACHMENTS
1. FY 2025/26 WY Rate Schedule
2. WY Rate analysis

ATTACHMENT 1

WEST YOST
Water. Engineered.

Fiscal Year 2025/26 Billing Rate Schedule

Chino Basin Watermaster

(Effective July 1, 2025, through June 30, 2026)*

POSITIONS	LABOR CHARGES (DOLLARS PER HOUR)
ENGINEERING	
Principal/Vice President	$373
Engineer/Scientist/Geologist Manager I / II	$352 / $369
Principal Engineer/Scientist/Geologist I / II	$317 / $338
Senior Engineer/Scientist/Geologist I / II	$286 / $300
Associate Engineer/Scientist/Geologist I / II	$237 / $255
Engineer/Scientist/Geologist I / II / III	$185 / $215 / $224
Engineering Aide	$111
Field Monitoring Services	$138
Administrative I / II / III / IV	$102 / $127 / $152 / $168
ENGINEERING TECHNOLOGY	
Engineering Tech Manager I / II	$366 / $369
Principal Tech Specialist I / II	$336 / $348
Senior Tech Specialist I / II	$308 / $321
Senior GIS Analyst	$278
GIS Analyst	$264
Technical Specialist I / II / III / IV	$196 / $224 / $251 / $280
Technical Analyst I / II	$141 / $168
Technical Analyst Intern	$113
Cross-Connection Control Specialist I / II / III / IV	$147 / $159 / $179 / $198
CAD Manager	$222
CAD Designer I / II	$172 / $194
CONSTRUCTION MANAGEMENT	
Senior Construction Manager	$355
Construction Manager I / II / III / IV	$211 / $226 / $239 / $303
Resident Inspector (Prevailing Wage Groups 4 / 3 / 2 / 1)	$190 / $211 / $235 / $244
Apprentice Inspector	$172
CM Administrative I / II	$91 / $124
Field Services	$244

- Hourly rates include charges for technology and communication, such as general and CAD computer software, telephone calls, routine in-house copies/prints, postage, miscellaneous supplies, and other incidental project expenses.
- Outside services, such as vendor reproductions, prints, and shipping; major West Yost reproduction efforts; as well as engineering supplies, etc., will be billed at the actual cost.
- The Federal Mileage Rate will be used for mileage charges and will be based on the Federal Mileage Rate applicable to when the mileage costs were incurred. Travel other than mileage will be billed at cost.
- Subconsultants will be billed at actual cost.
- Expert witness services, research, technical review, analysis, preparation, and meetings will be billed at 150% of standard hourly rates. Expert witness testimony and depositions will be billed at 200% of standard hourly rates.
- A finance charge of 1.5% per month (an annual rate of 18%) on the unpaid balance will be added to invoice amounts if not paid within 45 days from the date of the invoice.

* This schedule is updated annually

Fiscal Year 2025/26 Billing Rate Schedule
Chino Basin Watermaster
(Effective July 1, 2025, through June 30, 2026)*

Equipment Charges

EQUIPMENT	BILLING RATES
2" Purge Pump & Control Box	$300 / day
Aquacalc / Pygmy or AA Flow Meter	$28 / day
Emergency SCADA System	$35 / day
Field Vehicles (Groundwater)	$1.02 / mile
Gas Detector	$80 / day
Generator	$60 / day
Hydrant Pressure Gauge	$10 / day
Hydrant Pressure Recorder, Impulse (Transient)	$55 / day
Hydrant Pressure Recorder, Standard	$40 / day
Low Flow Pump Back Pack	$135 / day
Low Flow Pump Controller	$200 / day
Powers Water Level Meter	$32 / day
Precision Water Level Meter 300ft	$30 / day
Precision Water Level Meter 500ft	$40 / day
Precision Water Level Meter 700ft	$45 / day
QED Sample Pro Bladder Pump	$65 / day
Skydio 2+ Drone (2 hour minimum)	$100 / hour
Storage Tank	$20 / day
Sump Pump	$24 / day
Transducer Communications Cable	$10 / day
Transducer Components (per installation)	$23 / day
Trimble GPS – Geo 7x	$220 / day
Tube Length Counter	$22 / day
Turbidity Meter	$30 / day
Turbidity Meter (2100Q Portable)	$35 / day
Vehicle (Construction Management)	$10 / hour
Water Flow Probe Meter	$20 / day
Water Quality Meter	$50 / day
Water Quality Multimeter	$185 / day
Well Sounder	$30 / day

* This schedule is updated annually

Fiscal Year **2024**/25 **Billing Rate Schedule**
Chino Basin Watermaster

(Effective July **1, 2024, through** June **30, 2025)***

POSITIONS	LABOR CHARGES (DOLLARS PER HOUR)			
ENGINEERING				
Principal/Vice President				$355
Engineer/Scientist/Geologist Manager I / II			$335 /	$351
Principal Engineer/Scientist/Geologist I / II			$302 /	$322
Senior Engineer/Scientist/Geologist I / II			$272 /	$286
Associate Engineer/Scientist/Geologist I / II			$226 /	$243
Engineer/Scientist/Geologist I / II			$176 /	$205
Engineering Aide				$106
Field Monitoring Services				$131
Administrative I / II / III / IV	$97 /	$121 /	$145 /	$160
ENGINEERING TECHNOLOGY				
Engineering Tech Manager I / II			$349 /	$351
Principal Tech Specialist I / II			$320 /	$331
Senior Tech Specialist I / II			$293 /	$306
Senior GIS Analyst				$265
GIS Analyst				$251
Technical Specialist I / II / III / IV	$187 /	$213 /	$239 /	$267
Technical Analyst I / II			$134 /	$160
Technical Analyst Intern				$108
Cross-Connection Control Specialist I / II / III / IV	$140 /	$151 /	$170 /	$189
CAD Manager				$211
CAD Designer I / II			$164 /	$185
CONSTRUCTION MANAGEMENT				
Senior Construction Manager				$338
Construction Manager I / II / III / IV	$201 /	$215 /	$228 /	$289
Resident Inspector (Prevailing Wage Groups 4 / 3 / 2 / 1)	$181 /	$201 /	$224 /	$232
Apprentice Inspector				$164
CM Administrative I / II			$87 /	$118
Field Services				$232

- Hourly rates include charges for technology and communication, such as general and CAD computer software, telephone calls, routine in-house copies/prints, postage, miscellaneous supplies, and other incidental project expenses.
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(Effective July 1, 2024, through June 30, 2025)*

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Generator	$60 / day
Hydrant Pressure Gauge	$10 / day
Hydrant Pressure Recorder, Impulse (Transient)	$55 / day
Hydrant Pressure Recorder, Standard	$40 / day
Low Flow Pump Back Pack	$135 / day
Low Flow Pump Controller	$200 / day
Powers Water Level Meter	$32 / day
Precision Water Level Meter 300ft	$30 / day
Precision Water Level Meter 500ft	$40 / day
Precision Water Level Meter 700ft	$45 / day
QED Sample Pro Bladder Pump	$65 / day
Storage Tank	$20 / day
Sump Pump	$24 / day
Transducer Communications Cable	$10 / day
Transducer Components (per installation)	$23 / day
Trimble GPS – Geo 7x	$220 / day
Tube Length Counter	$22 / day
Turbidity Meter	$30 / day
Turbidity Meter (2100Q Portable)	$35 / day
Vehicle (Construction Management)	$10 / hour
Water Flow Probe Meter	$20 / day
Water Quality Meter	$50 / day
Water Quality Multimeter	$185 / day
Well Sounder	$30 / day

* This schedule is updated annually

CHINO BASIN WATERMASTER
COMPARISON OF WEST YOST BILLING RATES
06/11/2025

ATTACHMENT 2

CATEGORY	FY 2024/2025 RATE	FY 2025/2026 RATE	$ DIFFERENCE	% DIFFERENCE
ENGINEERING				
Principal/Vice Principal	$355	$373	$18	5.07%
Engineer/Scientist/Geologist Manager I	$335	$352	$17	5.07%
Engineer/Scientist/Geologist Manager II	$351	$369	$18	5.13%
Principal Engineer/Scientist/Geologist I	$302	$317	$15	4.97%
Principal Engineer/Scientist/Geologist II	$322	$338	$16	4.97%
Senior Engineer/Scientist/Geologist I	$272	$286	$14	5.15%
Senior Engineer/Scientist/Geologist II	$286	$300	$14	4.90%
Associate Engineer/Scientist/Geologist I	$226	$237	$11	4.87%
Associate Engineer/Scientist/Geologist II	$243	$255	$12	4.94%
Engineer/Scientist/Geologist I	$176	$185	$9	5.11%
Engineer/Scientist/Geologist II	$205	$215	$10	4.88%
Engineer/Scientist/Geologist III (New)		**$224**		
Engineering Aide	$106	$111	$5	4.72%
Field Monitoring Services	$131	$138	$7	5.34%
Administrative I	$97	$102	$5	5.15%
Administrative II	$121	$127	$6	4.96%
Administrative III	$145	$152	$7	4.83%
Administrative IV	$160	$168	$8	5.00%
ENGINEERING TECHNOLOGY				
Engineering Tech Manager I	$349	$366	$17	4.87%
Engineering Tech Manager II	$351	$369	$18	5.13%
Principal Tech Specialist I	$320	$336	$16	5.00%
Principal Tech Specialist II	$331	$348	$17	5.14%
Senior Tech Specialist I	$293	$308	$15	5.12%
Senior Tech Specialist II	$306	$321	$15	4.90%
Senior GIS Analyst	$265	$278	$13	4.91%
GIS Analyst	$251	$264	$13	5.18%
Technical Specialist I	$187	$196	$9	4.81%
Technical Specialist II	$213	$224	$11	5.16%
Technical Specialist III	$239	$251	$12	5.02%
Technical Specialist IV	$267	$280	$13	4.87%

CATEGORY	FY 2024/2025 RATE	FY 2025/2026 RATE	$ DIFFERENCE	% DIFFERENCE
Technical Analyst I	$134	$141	$7	5.22%
Technical Analyst II	$160	$168	$8	5.00%
Technical Analyst Intern	$108	$113	$5	4.63%
Cross-Connection Control Specialist I	$140	$147	$7	5.00%
Cross-Connection Control Specialist II	$151	$159	$8	5.30%
Cross-Connection Control Specialist III	$170	$179	$9	5.29%
Cross-Connection Control Specialist IV	$189	$198	$9	4.76%
CAD Manager	$211	$222	$11	5.21%
CAD Designer I	$164	$172	$8	4.88%
CAD Designer II	$185	$194	$9	4.86%
CONSTRUCTION MANAGEMENT				
Senior Construction Manager	$338	$355	$17	5.03%
Construction Manager I	$201	$211	$10	4.98%
Construction Manager II	$215	$226	$11	5.12%
Construction Manager III	$228	$239	$11	4.82%
Construction Manager IV	$289	$303	$14	4.84%
Resident Inspector (Prevailing Wage Group 4)	$181	$190	$9	4.97%
Resident Inspector (Prevailing Wage Group 3)	$201	$211	$10	4.98%
Resident Inspector (Prevailing Wage Group 2)	$224	$235	$11	4.91%
Resident Inspector (Prevailing Wage Group 1)	$232	$244	$12	5.17%
Apprentice Inspector	$164	$172	$8	4.88%
CM Administrative I	$87	$91	$4	4.60%
CM Administrative II	$118	$124	$6	5.08%
Field Services	$232	$244	$12	5.17%

5.00% Average Increase

CHINO BASIN WATERMASTER

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STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: 2024 Annual Report of the Prado Basin Habitat Sustainability Program (Business Item II.A.)

Issue: Pursuant to the monitoring and mitigation requirements of the Peace II Subsequent Environmental Impact Report, the Prado Basin Habitat Sustainability Committee must prepare an Annual Report. The Committee presents its 9th Annual Report for Water Year 2024. [Within WM Duties and Powers]

Recommendation: Recommend the Watermaster Board receive and file the 2024 Annual Report, as presented.

Financial Impact: None.

ACTIONS:
Appropriative Pool – June 12, 2025 [Final]: Provided advice and assistance
Non-Agricultural Pool – June 12, 2025 [Final]: Provided advice and assistance..
Agricultural Pool – June 12, 2025 [Final]: Provided advice and assistance..
Advisory Committee – June 19, 2025 [Final]: Provided advice and assistance.
Watermaster Board – June 26, 2025 [Recommended]: Receive and file.

BACKGROUND

The Prado Flood Control Basin (Prado Basin) is located in the southernmost, downgradient portion of the Chino Groundwater Basin (Chino Basin). Surface-water flow within the middle Santa Ana River (SAR) and its tributaries discharge into and through the Prado Basin behind Prado Dam, the main flood-control facility on the middle SAR. The US Army Corps of Engineers, in coordination with the Orange County Water District (OCWD), regulates releases from Prado Dam for the purposes of flood control and groundwater recharge in Orange County. The SAR and its tributaries are unlined across the Prado Basin, which allows for groundwater/surface-water interaction. Depth to groundwater is relatively shallow in the Prado Basin area, where groundwater losses can occur via evapotranspiration by riparian vegetation and rising-groundwater outflow to the SAR and its tributaries.

The surface-water impoundments behind Prado Dam and the shallow groundwater have created within Prado Basin the largest riparian forest in Southern California. The riparian forest provides critical habitat for various threatened and endangered species including the Least Bell's vireo, Southwestern willow flycatcher, and the Santa Ana sucker.

To further implement the goals and objectives of the Chino Basin Optimum Basin Management Program (OBMP), the Chino Basin Watermaster (Watermaster) executed the Peace II Agreement in 2007. The primary features of the Peace II Agreement are expansion of pumping at the Chino Basin Desalter wells and Basin Re-operation for the attainment of Hydraulic Control of the Chino Basin. Hydraulic Control is defined as the elimination of groundwater discharge from the Chino-North Groundwater Management Zone (GMZ) to the Prado Basin, or its reduction to *de minimis* quantities (i.e., less than 1,000 acre-feet per year [afy]). Hydraulic Control ensures that the water management activities in the Chino-North GMZ will not impair the beneficial uses designated for the SAR downstream of Prado Dam. Basin Re-operation means the increase in controlled overdraft of the Chino Basin, as defined in the Judgment, from 200,000 acre-ft (af) over the period of 1978 through 2017 to 600,000 af through 2030. Both Chino Basin Desalter expansion and Basin Re-operation are required to achieve Hydraulic Control. Hydraulic Control was achieved in 2016 and will be maintained through Chino Desalter well pumping of 40,000 afy, and the completion of Basin Re-operation.

At the time of its consideration, OCWD expressed concern that one of the potential impacts of the Peace II Agreement activities described above would be the lowering of groundwater levels (drawdown) in the Prado Basin area, which might impact the riparian habitat that is dependent upon groundwater. To address the potential drawdown and its impact on the riparian habitat, the monitoring and mitigation requirements in the Peace II Subsequent Environmental Impact Report (SEIR) calls for the development and implementation of an adaptive management program for the Prado Basin habitat:

Biological Resources/Land Use & Planning—Section 4.4-3 of the Peace II SEIR
The Chino Basin Stakeholders are committed to ensuring that the Peace II Agreement actions will not significantly adversely impact the Prado Basin riparian habitat. This includes the riparian portions of Chino and Mill Creek's between the terminus of hard lined channels and Prado Basin proper.

The available modeling data in the SEIR indicates that Peace II Agreement implementation will not cause significant adverse effects on the Prado Basin riparian habitat. However, the following contingency measure will be implemented to ensure that the Prado Basin riparian habitat will not incur unforeseeable significant adverse effects, due to implementation of Peace II. IEUA, Watermaster, OCWD and individual stakeholders, that choose to participate, will jointly fund and develop an adaptive management program that will include, but not be limited to:

- *monitoring riparian habitat quality and extent;*
- *investigating and identifying essential factors to long-term sustainability of Prado Basin riparian habitat*
- *identification of specific parameters that can be monitored to measure potential effects of Peace II Agreement implementation effects on Prado Basin; and*
- *identification of water management options to minimize the Peace II Agreement effects on Prado Basin*

This adaptive management program will be prepared as a contingency to define available management actions by Prado Basin stakeholders to address unforeseeable significant adverse impacts, as well as to contribute to the long-term sustainability of the Prado Basin riparian habitat.

The above effort will be implemented under the supervision of a newly formed Prado Basin Habitat Sustainability Committee. This Committee will include representatives from all interested parties and will be convened by the Watermaster and IEUA. Annual reports will be prepared and will include recommendations for ongoing monitoring and any adaptive management actions required to mitigate any measured loss or prospective loss of riparian habitat that may be attributable to the Peace II Agreement. As determined by Watermaster and IEUA, significant adverse impacts to riparian habitat that are attributable to the Peace II Agreement will be mitigated.

Pursuant to these monitoring and mitigation requirements of the Peace II SEIR, the Inland Empire Utilities Agency (IEUA) and the Watermaster convened the Prado Basin Habitat Sustainability Committee (PBHSC) to develop the Prado Basin Habitat Sustainability Program (PBHSP). The PBHSP is an adaptive management program to ensure that the riparian habitat in the Prado Basin will not incur unforeseeable significant adverse effects due to implementation of the Peace II Agreement. Annual reports are prepared to document monitoring and modeling activities, the analysis and interpretation of the monitoring and modeling results, and any recommendations for changes to the PBHSP.

DISCUSSION

The Annual Report for Water Year 2024 is the ninth annual report prepared by the Watermaster and IEUA for the PBHSP. It documents the collection, analysis, and interpretations of the data and information generated by the PSHSP through October 31, 2024, and is organized into the following sections:

Section 1 – Background and Objectives This section describes the background and objectives of the PBHSP and the Annual Report.

Section 2 – Monitoring, Data Collection, and Methods This section describes the collection of recent monitoring data, and the groundwater-modeling activities performed during Water Year 2024 for the PBHSP.

Section 3 – Results and Interpretations This section describes the results and interpretations that were derived from the information, data, and groundwater-modeling.

Section 4 – Conclusions and Recommendations This section summarizes the main conclusions derived from the PBHSB through the prior water year and describes the recommended activities for the subsequent fiscal year as a proposed scope-of-work, schedule, and budget.

Section 5 – References This section lists the publications cited in the report.

The draft Annual Report for Water Year 2024 was published and distributed on May 1, 2025. Watermaster and IEUA presented the draft report to members of the PBHSC at a meeting on May 14, 2025. A four-week comment period was provided; comments were received and responded to in Appendix D of the Annual Report.

The main interpretations and findings of the PBHSP Annual Report for Water Year 2024 are:

- Based on the NDVI time series analysis, NDVI spatial change maps, and aerial photos, the quality (greenness) of the riparian habitat vegetation either decreased or remained stable across most of the Prado Basin from 2023 to 2024. All observed decreases in vegetation greenness were relatively minor and within range of historical one-year changes. These decreases occurred during a time of stable or increasing groundwater levels and above-average precipitation for Water Year 2024, although precipitation was less than the previous year.
- There were two notable areas of decreases in greenness observed in the Prado Basin between 2023 and 2024, which were likely caused by reduced growth of perennial vegetation due to lower precipitation compared to the previous year, as well as some scouring along the edges of the creeks and river from the previous wet year. None of the reductions in greenness were related to declining groundwater levels during the period of Peace II Agreement implementation.
- From 2023-2024, groundwater levels at the PBHSP monitoring wells along Chino Creek, Mill Creek, and the Santa Ana River in the Prado Basin remained stable and changed less than one foot at most wells.
- From 2016-2024, groundwater levels throughout most of the riparian vegetation extent in reaches of Chino Creek, Mill Creek and SAR changed less than 5 feet, but there are some notable areas of change:
    - The northern portion of Mill Creek just south of monitoring well PB-2 saw groundwater levels decline by about eight feet from 2016-2022, likely due to increased pumping at the Chino Desalter well to the north. During 2023 and 2024, groundwater levels increased by about four feet in this area, for a net change in groundwater levels of minus four feet since 2016 During Water Year 2024, groundwater levels remained mostly stable and the depth to groundwater is at an estimated depth of 10-15ft-bgs. Recent observations of the air photos in 2024 have noted a decline in the greenness of the riparian vegetation in this northern area of Mill Creek reach.
    - At the northernmost reach of Mill Creek near PB-2, additional declines in groundwater levels in the area could result in adverse impacts to the riparian habitat.
    - Groundwater levels at the northern reach of Chino Creek increased by about ten feet from 2016-2024, likely due to decreased pumping in the area.
    - Groundwater-level declines in the northern reach of the SAR near PB-3 are not a concern for the riparian vegetation because the depth to groundwater in this area is shallow (4 to 8ft-bgs) and is supported by SAR recharge.
- PBHSP monitoring and reporting should continue to monitor the extent and quality of the riparian habitat and the factors that can influence it as it has been conducted through Water Year 2024. The additional monitoring in the northernmost reach of Mill Creek set up in 2022 should continue as well. While the overall threat to riparian vegetation health has decreased following an increase in groundwater levels from 2023 to 2024 and reduced production at the CDA wells, it remains important to monitor any potential impacts to the extent and quality of the riparian habitat that could be caused by the lowering of groundwater levels in this area. Vegetation surveys will be conducted during WY 2025 and will be tailored to focus on the northern portion of Mill Creek to verify and document current vegetation conditions relative to those of the recent past. Any recommended enhancements to the monitoring program based on the vegetation surveys can be reviewed and incorporated by the PBHSC as appropriate.
- The high-frequency monitoring for groundwater elevation, temperature and EC at each pair of PBHSP monitoring wells and nearby surface water field measurements, initiated in 2023, should continue to better characterize groundwater/surface water interactions.

Once adopted by the Watermaster Board, a copy of the Annual Report of the Prado Basin Habitat Sustainability Program Water Year 2024 will be considered received and filed.

At the June 19, 2025 Advisory Committee meeting, the Committee unanimously recommended the Watermaster Board to receive and file.

ATTACHMENTS
1. Annual Report of the Prado Basin Habitat Sustainability Program Water Year 2024

FINAL REPORT | JUNE 2025

Annual Report of the Prado Basin Habitat Sustainability Program Water Year 2024

PREPARED FOR

Chino Basin Watermaster and
Inland Empire Utilities Agency

PREPARED BY

Annual Report of the Prado Basin Habitat Sustainability Committee Water Year 2024

Prepared for

Chino Basin Watermaster and Inland Empire Utilities Agency

Project No. 941-80-24-16

06/05/2025

Project Manager: Lucy Hedley | Date

06/05/2025

Project Manager: Veva Weamer | Date

06/05/2025

QA/QC Review: Andy Malone | Date

WEST YOST
Water. Engineered.

FINAL REPORT | JUNE 2025

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LIST OF ACRONYMS AND ABBREVIATIONS

ACOE	Army Corps of Engineers
af	Acre-Feet
afy	Acre-Feet Per Year
AMP	Adaptive Management Plan
Annual Report	Annual Report of The Prado Basin Habitat Sustainability Committee
CAL FIRE	California Department of Forestry and Fire Protection
CBMWD	Chino Basin Municipal Water District
CBWM	Chino Basin Watermaster
CCWF	Chino Creek Well Field
CDA	Chino Basin Desalter Authority
CDFM	cumulative departure from the mean
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
Chino Basin	Chino Groundwater Basin
DBH	Diameter at Breast Height
EC	Electrical Conductivity
EIR	Environmental Impact Report
EROS	Earth Resources Observation and Science
ESPA	Center Science Processing Architecture
FD	Fusarium Dieback
ft-amsl	Feet Above Mean Sea Level
ft-bgs	Feet Below Ground Surface
FRAP	Fire And Resource Assessment Program
GIS	Geographic Information System
GMP	Groundwater Monitoring Program
GMZ	Groundwater Management Zone
HCMP	Hydraulic Control Monitoring Program
IEUA	Inland Empire Utilities Agency
In/yr	Inches Per Year
LEDAPS	Landsat Ecosystem Disturbance Adaptive Processing System

mi^2	Square Miles
MWD	Metropolitan Water District of Southern California
NDVI	Normalized Difference Vegetation Index
NASA	National Aeronautics and Space Administration
NEXRAD	Next Generation Radar
OBMP	Optimum Basin Management Program
OC-59	The OCWD's Imported Water Turnout Tributary to Prado Basin
OCWD	Orange County Water District
Parties	Parties to The Chino Basin Judgment
PBHSC	Prado Basin Habitat Sustainability Committee
PBHSP	Prado Basin Habitat Sustainability Program
PBMZ	Prado Basin Management Zone
POTWs	Publicly Owned Treatment Works
ppm	Parts Per Million
Prado Basin	Prado Basin Management Zone
PSHB	Polyphagous Shot Hole Borer - *Euwallacea Fornicates*
QA/QC	Quality Assurance and Quality Control
RHMP	Riparian Habitat Monitoring Program
SAWA	Santa Ana Watershed Association
SAR	Santa Ana River
SARWM	Santa Ana River Watermaster
SEIR	Subsequent Environmental Impact Report
SWMP	Surface-Water Monitoring Program
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
USDA	United State Department of Agriculture
USFWS	United States Fish and Wildlife Service
VOCs	Volatile Organic Compounds
Watermaster	Chino Basin Watermaster
WEI	Wildermuth Environmental Inc.
WRCRWA	Western Riverside County Regional Wastewater Authority
WY	Water Year

2024 Annual Report of the Prado Basin Habitat Sustainability Program

1.0 BACKGROUND AND OBJECTIVES

This *Annual Report of the Prado Basin Habitat Sustainability Program for Water Year 2024* (Annual Report) was prepared on behalf of the Prado Basin Habitat Sustainability Committee (PBHSC), convened by the Inland Empire Utilities Agency (IEUA) and the Chino Basin Watermaster (Watermaster) pursuant to the mitigation monitoring and reporting requirements of the Peace II Subsequent Environmental Impact Report (SEIR) (Tom Dodson, 2010).

This introductory section provides background on the general hydrologic setting of the Prado Basin Management Zone (Prado Basin); the Chino Basin Judgment; the Optimum Basin Management Program (OBMP), its Programmatic Environmental Impact Report (EIR) and the Peace Agreement; the Peace II Agreement and its SEIR; and the formation of the PBHSC and the development of the adaptive management plan (AMP) for the Prado Basin Habitat Sustainability Program (PBHSP).

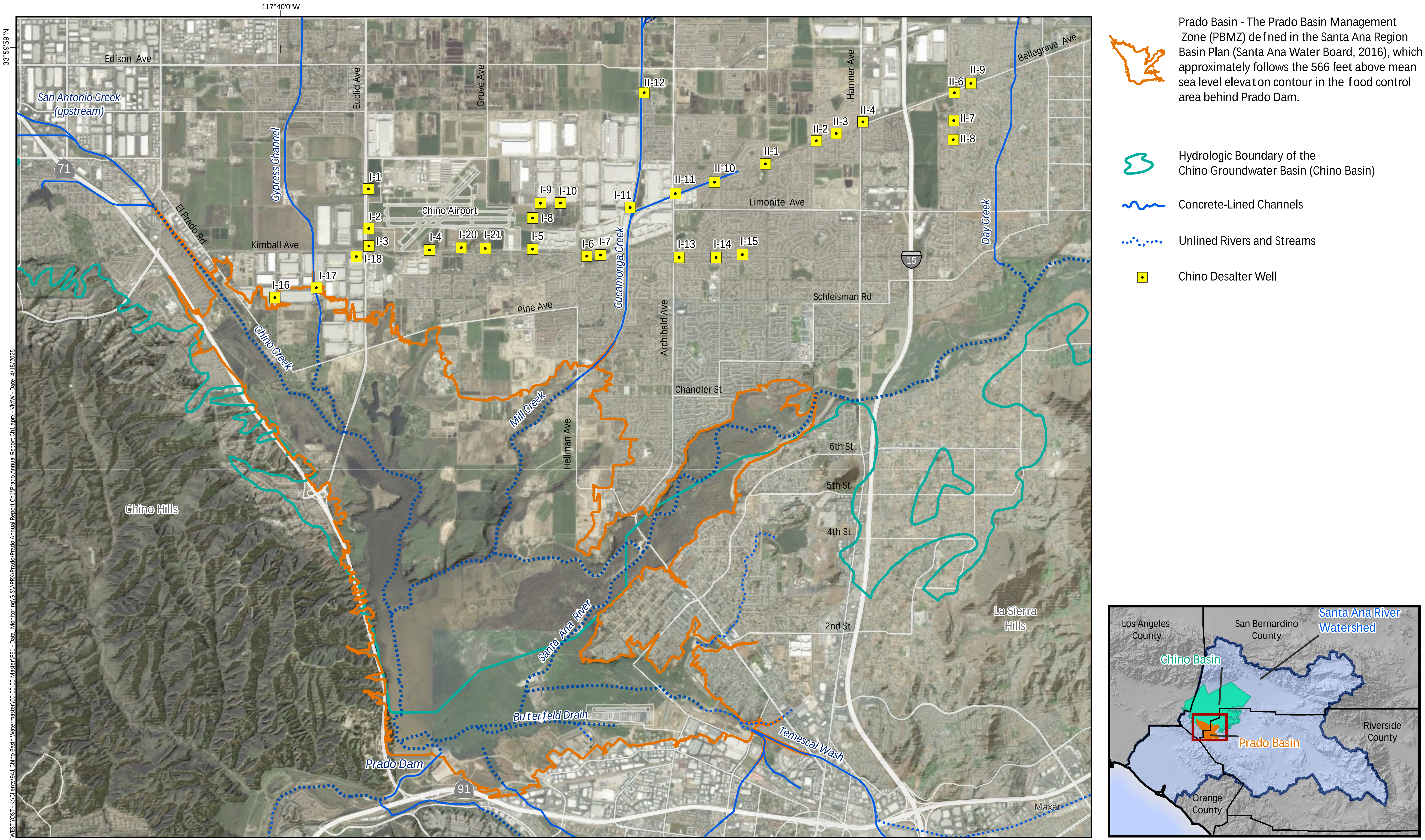
1.1 Prado Basin

The Prado Basin is the flood control area behind Prado Dam, which was constructed in 1941 as the major flood-control facility within the Santa Ana River (SAR) Watershed. The U.S. Army Corps of Engineers (ACOE) regulates releases of water from Prado Dam for both purposes of flood control and groundwater recharge in Orange County Groundwater Management Zone (GMZ). Releases of water temporarily held in storage in the Prado Basin for groundwater recharge in Orange County is coordinated with the Orange County Water District (OCWD). Figure 1-1 shows the location of the Prado Basin in the southern portion of the Chino Groundwater Basin (Chino Basin). The Prado Basin boundary shown on Figure 1-1 is the Prado Basin Management Zone (PBMZ) boundary as defined in the Water Quality Control Plan for the Santa Ana River Basin ([Basin Plan] Santa Ana Regional Water Quality Control Board [Santa Ana Water Board], 2016), which approximately follows the 566 feet above mean sea level (ft-amsl) elevation contour behind Prado Dam.

Approximately 4,300 acres of riparian habitat have developed within the Prado Basin, creating the largest riparian habitat in Southern California. Portions of the riparian habitat have been designated as critical habitat to several endangered or threatened species. Figure 1-2 shows the locations of the critical habitat, as defined by the U.S. Fish and Wildlife Service (USFWS). Most of the riparian habitat in Prado Basin is designated as critical habitat for one or multiple species, including the Santa Ana Sucker, the Southwestern Willow Flycatcher, and the Least Bell's Vireo.

The SAR flows through the Prado Basin from east to west. The tributaries of the SAR that flow into the Prado Basin include San Antonio/Chino, Cucamonga/Mill, and Temescal Creeks. The major components of flow within the SAR and its tributaries are runoff from precipitation, discharge of tertiary-treated effluent from wastewater treatment plants, rising groundwater, and dry-weather runoff.[1]

[1] Dry-weather runoff consists of excess irrigation runoff, purging of wells, dewatering discharges, etc.



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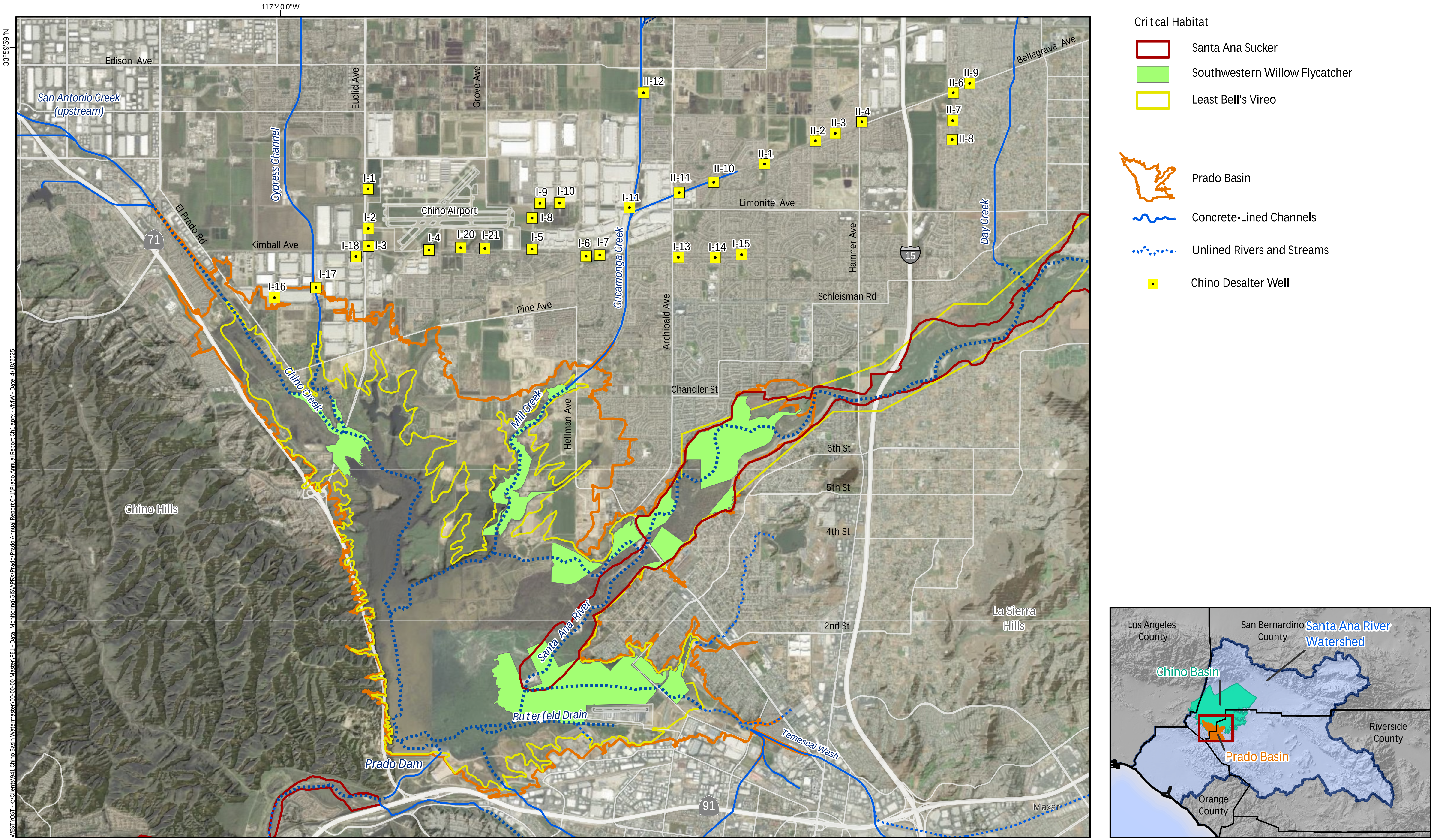
Prado Basin Habitat Sustainability Committee
2024 Annual Report

CHINO BASIN WATERMASTER Partners in Basin Management

Prado Basin Area

Figure 1-1



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Prepared for:

Prado Basin Habitat Sustainability Commi t ee
2024 Annual Report

Cri t cal Habitat for Endangered or Threatened Species in the Prado Basin Area

Figure 1-2

The Prado Basin is a hydrologically complex region of the lower Chino Basin. Groundwater in the Chino Basin generally flows from the forebay regions in the north towards the Prado Basin in the south. Depth to groundwater is relatively shallow in the Prado Basin area, and the SAR and its tributaries are unlined across the Prado Basin, which allows for groundwater/surface-water interaction. Groundwater outflows in the Prado Basin occur via evapotranspiration by riparian vegetation and rising-groundwater discharge to the SAR and its tributaries.

To the north of the Prado Basin, the Chino Basin Desalter Authority (CDA) owns and operates the Chino Desalter well field. Figure 1-1 shows the locations of Chino Desalter wells. The well field pumps groundwater with high concentrations of total dissolved solids (TDS) and nitrate. The CDA treats the groundwater at two regional facilities using reverse osmosis, ion exchange, and blending to produce a potable water supply for the region. CDA operations are fundamental to achieving many of the management goals outlined in the OBMP and both Peace Agreements, which are discussed below. The CDA facilities were expanded in 2021 and 2023 with additional treatment processes of air stripping and granulated activated carbon to treat for volatile organic compounds (VOCs) associated with the South Archibald plume and Chino Airport plume, respectively.

1.2 Chino Basin Judgment, OBMP, and Peace Agreement

A 1978 Judgment entered in the Superior Court of the State of California for the County of San Bernardino (Chino Basin Municipal Water District vs. City of Chino et al.) established pumping and storage rights in the Chino Basin. The Judgment established Watermaster to oversee the implementation of the Judgment and provided Watermaster with the discretionary authority to develop an OBMP to maximize the beneficial use of the Chino Basin. The OBMP was developed by Watermaster and the parties to the Judgment (Parties) in the late 1990s (Wildermuth Environmental Inc. [WEI], 1999). The OBMP maps a strategy to enhance the yield of the Chino Basin and provide reliable high-quality water supplies for the development expected to occur in the region. The goals of the OBMP are to enhance basin water supplies, to protect and enhance water quality, to enhance the management of the Basin, and to equitably finance the OBMP.

In 2000, the Parties executed the Peace Agreement (Watermaster, 2000), which documented their intent to implement the OBMP. The Peace Agreement included an OBMP Implementation Plan which outlined the time frame for implementing tasks and projects in accordance with the Peace Agreement and the OBMP. The OBMP Implementation Plan is a comprehensive, long-range water-management plan for the Chino Basin and includes: the use of recycled water for direct reuse and artificial recharge, the capture of increased quantities of high-quality storm-water runoff, the recharge of imported water when TDS concentrations are low, the desalting of poor-quality groundwater in impaired areas of the basin via the Chino Basin Desalters, the support of regulatory efforts to improve water quality in the basin, subsidence management, storage management, and the implementation of management activities to reduce the discharge of high-TDS/high-nitrate groundwater to the SAR, thus ensuring the protection of downstream beneficial uses in the Orange County GMZ.

The Chino Basin Municipal Water District (CBMWD) was the plaintiff in the legal action that resulted in the Judgment. The CBMWD was formed in 1950 to supply supplemental, imported water purchased from the Metropolitan Water District of Southern California (MWD) to the Chino Basin. On July 1, 1998, the CBMWD changed its name to the IEUA and expanded its role to become the regional supplier of recycled water for most of the Chino Basin. For OBMP implementation, the IEUA has served as the lead agency for compliance with the California Environmental Quality Act (CEQA). A Program Environmental Impact Report for the OBMP (SCH#2000041047) was certified by the IEUA in July 2000 (Tom Dodson, 2000).

1.3 The Peace II Agreement and its Subsequent EIR

To further implement the goals and objectives of the OBMP, the Parties executed the Peace II Agreement in 2007, which modified the OBMP Implementation Plan (Watermaster, 2007). The two main activities of the Peace II Agreement are: (i) increasing the controlled overdraft of the Chino Basin, as defined in the Judgment,[2] by 400,000 acre-feet (af) through 2030 (re-operation), and (ii) refining the planned expansion of the Chino Basin Desalters facilities to increase groundwater pumping from about 30,000 to 40,000 acre-feet per year (afy). Re-operation is allocated specifically to offset the production of the Chino Basin Desalters. Both re-operation and desalter expansion contribute to the attainment of "hydraulic control" of groundwater outflow from the Chino Basin to the SAR. The attainment and maintenance of hydraulic control is a requirement of Watermaster and the IEUA, as defined in the Basin Plan (Santa Ana Water Board, 2016). Hydraulic control ensures that the water management activities in the Chino Basin will not impair the beneficial uses designated for SAR water quality downstream of Prado Dam.

The expansion of the Chino Basin Desalters, described in the Peace II Agreement, was accomplished, in part, by the construction and operation of the Chino Creek Well Field (CCWF) in the southwest portion of Chino Basin (see Figure 1-3). During Peace II Agreement planning, the estimated capacity of the CCWF was about 5,000 to 7,700 afy (WEI, 2007). The CCWF wells were constructed in 2011-2012, and their actual capacity is about 1,500 afy.

In 2010, the IEUA certified the Peace II SEIR (Tom Dodson, 2010) to evaluate the environmental impacts that could result from implementing the Peace II Agreement. One of the potential impacts evaluated was the possible lowering of groundwater levels (drawdown) in the Prado Basin area, which could impact riparian vegetation that is dependent upon shallow groundwater. In order to assess this potential impact, Watermaster used its 2007 groundwater model to predict the extent and magnitude of the drawdown associated with the implementation of the Peace II Agreement, using the planned capacity of 7,700 afy[3] of the CCWF (WEI, 2007). Figure 1-3 (modified from Figure 4.4-10 from the Peace II SEIR) shows the 2007 model-predicted drawdown in the Prado Basin area for the period of 2005 to 2030. The 2007 model predictions showed drawdown of less than five feet by 2030 throughout the riparian habitat areas and less than 10 feet along the northern portion of Prado Basin near the northern reaches of Chino Creek, Mill Creek, and the SAR.[4]

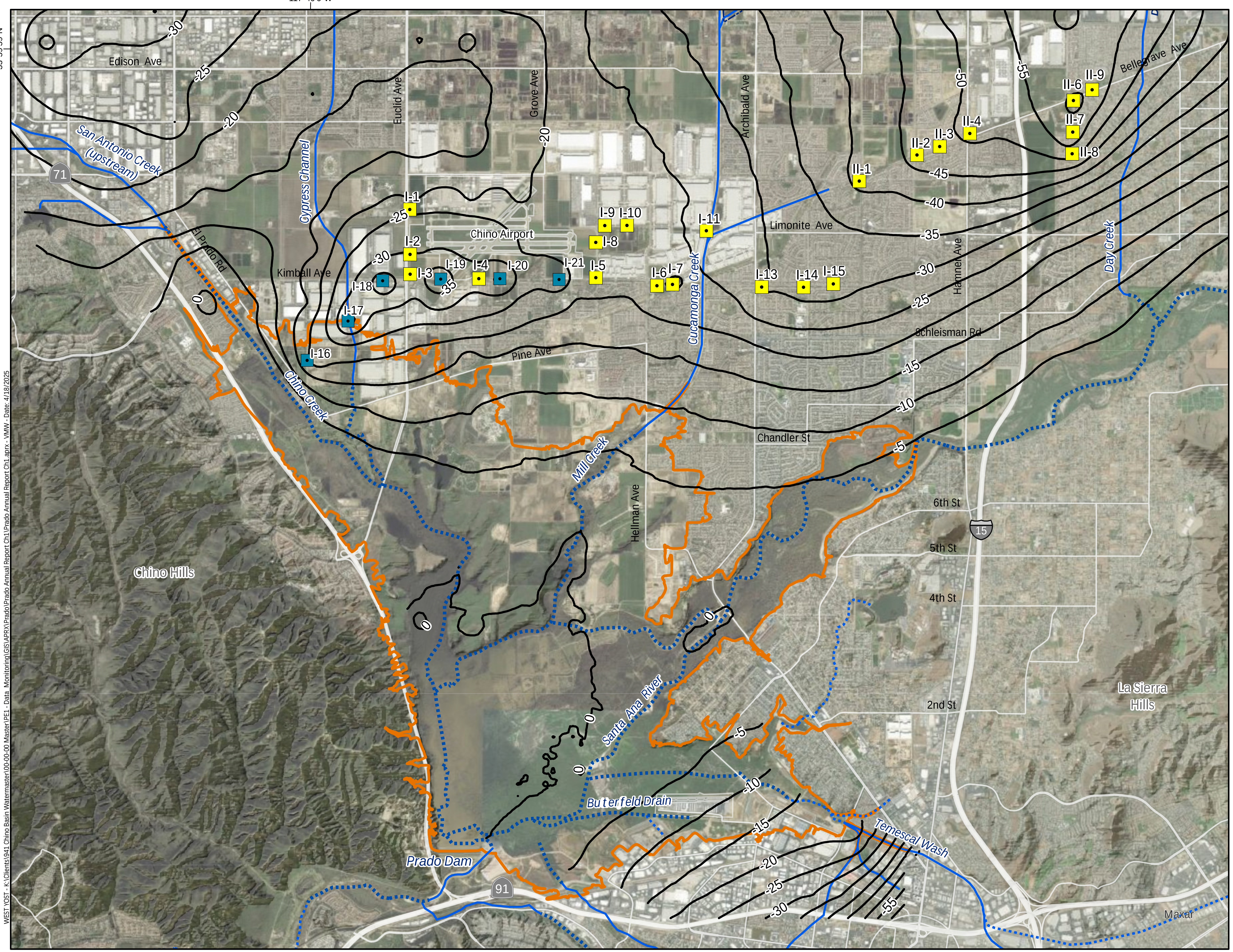
Although this modeling work indicated that implementing the Peace II Agreement would not cause significant adverse effects on Prado Basin riparian habitat, a contingency measure to address the potential for drawdown of groundwater levels and its impact on riparian vegetation was included in the Peace II SEIR as Mitigation Measure 4.4-3 (Biological Resources/Land Use & Planning section of the Mitigation Monitoring and Reporting Program).

---

[2] The Judgment established 200,000 af of controlled overdraft over the period of 1978 to 2017. Re-operation increases the controlled overdraft to 600,000 af through 2030.

[3] The CCWF wells were constructed in 2011-2012 and their actual capacity is about 1,500 afy, not the 7,700 afy used as the planning assumption for this modeling work in 2007 for the Peace II SEIR. The PBHSP includes the use of Watermaster's most recent groundwater model update and planning data (including actual capacity of the CCWF) to evaluate potential impacts to groundwater levels from the implementation of the Peace II Agreement and identify areas of prospective loss of riparian habitat. This updated modeling work is described in Section 3.7.

[4] The primary area that would be influenced by the Peace II Agreement implementation is the upper portion of Prado Basin. The Temescal Wash area is outside of the Chino Basin hydrologic boundary and is not an area of influence of potential impacts of groundwater levels from pumping at the Chino Desalter well field and implementation of the Peace II Agreement.



-10 Projected Change in Groundwater Levels *FY 2005 to FY 2030, feet*

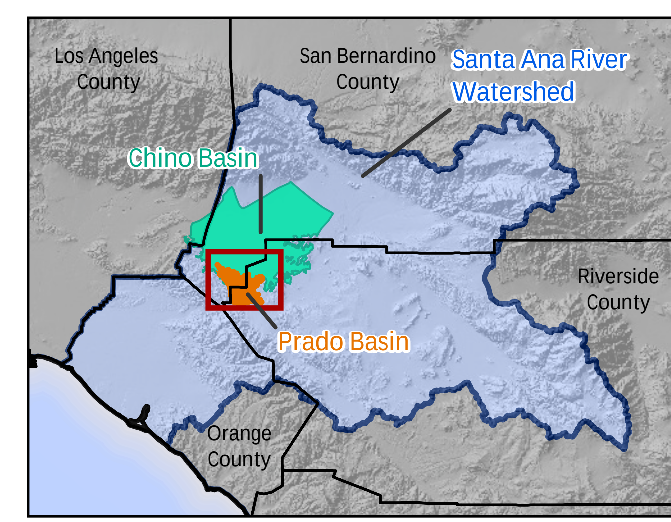
Chino Desalter Well - Location of Existing wells in 2007 modeled for the Peace II SEIR

Chino Desalter Well – Planned Location of the Chino Creek Well Field (CCWF) in 2007 as modeled for the Peace II SEIR with a Planned Capacity of 7,700 afy. Actual Location of the CCWF Constructed in 2011-2012 Shown in Figure 1-1 with an Actual Capacity 1,500 afy

Prado Basin

Concrete-Lined Channels

Unlined Rivers and Streams



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Prado Basin Sustainability Committee
2024 Annual Report

Projected Change in Groundwater Levels
FY 2005 to 2030 - Peace II Alternative

Figure 1-3

Mitigation Measure 4.4-3 was developed to ensure that the riparian habitat would not incur unforeseeable significant adverse effects from the Peace II implementation and to contribute to the long-term sustainability of the riparian habitat. Mitigation Measure 4.4-3 calls for:

- Watermaster, the IEUA, the OCWD, and other stakeholders that choose to participate to jointly fund the development of an adaptive management program to monitor the extent and quality of the Prado Basin riparian habitat and investigate and identify essential factors to its long-term sustainability.
- Watermaster and the IEUA to convene the PBHSC, comprised of representatives from all interested parties to implement the adaptive management program.
- The PBHSC to prepare annual reports pursuant to the adaptive management program. Annual reports are to include recommendations for ongoing monitoring and any adaptive management actions required to mitigate any measured or prospective loss of riparian habitat resulting from Peace II activities.

1.4 Adaptive Management Plan for the PBHSP

Pursuant to Mitigation Measure 4.4-3 in the SEIR, Watermaster and the IEUA convened four meetings of the PBHSC, starting in late-2012, to develop the adaptive management plan for the PBHSP and facilitate its implementation. Watermaster and the IEUA adopted the final 2016 Adaptive Management Plan for the Prado Basin Habitat Sustainability Program (AMP) in August 2016 (WEI, 2016). The AMP was designed to answer the following questions to satisfy the monitoring and mitigation requirements of the Peace II SEIR:

1. What are the factors that can potentially affect the extent and quality of the riparian habitat?
2. What is a consistent, quantifiable definition of "riparian habitat quality", including metrics and measurement criteria?
3. What has been the historical extent and quality of the riparian habitat in the Prado Basin?
4. How has the extent and quality of the riparian habitat changed during implementation of Peace II?
5. How have groundwater levels and quality, surface-water discharge, weather, and climate changed over time? What were the causes of the changes? And, did those changes result in an adverse impact to riparian habitat in the Prado Basin?
6. Are there other factors besides groundwater levels, surface-water discharge, weather, and climate that affect riparian habitat in the Prado Basin? What are those factors? And, did they (or do they) result in an adverse impact to riparian habitat in the Prado Basin?
7. Are the factors that result in an adverse impact to riparian habitat in the Prado Basin related to Peace II implementation?
8. Are there areas of prospective loss of riparian habitat that may be attributable to the Peace II Agreement?
9. What are the potential mitigation actions that can be implemented if Peace II implementation results in an adverse impact to the riparian habitat?

The AMP outlines a process for monitoring, modeling, and annual reporting to answer and address the questions listed above. Appendix A to the AMP is the initial monitoring program: *2016 Monitoring Program for the Prado Basin Habitat Sustainability Program*. Annual reports are intended to document monitoring and modeling activities, the analysis and interpretation of the monitoring and modeling results, and recommendations for changes to the PBHSP, which may include monitoring, modeling, and/or mitigation, if deemed necessary. Any future mitigation measures that are deemed necessary will be developed jointly by Watermaster and the IEUA.

1.5 Annual Report Organization

This Annual Report for water year (WY) 2024 is the ninth annual report of the PBHSC; it documents the collection, analysis, and interpretations of the data and information generated by the PSHSP through October 31, 2024[5]. The remainder of this report is organized as follows:

Section 2.0 – Monitoring, Data Collection, and Methods. This section describes the collection of historical information and recent monitoring data and describes the groundwater-modeling activities performed during WY 2024 for the PBHSP.

Section 3.0 – Results and Interpretations. This section describes the results and interpretations that were derived from the information, data, and groundwater-modeling.

Section 4.0 – Conclusions and Recommendations. This section summarizes the main conclusions derived from the PBHSP through 2024 and describes the recommended activities for the subsequent fiscal year as a proposed scope-of-work, schedule, and budget.

Section 5.0 – References. This section lists the publications cited in the report.

[5] Includes the WY 2024 Period of October 1, 2023 to September 30, 2024 and the month of October 2024 cover the entire growing season period.

2.0 MONITORING, DATA COLLECTION, AND METHODS

The PBHSP was designed, in part, to answer Question 1 from the AMP:

- What are the factors that can potentially affect the extent and quality of the riparian habitat?

The main hydrologic factors that can potentially affect the extent and quality of the riparian habitat in the Prado Basin include, but are not limited to, groundwater levels, surface-water discharge, weather events, and long-term climate. As such, the PBHSP includes integrated monitoring and analysis programs for riparian habitat, groundwater, surface water, climate, and other potential factors (e.g., wildfire, pests, etc.).

Since the implementation of the AMP in WY 2016, data collection efforts include the compilation of historical data through present. The period of data available for each data type varies, but all span both pre- and post-Peace II Agreement implementation. Data collection efforts for all historical data were described in the first two annual reports for WY 2016 and WY 2017. Data collection efforts for subsequent water years have focused on recent water year monitoring data. All data collected and compiled for this effort were uploaded to Watermaster's centralized relational database, HydroDaVE^{SM}, and used in the analyses.

This section describes the collection of recent monitoring data during WY 2024 and the groundwater-modeling activities performed for the PBHSP.

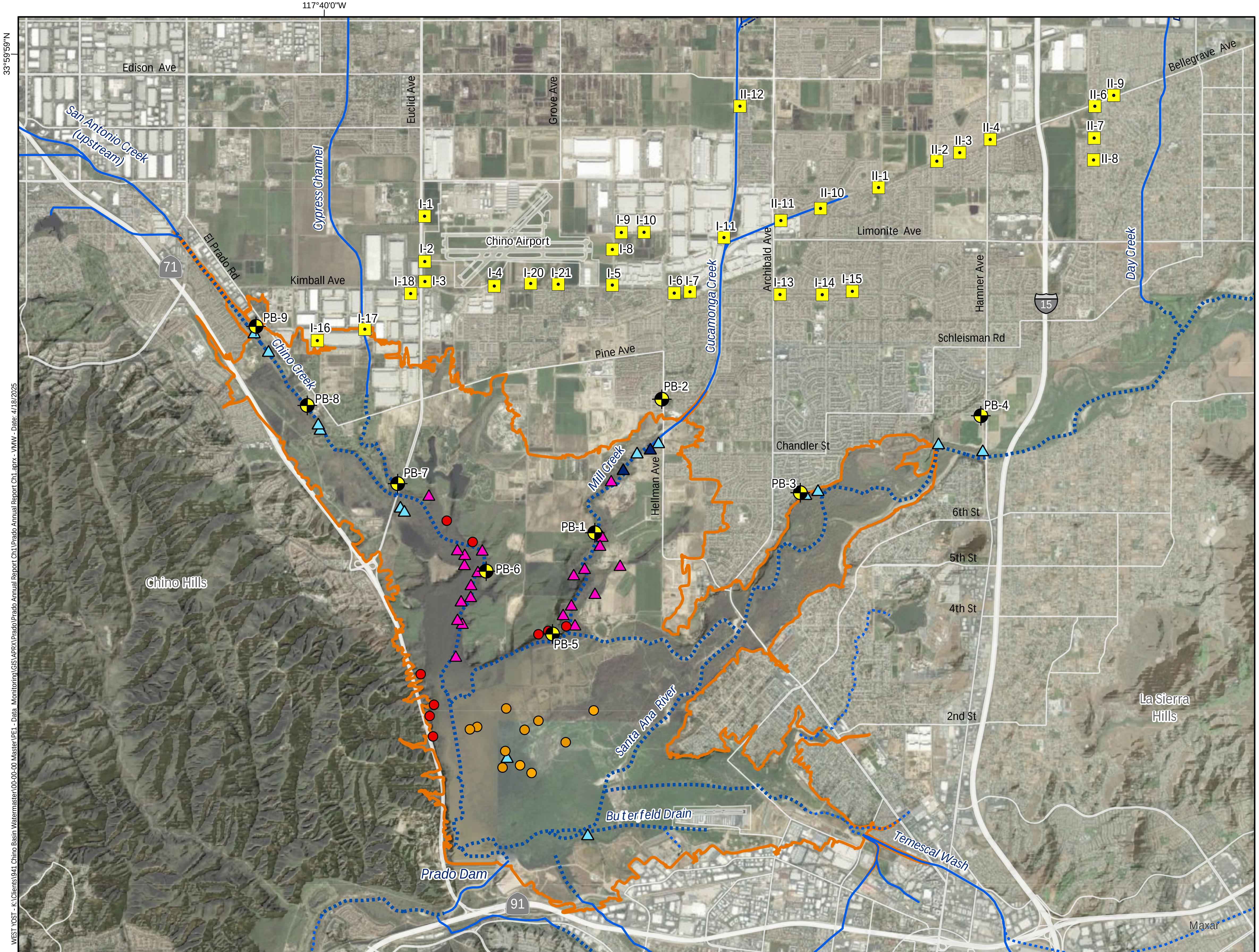
2.1 Riparian Habitat Monitoring

The objective of the Riparian Habitat Monitoring Program (RHMP) is to collect data to help answer questions 2, 3, and 4 from the AMP:

- What is a consistent quantifiable definition of "riparian habitat quality", including metrics and measurement criteria?
- What has been the historical extent and quality of the riparian habitat in the Prado Basin?
- How has the extent and quality of the riparian habitat changed during the implementation of Peace II?

To answer these questions, the RHMP includes time-series data and information on the extent and quality of riparian habitat in the Prado Basin over a historical period, including both pre- and post-Peace II implementation.

Figure 2-1 displays the features of the RHMP. Two types of monitoring and assessment are performed: regional and site-specific. Regional monitoring and assessment are appropriate because the main potential stress to the riparian habitat associated with Peace II activities is the regional drawdown of groundwater levels. The intent of site-specific monitoring and assessment is to verify and complement the results of regional monitoring.



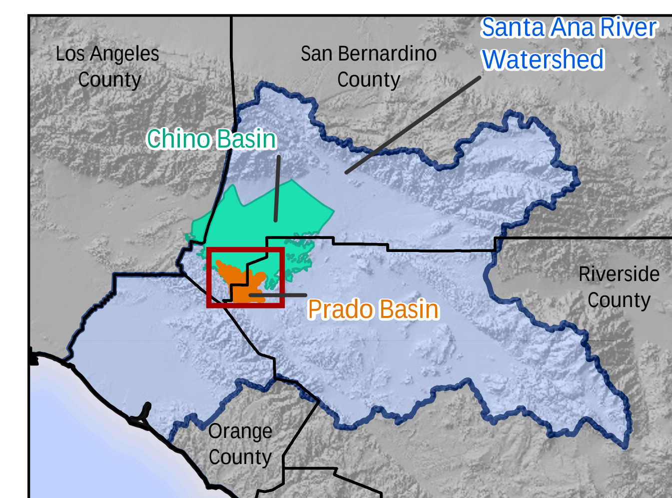
Riparian Habitat Monitoring Program

USBR Site-Specifc Monitoring

- USBR Vegetaton Survey Site established in 2007
- USBR Vegetaton Survey Site added in 2016
- USBR Vegetaton Survey Site added in 2022

OCWD Site-Specifc Monitoring

- Understory Photo Statons
- Canopy Photo Statons
- PBHSP Monitoring Well
- Prado Basin
- Concrete-Lined Channels
- Unlined Rivers and Streams
- Chino Desalter Well



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2024 Annual Report

CHINO BASIN WATERMASTER Partners in Basin Management

Riparian Habitat Monitoring Program

Figure 2-1

2.1.1 Regional Monitoring of Riparian Habitat

Regional monitoring and assessment of the riparian habitat is performed by mapping the extent and quality of riparian habitat over time using: 1) multi-spectral remote-sensing data and 2) air photos.

2.1.1.1 Multi-Spectral Remote Sensing Data

The Normalized Difference Vegetation Index (NDVI), derived from remote sensing measurements by Landsat Program satellites, is used to assess the extent and quality of the riparian vegetation in the Prado Basin over a long-term historical period. NDVI is a commonly used numerical indicator of vegetation health that can be calculated from satellite remote-sensing measurements (Ke et al., 2015; Xue, J. and Su, B., 2017). NDVI is calculated from visible and near-infrared radiation reflected by vegetation and is an index of greenness correlated with photosynthesis that can be used to assess spatial and temporal changes in the distribution and productivity of vegetation (Pettorelli, 2013). Areas where the NDVI is higher have greener vegetation than areas where NDVI is lower, indicating areas where the overall vegetation is healthy.

Although NDVI does not provide species-specific vegetation information, the regional scale of NDVI makes it an appropriate “first indicator” of regional changes in the extent and quality of riparian vegetation. Additionally, there are NDVI data for the entire extent of the Prado Basin dating from the early 1980s to present, which provide a historical characterization of the spatial extent and quality of the riparian vegetation prior to and after the implementation of Peace II activities (2007).

A limitation of NDVI data is that it is a composite view of plant species diversity, form, structure, density, and vigor. As such, changes in NDVI may be caused by various changes in riparian habitat (Markon et al., 1995; Markon and Peterson, 2002). In other words, NDVI does not provide a complete picture of how and why vegetative changes are occurring; it simply indicates a change in vegetation. These changes can then be ground-truthed using other types of monitoring. Appendix A provides background information on NDVI, further explains why NDVI was chosen as an analytical tool for the PBHSP, discusses additional advantages and limitations of NDVI, and describes how NDVI estimates were used for the PBHSP.

For the current reporting period, NDVI estimates were collected from the United States Geological Survey (USGS) using the Earth Resources Observation and Science (EROS) Center Science Processing Architecture (ESPA) On Demand Interface[6] (USGS, 2017b) over the period of November 2023 through October 2024 to span the entire growing-season period (March-October 2024). To obtain complete spatial coverage of the Prado Basin area, NDVI estimates were requested for all Landsat scenes for Path 040, Rows 036 and 037 from the Landsat 8 and Landsat 9 satellites. The NDVI were processed and uploaded to Watermaster’s centralized relational database, HydroDaVE^{SM}, which includes tools to manage, review, and extract NDVI estimates. The frequency of NDVI estimates from the Landsat 8 and 9 satellites is once every eight days. However, not all NDVI estimates are useable due to disturbances that can be caused by cloud cover, unfavorable atmospheric conditions, or satellite equipment malfunction. NDVI estimates were reviewed for these disturbances and excluded from analysis if they were determined erroneous due to these disturbances. Appendix A describes how the NDVI estimates were collected, reviewed, and assembled for the PBHSP.

[6] ESPA USGS

2.1.1.2 Collection and Analysis of Air Photos

Georeferenced air photos are used to visually characterize the spatial extent and quality of the riparian habitat in the Prado Basin. The air photos also serve as an independent check on interpretations of NDVI, which involves visual comparison of the extent and density of the riparian habitat (as shown in the air photos) to the NDVI maps. For ongoing monitoring, a high-resolution (3-inch pixel) image of the visible spectrum for the entire Prado Basin is acquired during the middle of the growing season, typically in July.

For the current reporting period, the acquisition of the 2024 air photo included a custom flight that was performed by Tetra Tech on July 1, 2024. The cost to acquire the 2024 air photo was shared with the OCWD. This was the eighth annual high-resolution air photo acquired for the PBHSP and cost-shared with the OCWD.

2.1.2 Site-Specific Monitoring of Riparian Habitat

The objective of the site-specific monitoring of riparian habitat is to collect data that can be used to ground-truth the interpretations derived from the regional monitoring and assessment of the riparian habitat (Pettorelli, 2013). Prior to the implementation of the AMP, site-specific monitoring performed in the Prado Basin included vegetation surveys performed by the United States Bureau of Reclamation (USBR) in 2007 and 2013 (USBR, 2008b; 2015). Since the implementation of the AMP, the USBR conducted vegetation surveys for the PBHSP in 2016, 2019, and 2022. The USBR vegetation surveys performed in 2016 and 2019 consist of 37 sites, including 23 previously established sites surveyed in 2007 and 2013, and 14 new sites established in 2016 primarily located near the PBHSP monitoring wells. The USBR vegetation surveys conducted in 2022 encompassed 39 sites, including the 37 previously established sites surveyed in 2016 and 2019, and two additional sites in the upper portion of Mill Creek to increase the monitoring is an area where there has been some observed drawdown of groundwater levels since the PBHSP monitoring began. The OCWD also performs site-specific monitoring in the southern portion of Prado Basin to monitor for effects of the operation of Prado Dam on riparian habitat. OCWD site-specific monitoring includes seasonal monitoring at nine canopy photo stations located along the edge of Prado Basin and at 11 understory photo stations within different surface elevations of the inundation zone behind the dam. The most recent annual report prepared by OCWD on the results of this monitoring is the *Prado Basin Water Conservation and Habitat Assessment 2023-2024* report (OCWD, 2025).

Figure 2-1 shows the locations of the USBR vegetation surveys and the OCWD photo monitoring sites.

2.2 Factors that Potentially Affect the Riparian Habitat

The main factors that can potentially affect riparian habitat in Prado Basin include but are not limited to groundwater levels, surface-water discharge, weather/climate, wildfires, and pests. This section describes the methods employed to collect and analyze information on these factors to help answer questions 5, 6, and 7 from the AMP:

- How have groundwater levels and quality, surface-water discharge, weather, and climate changed over time? What were the causes of the changes? And did those changes result in an adverse impact to riparian habitat in the Prado Basin?
- Are there other factors besides groundwater levels, surface-water discharge, weather, and climate that affect riparian habitat in the Prado Basin? What are those factors? And did they (or do they) result in an adverse impact to riparian habitat in the Prado Basin?

- Are the factors that result in an adverse impact to riparian habitat in the Prado Basin related to Peace II implementation?

2.2.1 Groundwater Monitoring Program

A primary result of implementation of the Peace II Agreement is the lowering of groundwater levels (drawdown) in the southern portion of Chino Basin. Hence, drawdown is a factor that is potentially related to Peace II implementation and could adversely impact riparian habitat.

The Groundwater Monitoring Program (GMP) includes the collection of three types of data: groundwater production, groundwater level, and groundwater quality. Watermaster has been implementing a groundwater monitoring program across the entire Chino Basin to support various basin management initiatives and activities, and all data within Watermaster's centralized relational database are available to the GMP.

In 2015, Watermaster's groundwater monitoring network was expanded specifically for the PBHSP, with the construction of 16 new monitoring wells at nine sites located along the fringes of the riparian habitat and between the riparian habitat and the CDA well field. These wells, along with two existing monitoring wells, HCMP-5/1 and RP2-MW3, are specifically monitored for the PBHSP and are called the "PBHSP monitoring wells".

Figure 2-2 shows the extent of the study area for which the GMP data are compiled and used for the PBHSP. The area covers the Prado Basin and the upgradient areas to the north that encompass the Chino Desalter well field. Figure 2-2 also shows the wells in the study area where groundwater data were available in WY 2024.

2.2.1.1 Groundwater Production

Groundwater production influences groundwater levels and groundwater-flow patterns. Groundwater-production data are analyzed together with groundwater-level data to characterize the influence of groundwater production on groundwater levels. Groundwater-production data are also used as an input to the Chino Basin groundwater-flow model to evaluate past and future conditions in the Chino Basin, which, for the PBHSP, supports the analysis of prospective losses of riparian habitat (see Section 2.3).

Watermaster collects quarterly groundwater-production data for all active production wells within the Chino Basin. The data are checked for quality assurance and quality control (QA/QC) and uploaded to Watermaster's centralized relational database. The active production wells within the study area include CDA wells and privately owned wells used for agricultural, dairy, or domestic purposes.

During WY 2024, Watermaster collected groundwater-production data at about 80 wells in the GMP study area.

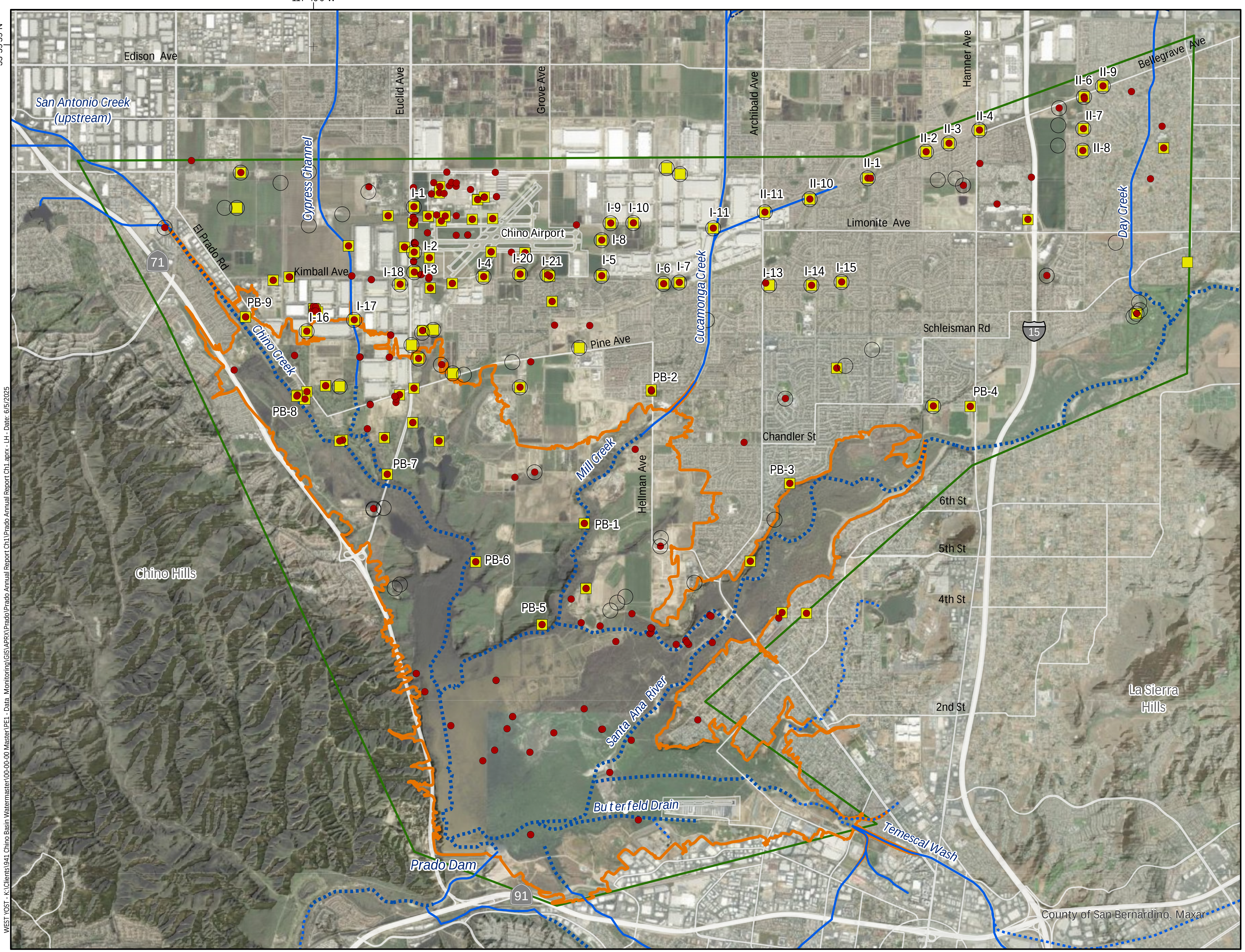
2.2.1.2 Groundwater Level

Monitoring groundwater levels in the Prado Basin is a key component of the PBHSP, as the potential for declining groundwater levels related to Peace II implementation could be a factor that adversely impacts riparian habitat. Groundwater-level data are analyzed together with production data to characterize how groundwater levels have changed over time in the GMP study area and to explore the relationship(s) to any observed changes that occurred in the extent and quality of the riparian habitat. Groundwater-level and production data are also used as input to the Chino Basin groundwater-flow model to evaluate past and future conditions in the Chino Basin, which, for the PBHSP, supports the analysis of prospective losses of riparian habitat (see Section 2.3). Groundwater level data are also used with other data to evaluate groundwater/surface water interactions (see Section 3.3).

Watermaster collects groundwater-level data at various frequencies at wells in the GMP study area to support various groundwater-management initiatives. The data are checked for QA/QC and uploaded to Watermaster's centralized relational database.

During WY 2024, Watermaster collected groundwater-level data from 278 wells in the study area (see Figure 2-2). Approximately 106 wells are CDA wells, dedicated monitoring wells, or private wells that are monitored by Watermaster using manual methods once per month or with pressure transducers that record water levels once every 15 minutes. At the remaining 172 wells, water levels were measured by well owners at varying frequencies and provided to Watermaster. Since May 2015, groundwater-levels at the 18 PBHSP monitoring wells have been measured with pressure transducers that record water levels once every 15 minutes.

In June 2024, Guida Surveying Inc. conducted professional surveys to measure the thalweg elevations in the adjacent water bodies near the PBHSP monitoring wells (Chino Creek, Mill Creek or SAR). The thalweg elevations were referenced to the same elevation datum as the monitoring wells, which allows for comparison of all elevation data. The groundwater elevations in PBHSP monitoring wells can be compared to the thalweg elevation of the nearby surface water body to help characterize groundwater/surface-water interactions within the GMP study area and determine if the shallow groundwater supporting the riparian vegetation is supported by the groundwater and/or the surface water.



Wells with Groundwater Data - Water Year 2024

Wells with Product on Data

Wells with Water Level Data

Wells with Water Quality Data

Wells Labeled on the Map

Chino Basin Desalter Well - Labeled with "I-" or "II-"

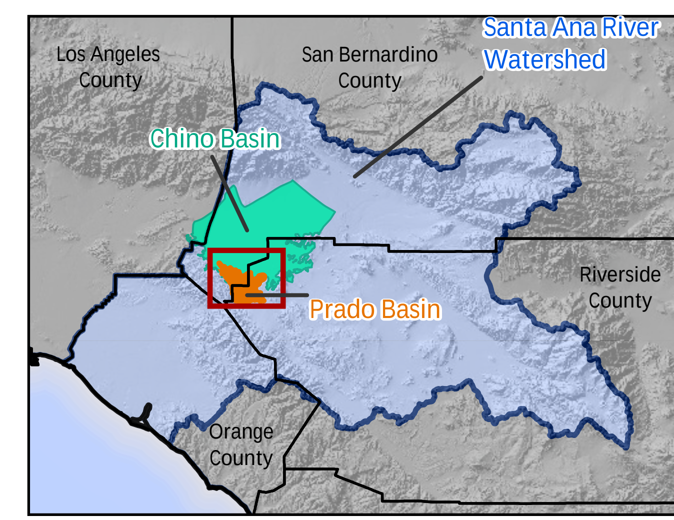
PBHSP Monitoring Well - Labeled with "PB-"

Groundwater Monitoring Program (GMP) Study Area

Prado Basin

Concrete-Lined Channels

Unlined Rivers and Streams



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Groundwater Monitoring Program

Figure 2-2

2.2.1.3 Groundwater Quality

Water-quality data can be used to understand the various potential sources of shallow groundwater in the Prado Basin. Groundwater-quality data are compared to surface-water-quality data to characterize groundwater/surface-water interactions in the Prado Basin and assess the importance of those interactions to the extent and quality of the riparian habitat.

Watermaster collects groundwater-quality data from wells in the GMP study area to support various groundwater-management initiatives. These data are checked for QA/QC and uploaded to Watermaster's centralized relational database. During WY 2024, groundwater-quality data were collected from 162 wells in the study area (see Figure 2-2). Of these wells, 56 wells are dedicated monitoring wells or private wells sampled by Watermaster either using transducers that record high-frequency data, or grab samples collected quarterly, annually, or triennially (every three years). The remaining 106 were sampled by the well owners at varying frequencies.

Watermaster has performed groundwater-quality sampling at the PBHSP monitoring wells since they were constructed in 2015. The groundwater-quality monitoring has been tailored to discern the groundwater/surface-water interactions important to the sustainability of the riparian habitat. Currently Watermaster conducts triennial water-quality sampling at the 18 PBHSP monitoring wells as part of their basin-wide water-quality monitoring to support various groundwater-management initiatives. The most recent water-quality sampling event occurred during September 2024 and the next triennial monitoring event will occur in summer of 2027.

In FY 2023/24 Watermaster began to collect and analyze high-frequency (15 minute) temperature and specific conductance (EC) readings using the transducers at the PBHSP monitoring wells. This high-frequency temperature and EC monitoring at all the PBHSP monitoring wells is a recommendation in the WY 2022 Annual Report and a replacement of a pilot monitoring program that was conducted at four of the wells from FY 2018/19 to FY 2022/23 to study groundwater/surface-water interactions (see section 4.1 of 2022 Annual Report, West Yost, 2023). High-frequency temperature data was already being measured by transducers in the 18 PBHSP monitoring wells. Additionally, high-frequency EC data was already being measured by the transducers in four of these wells. As transducers are replaced, they are upgraded to models that measure and record high-frequency EC data along with temperature and groundwater levels. In FY 2024/25 two transducers were replaced and currently there are twelve PBHSP monitoring wells with transducers that measure EC in addition to temperature and water level.

During FY 2024/25, the high-frequency temperature and EC data at the PBHSP monitoring sites were downloaded, processed, checked for QA/QC, and uploaded to Watermaster's relational database on a quarterly basis.

2.2.2 Surface-Water Monitoring Program

Surface-water discharge in the Prado Basin is another factor that can influence the extent and quality of riparian habitat and can influence groundwater levels. Surface-water discharge data are evaluated for the PBHSP to characterize historical and current trends in the discharge of the SAR and its tributaries in the Prado Basin, and to explore the relationship(s) to any observed changes that occur in the extent and quality of the riparian habitat. Surface-water discharge data are also used as input to the Chino Basin groundwater-flow model to evaluate past and future conditions in the Chino Basin, which for the PBHSP, supports the analysis of prospective losses of riparian habitat (see Section 2.3). Surface-water quality data is compared to groundwater-quality data to characterize groundwater/surface-water interactions in the Prado Basin and the importance of those interactions to the extent and quality of the riparian habitat. Figure 2-3 shows the location of the surface-water monitoring sites used in the PBHSP.

The surface-water monitoring program for the PBHSP involves collecting existing, publicly available surface-water discharge and quality data from sites within or tributary to the Prado Basin. These sites include discharge locations for publicly owned treatment works (POTWs), USGS stream gaging stations, Watermaster and the IEUA Maximum-Benefit Monitoring Program surface-water-quality monitoring sites, and ACOE's storage levels and inflow to Prado Dam. All surface-water discharge and quality data were collected for WY 2024, checked for QA/QC, and uploaded to Watermaster's relational database.

In FY 2023/24, Watermaster began to collect surface-water field measurements of temperature and EC at four sites located near PBHSP monitoring wells along Chino Creek and Mill Creek. This monitoring is done in coordination with high-frequency groundwater measurements of temperature and EC described above in the Groundwater Quality Section to study groundwater/surface-water interactions. Data were checked for QA/QC and uploaded to Watermaster's relational database.

2.2.3 Climatic Monitoring Program

Climate is another factor that can influence the extent and quality of riparian habitat and can influence groundwater levels. Climatic data are evaluated for the PBHSP to characterize how the climate has changed over time in the study area and to explore the relationship(s) to any observed changes that occurred in the extent and quality of the riparian habitat. Climatic data are also used for the Chino Basin groundwater-flow model to evaluate past and future conditions in the Chino Basin, which for the PBHSP, supports the analysis of prospective losses of riparian habitat (see Section 2.3).

The climatic monitoring program for the PBHSP involves collecting existing, publicly available spatially gridded climate datasets for precipitation and temperature in the vicinity of the Prado Basin. These climate datasets include Next-Generation Radar (NEXRAD) and the PRISM Climate Group. Figure 2-3 shows the location of the areas where the grided climate data is extracted from PRISM and NEXRAD to estimate a spatial average for precipitation and temperature for the PBHSP. The Chino Basin boundary is used to extract the spatially gridded data for precipitation, and the Prado Basin boundary is used to extract the spatially gridded data for maximum and minimum temperature. Climatic data are collected annually and uploaded to Watermaster's relational database.

2.2.4 Other Factors That Can Affect Riparian Habitat

The AMP recognizes that there are potential factors other than groundwater, surface water, and climate that can affect riparian habitat in the Prado Basin. These factors include, but are not limited to, wildfire, disease, pests, and invasive species. To the extent necessary and possible, data and information on these factors are collected and analyzed to explore relationships to changes in the extent and quality of the riparian habitat.

In WY 2016, during the analysis for the first Annual Report, two specific factors were identified as potential impacts to the riparian habitat in the Prado Basin: wildfires and an invasive pest known as the Polyphagous Shot-Hole Borer (Euwallacea fornicates; PSHB hereafter). In WY 2018, the removal of the non-native invasive weed Arundo donax (Arundo) was identified as another factor that could potentially impact the riparian habitat in the Prado Basin. The following describes the information that was collected for these three factors and how they are used to explore for relationships to changes that have occurred in the extent and quality of riparian habitat.

2.2.4.1 Wildfires

Wildfires occur periodically in the Prado Basin and can reduce the extent and quality of riparian habitat. For the PBHSP, the occurrence and locations of wildfires are used to help understand and explain the trends observed in the extent and quality of the riparian vegetation.

To map the extent of any wildfires that have occurred in the study area, fire-perimeter data were collected from the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CAL FIRE).[7]

For the current reporting period, wildfire data were obtained from the FRAP database for the Prado Basin region for calendar year 2023.[8]

2.2.4.2 Polyphagous Shot-Hole Borer (PSHB)

The PSHB is a beetle that burrows into trees, introducing a fungus (*Fusarium euwallacea*) into the tree bark that spreads the disease Fusarium Dieback (FD).[9,10] FD destroys the food and water conducting systems of the tree, eventually causing stress and tree mortality. The PSHB was first discovered in Southern California in 2003 and has been recorded to have caused branch die-back and tree mortality for various tree specimens throughout the Southern California region (USDA, 2013). Since 2016, the PSHB is an identified pest within the Prado Basin that has the potential to negatively impact riparian habitat vegetation (USBR, 2016; Palenscar, K., personal communication, 2016; McPherson, D., personal communication, 2016).

Information on the PSHB occurrence in the Prado Basin has been obtained during the USBR vegetation surveys of riparian habitat in the Prado Basin for the PBHSP during 2016, 2019, and 2022; from the University of California, United States Department of Agriculture (USDA) and Natural Resources' online PSHB/FD Distribution Map[11]; and from the OCWD's PSHB trap deployment and monitoring. For the PBHSP, the occurrences of the PSHB in the Prado Basin are used to help understand and explain the trends observed in the extent and quality of the riparian vegetation.

For the current reporting period, there was no data collected on the PSHB occurrence in Prado Basin. The most recent data collected was in 2022 during the USBR vegetation surveys.

[7] Frap.fire.ca.gov

[8] Data for the previous year is available each year in April.

[9] UCANR.edu

[10] Cisr.Ucr.Edu

[11] Ucanr.edu

2.2.4.3 Arundo Removal

Non-native Arundo is prominent throughout riparian habitat in the Prado Basin. Arundo consumes significantly more water than native plants, can out-compete native vegetation, and is flammable in nature, increasing the risk of wildfire. Several stakeholders in the SAR watershed are actively removing Arundo from the riparian habitat to restore native habitat and support the recovery of the threatened and endangered species, such as the Least Bell's Vireo and Santa Ana Sucker. For the PBHSP, tracking the occurrence and locations of these habitat restoration activities that include the removal of Arundo can help understand and explain trends in the extent and quality of the riparian habitat. The OCWD, Santa Ana Watershed Association (SAWA), and Santa Ana Watershed Project Authority (SAWPA), in coordination with others, are the main entities in the watershed that implement habitat restoration programs that include removing Arundo.

In WY 2024, information on recent Arundo removal and management activities in the Prado Basin were collected to track these programs and explore potential connections between these activities and observed trends in the extent and quality of riparian habitat. This effort involved coordinating with the OCWD and SAWA to obtain information on the location and timing of these programs.

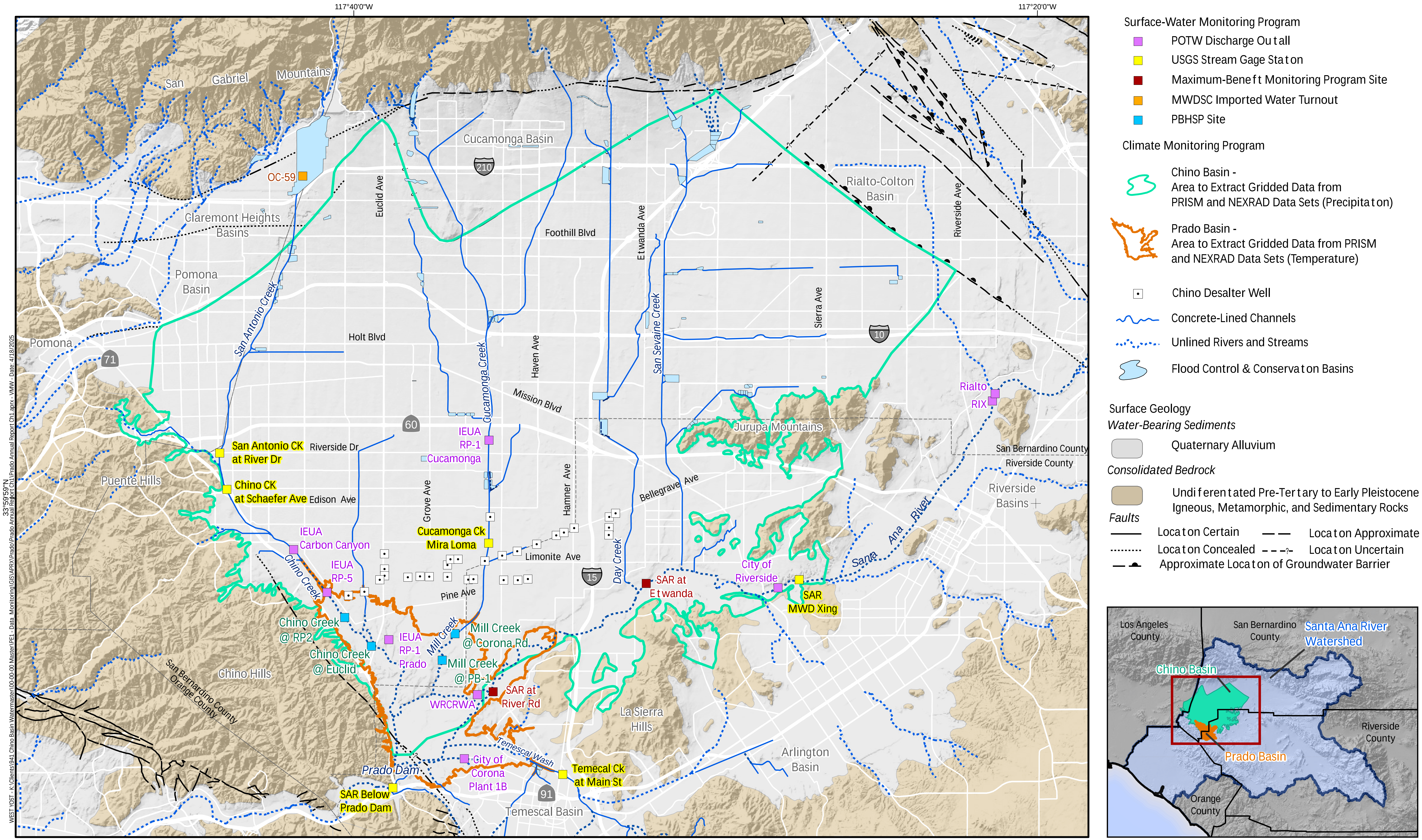

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Figure 2-3

2.3 Prospective Loss of Riparian Habitat

Monitoring and mitigation requirement 4.4-3 in the Peace II SEIR calls for annual reporting for the PBHSP, that will include recommendations for ongoing monitoring and any adaptive management actions required to mitigate any measured loss or **prospective loss** of riparian habitat that may be attributable to the Peace II Agreement (emphasis added). The meaning of "prospective loss" in this context is "future potential losses" of riparian habitat. Predictive modeling of groundwater levels can be used to answer Question 8 from the AMP:

- Are there areas of prospective loss of riparian habitat that may be attributable to the Peace II Agreement?

Watermaster's most recent groundwater-modeling results are used to evaluate forecasted groundwater-level changes within the Prado Basin under current and projected conditions in the Basin, including, but not limited to, plans for pumping, storm-water recharge, and supplemental water recharge. To perform this evaluation, the predictive model results of groundwater levels are mapped and analyzed to identify areas (if any) where groundwater levels are projected to decline to depths that may negatively impact riparian habitat in the Prado Basin.

Watermaster's most recent groundwater model projections are from the simulation of planning scenario "2020 SYR1" for the 2020 recalculation of Safe Yield using the updated Chino Basin groundwater-flow model (WEI, 2020). Section 3.7 of this Annual Report uses this most recent projection to characterize future groundwater-level conditions in the GMP study area and analyze prospective loss. The Chino Basin groundwater-flow model is currently being updated and used to project conditions for the 2025 Safe Yield Reset, and new model projections will be included in the WY 2025 Annual Report.

3.0 RESULTS AND INTERPRETATIONS

3.1 Trends in Riparian Habitat Extent and Quality

This section describes the analysis and interpretation of the monitoring data and groundwater-modeling results for the PBHSP. Analyzed data span various historical periods, based on data availability, and include both pre- and post-Peace II Agreement implementation (2007).

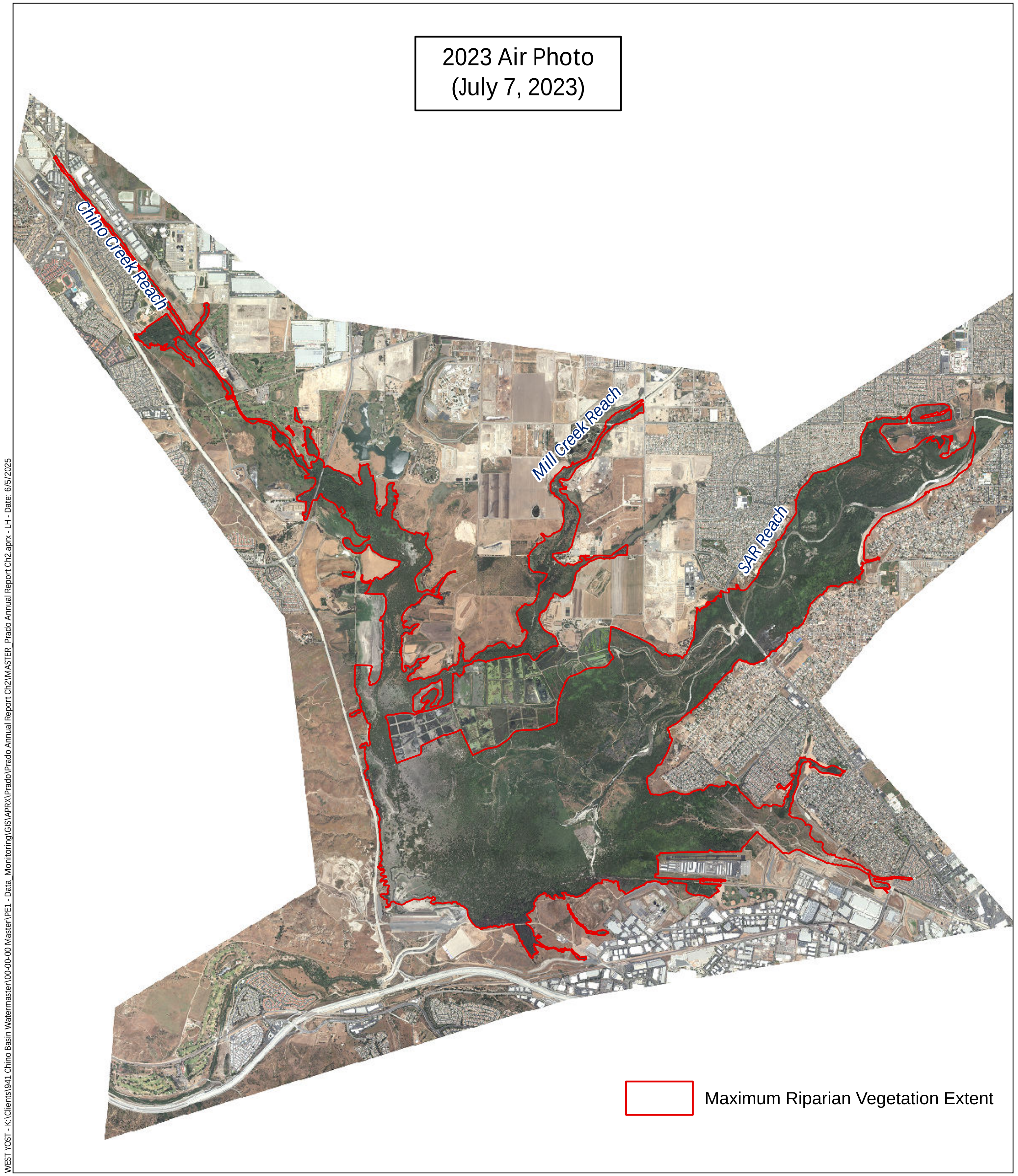
More specifically, this section describes the trends in the extent and quality of the riparian habitat, describes the trends in factors that can impact the riparian habitat, and evaluates potential cause-and-effect relationships—particularly any cause-and-effect relationships that may be associated with Peace II implementation. The factors that can potentially impact the extent and quality of the riparian habitat include changes in groundwater levels, surface-water discharge, climate, and other factors, such as pests, wildfires, and habitat management activities. Declining groundwater levels is the primary factor that is potentially related to Peace II implementation and could adversely impact the riparian habitat.

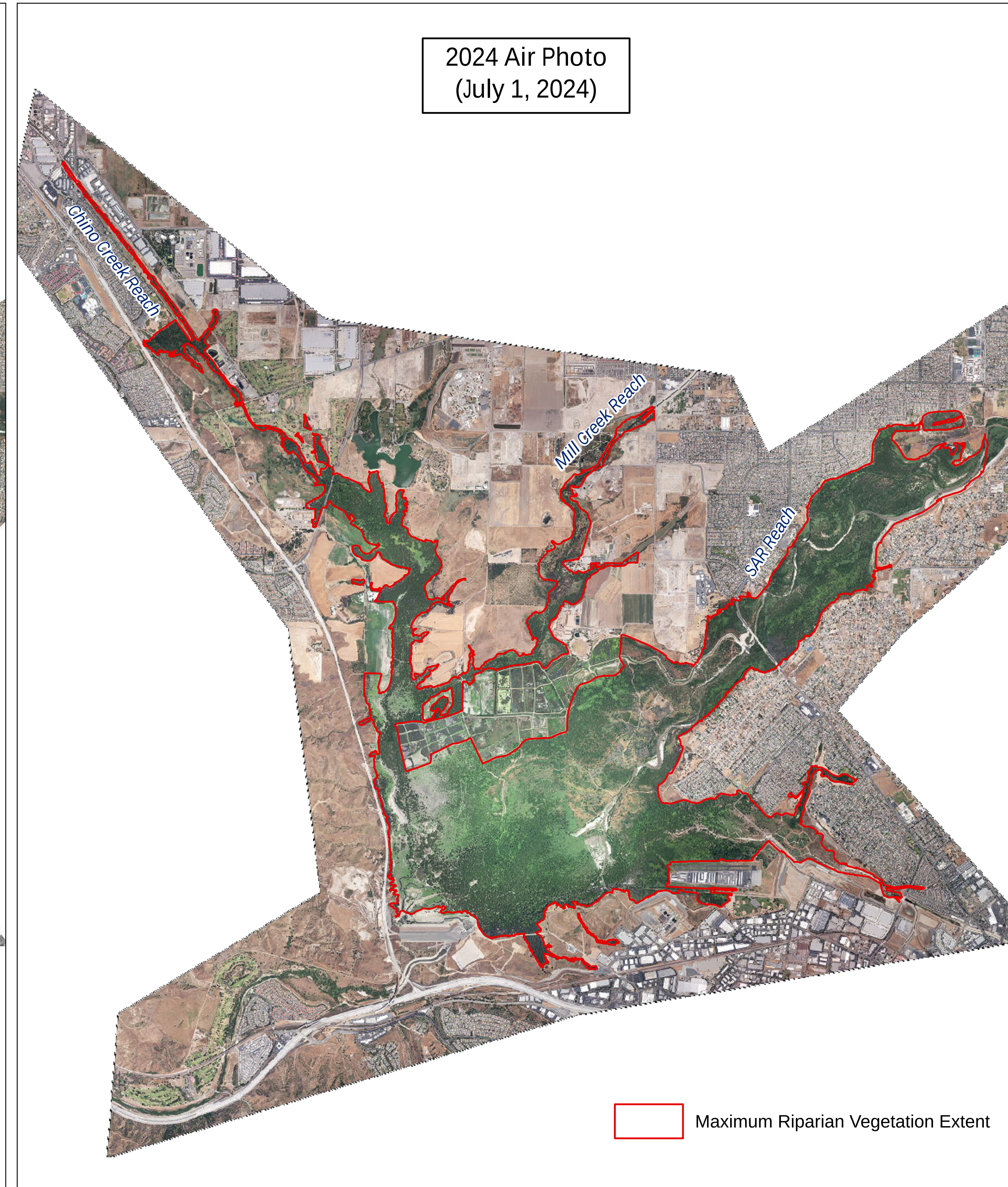
This section also includes a review of Watermaster's most recent predictive Chino Basin groundwater modeling results to identify areas of potential future declines in groundwater levels that could impact the riparian habitat.

3.1.1 Extent of the Riparian Habitat

The annual reports for the first four years of the PBHSP included an analysis of the riparian vegetation using historical air photos to map the density and extent of the vegetation in the Prado Basin (WEI, 2017; 2018; 2019; 2020). In general, these analyses concluded that from 1960 to 1999 the mapped extent of the riparian habitat increased from about 1.8 to 6.7 square miles (mi^2) and its vegetated density increased. The 1999 mapped extent is considered the maximum extent of the riparian habitat in the Prado Basin and has since remained relatively constant in the Prado Basin along the Chino Creek, Mill Creek, and SAR reaches in the Prado Basin.[12] The maximum extent of the riparian vegetation in Prado Basin is shown on Figure 3-1a which compares the air photos that were acquired for the PBHSP in July 2023 and July 2024. Both air photos are high resolution (3-inch pixels) which allow for a side-by-side visual comparison of riparian vegetation extent and quality in 2023 and 2024. There are no significant differences in these air photos that show a change to the extent of the riparian habitat in the Prado Basin along the Chino Creek, Mill Creek, and SAR reaches in the Prado Basin. The maximum extent of the riparian habitat in the Prado Basin will be the area used to evaluate the NDVI spatially and temporally to characterize changes in the quality of entire riparian habitat extent over the last year and over the 1984 to 2024 period (Sections 3.1.2.1 and 3.1.2.2).

[12] Since 1999 there has been a decrease to the extent and density of the riparian vegetation along the Temescal Wash in the southeastern portion of Prado Basin. This area is outside the Chino Basin hydrologic boundary and is not an area of influence of potential impacts of Peace II implementation on groundwater levels.





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Prado Basin Sustainability Commi t ee
2024 Annual Report

Air Photos and Extent of the Riparian Vegeta t on
2023 and 2024

Figure 3-1a

Figure 3-1b compares the 2024 air photo and the mapped extent of the riparian habitat to the NDVI estimates for the Prado Basin area on a date that corresponds to the maximum of the spatial average of NDVI during the growing season for 2024.[13] Generally, the following ranges in NDVI during the growing season correspond to these land cover types:

- < 0: Water
- 0 - 0.29: Non-vegetated surfaces, such as urbanized land cover and barren land
- 0.3 - 1.0: Vegetated land cover: higher NDVI values indicate greater photosynthetic activity

Three main observations and interpretations are derived from this figure:

- The majority of the Prado Basin riparian vegetation areas have NDVI estimates of about 0.3 to 0.9 during the growing season. Active agricultural lands in the Prado Basin region can also have NDVI values of a similar range during the growing season.
- The NDVI estimates support the delineation of the extent of the riparian habitat as drawn from the air photos.
- The consistency of NDVI values to land cover observed in the air photo indicates that the processing of NDVI estimates for this study were performed accurately, which supports subsequent analyses and interpretations.

3.1.2 Quality of the Riparian Habitat

As discussed, and referenced in Section 2.0, NDVI is an indicator of the photosynthetic activity of vegetation and therefore can be used to interpret the health or "quality" of the riparian vegetation. In this section, NDVI is spatially and temporally analyzed in maps and time-series charts for defined areas throughout Prado Basin to characterize changes in the quality of riparian habitat over the period 1984 to 2024.

3.1.2.1 Spatial Analysis of NDVI

Figure 3-2 compares maps of NDVI across the entire Prado Basin area for 2023 and 2024 on the dates that correspond to the maximum growing-season NDVI for the year as a spatial average across the entire extent of the riparian vegetation. Figure 3-3 is a map of change in NDVI from 2023 to 2024 that was prepared by subtracting the 2023 NDVI map from the 2024 NDVI map on Figure 3-2. These figures identify areas that may have experienced a change in the quality of riparian habitat from 2023 to 2024:

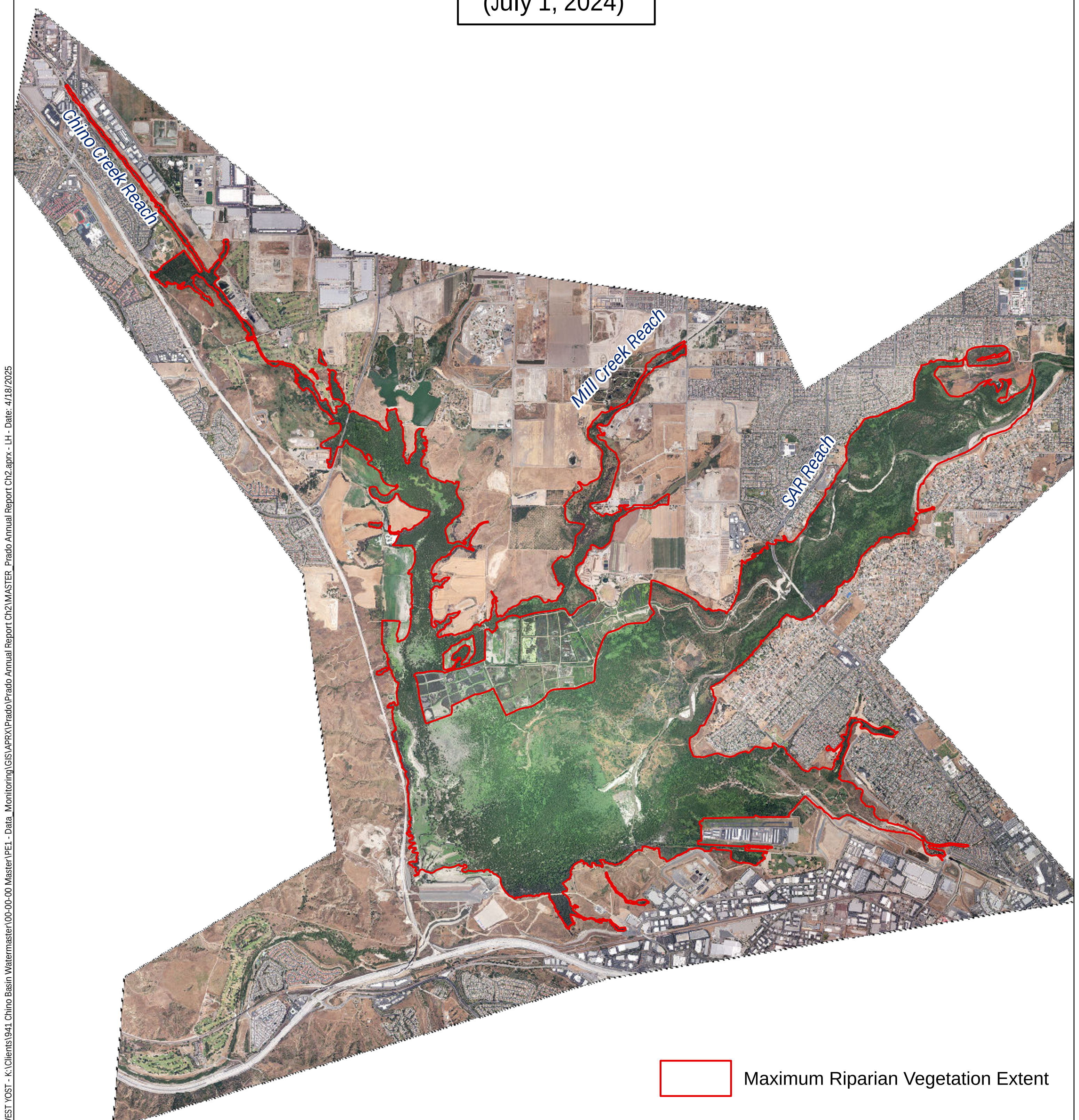
- About half of the riparian vegetation extent area showed no change in NDVI from 2023 to 2024.
- NDVI decreased and increased in scattered patches in the riparian vegetation throughout the Prado Basin.
- The notable patches of increase in NDVI are behind Prado Dam and in the middle portion of Chino Creek northwest of the OCWD wetlands.
- The notable patches of decrease in NDVI are located in the lower area of Prado Basin along the SAR and below the OCWD wetlands.

These spatial changes in NDVI will be analyzed along with the factors that can impact riparian habitat in Sections 3.2 through 3.6 of this report.

---

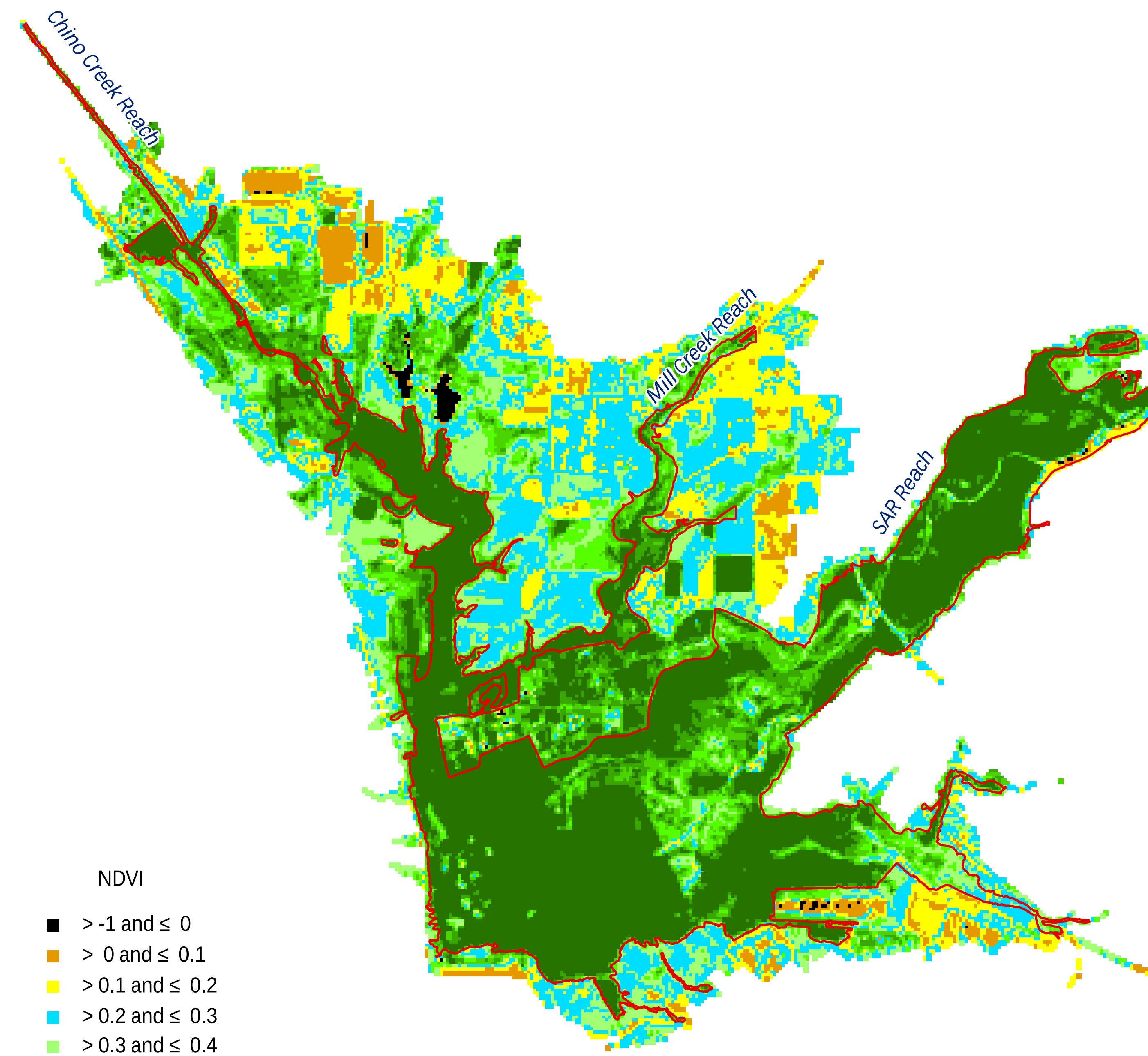
[13] The growing season for the Prado Basin riparian vegetation is from March through October (Merkel, 2007; USBR, 2008). The maximum NDVI for the 2024 growing season occurred on July 31, 2024.

2024 Air Photo
(July 1, 2024)



Maximum Riparian Vegetation Extent

2024 NDVI
(July 31, 2024)*



NDVI

- > -1 and ≤ 0
- > 0 and ≤ 0.1
- > 0.1 and ≤ 0.2
- > 0.2 and ≤ 0.3
- > 0.3 and ≤ 0.4
- > 0.4 and ≤ 0.5
- > 0.5 and ≤ 0.6
- > 0.6 and ≤ 0.7
- > 0.7 and ≤ 1

*Maximum growing-season NDVI for 2024

Maximum Riparian Vegetation Extent

WEST YOST - K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE1 - Data_Monitoring\GIS\APRX\Prado\Prado Annual Report Ch2\MASTER_Prado Annual Report Ch2.aprx - LH - Date: 4/18/2025

Prepared by:

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0 1 2 Miles

0 1 2 Km

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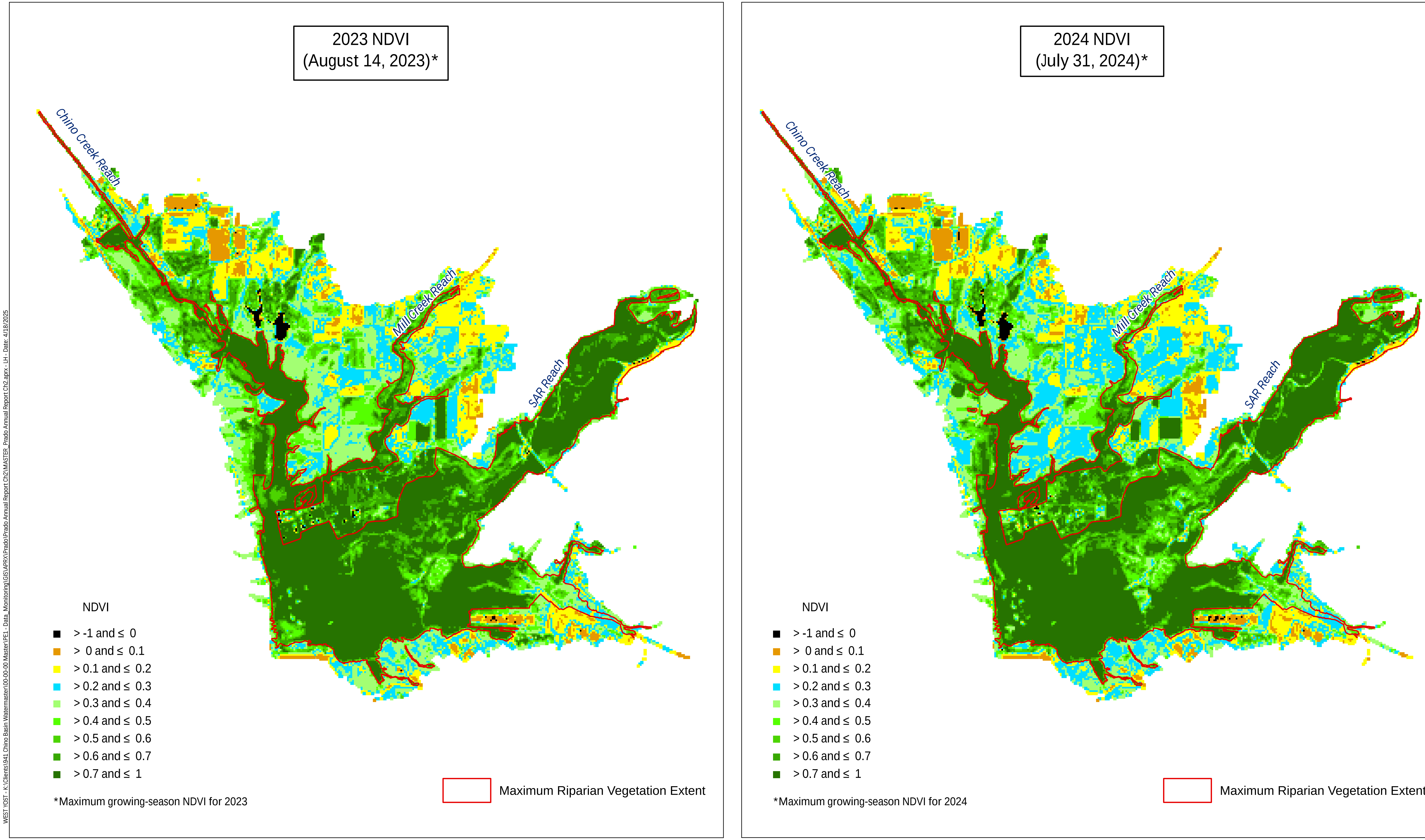
Air Photo and Spa t al NDVI for the Prado Basin
2024

Figure 3-1b



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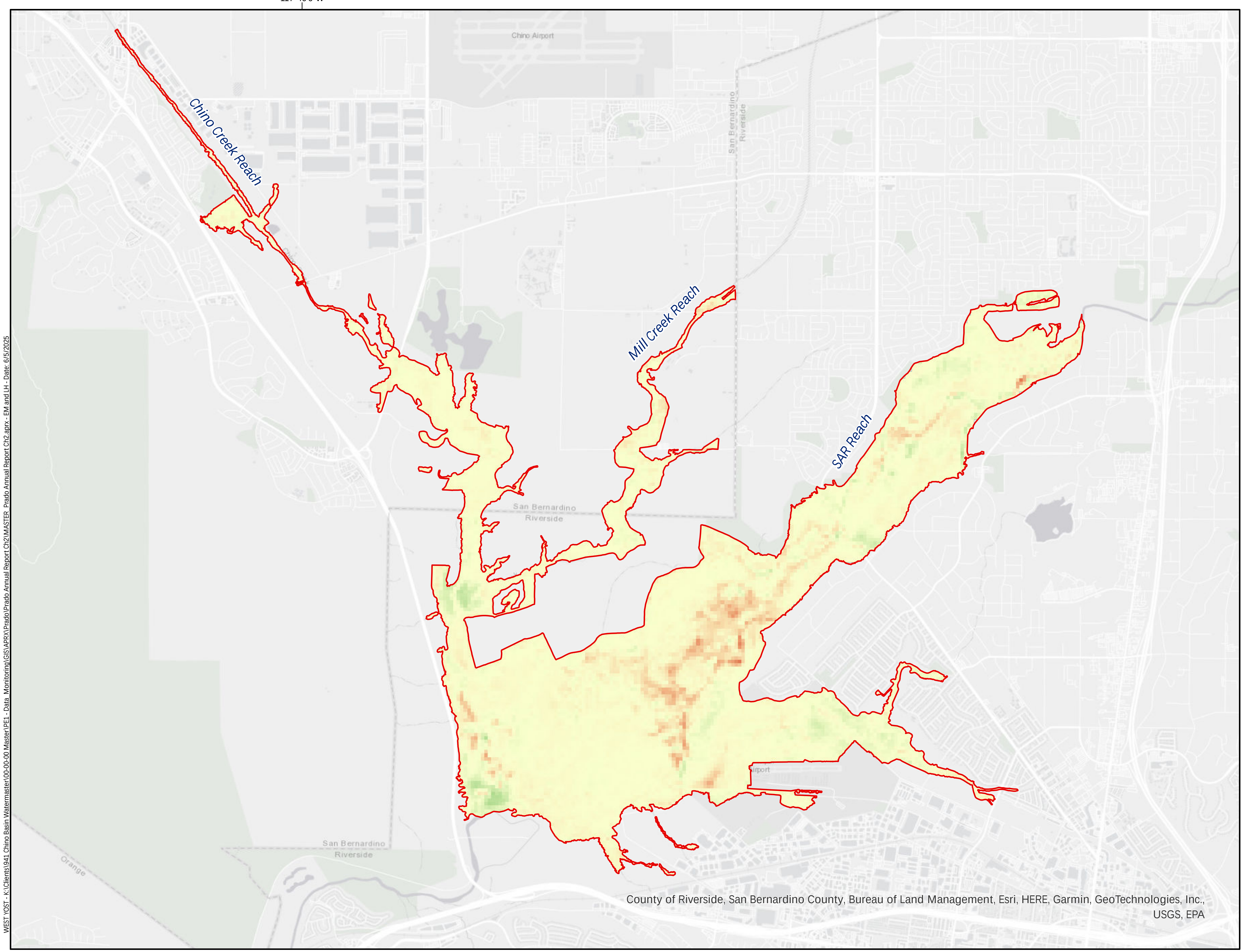
Spatial NDVI for the Prado Basin
2023 and 2024

Figure 3-2

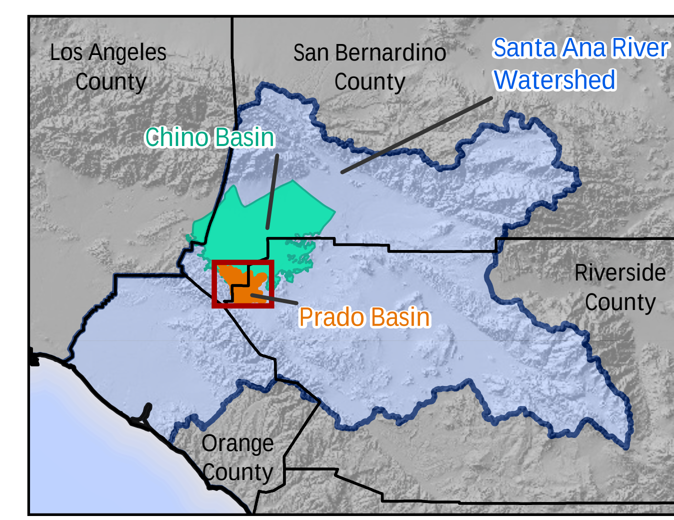


WEST YOST - K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE1 - Data Monitoring\GIS\APRX\Prado\Prado Annual Report Ch2\MASTER_Prado Annual Report Ch2.aprx - EM and LH - Date: 6/5/2025

Change in Maximum Growing-Season NDVI Values
2023 to 2024

1.0 Increase
-1.0 Decrease

Maximum Riparian Vegetation Extent in Prado Basin



Prepared by:

WEST YOST

0 1 2 Miles
0 1 2 Km

Prepared for:

Prado Basin Sustainability Committee
2024 Annual Report

Spatial Change in NDVI for the Prado Basin
2023 to 2024

Figure 3-3

3.1.2.2 Temporal Analysis of NDVI

NDVI pixels[14] within defined areas throughout the Prado Basin were spatially averaged and temporally analyzed in time-series charts. The defined areas include four large and 14 small areas within Prado Basin and are shown in Figure 3-4. The large areas include the extent of the riparian habitat in the entire Prado Basin (6.8 mi^2 - 19,520 NDVI pixels), the upper portion of Chino Creek (0.74 mi^2 - 2,134 NDVI pixels), the entire Mill Creek reach (0.26 mi^2 - 759 NDVI pixels), and the upper portion of Mill Creek (0.03 mi^2 – 92 NDVI pixels). The small areas are located along the northern reaches of the Prado Basin riparian habitat near the PBHSP monitoring wells and a USBR vegetation survey site (10-meter radius plot). All the small areas are one NDVI pixel (30 x 30-meter pixel – 900 square meters).[15]

Figures 3-5, 3-6, 3-7a, 3-7b, and 3-8a through 3-8n are time-series charts of the NDVI for each defined area, illustrating changes in the riparian habitat quality over time. These figures characterize long- and short-term changes in NDVI in specific areas, providing context for interpreting trends and changes during Peace II implementation. Each figure shows two datasets that illustrate trends in the NDVI estimates:

- **Spatial Average NDVI (green dots)**. Spatial Average NDVI are the spatial average of the NDVI pixels within the defined area. These data characterize the seasonal and long-term trends in NDVI for each defined area. The NDVI exhibits an oscillatory pattern caused by seasonal changes in the riparian habitat. The NDVI time-series are typical for a deciduous forest, where NDVI values are higher in the growing season from March through October and lower in the dormant season from November through February when plants and trees shed their leaves.
- **Average Growing-Season NDVI (black dots and black curve).** The Average Growing-Season NDVI is the annual average of the Spatial Average NDVI for each growing season from March through October. This curve shows the annual changes and long-term trends in the NDVI for the growing season. This metric is used to analyze year-to-year changes and long-term trends in NDVI.

NDVI maps or air photos are included on the time-series charts for spatial reference and as a visual check on the interpretations derived from the time-series charts. The air photos are for 2021, 2022, 2023, and 2024, showing the last four years using the high-resolution air photos collected for the PBHSP.

To statistically characterize long-term trends in NDVI, the Mann-Kendall statistical trend test (Mann-Kendall test) was performed on the Average Growing-Season NDVI for all defined areas over the following three periods:

- 1984 to 2024: the entire period of record
- 1984 to 2006: period prior to Peace II Agreement implementation
- 2007 to 2024: period subsequent to Peace II Agreement implementation

The Mann-Kendall test utilizes a ranking formula to statistically analyze if there is an increasing trend, decreasing trend, or no trend in the NDVI. Appendix B describes the Mann-Kendall test methods and results. The final Mann-Kendall test results for the Average Growing-Season NDVI are shown on each time-series chart and are summarized in Table 3-1.

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[14] Each NDVI pixel is approximately 30 x 30 meters.

[15] In previous annual reports, these small areas were four NDVI pixels in this same general area. During WY 2020, these areas were modified to one NDVI pixel that aligned with the USBR vegetation survey so that the field vegetation survey data can better correlate with the NDVI time-series data.

Table 3-1. Mann-Kendall Test Results of the Average-Growing Season NDVI Trends for Defined Areas in the Prado Basin

Defined Area	Figure Number	Mann Kendal Test Result[(a)] Period of Record 1984-2024	Prior to Peace II 1984-2006	Post Peace II 2007-2024
Riparian Vegetation Extent	3-5	No Trend	No Trend	No Trend
Chino Creek	3-6	Increasing	Increasing	Increasing
Mill Creek	3-7a	No Trend	Decreasing	Increasing
Upper Mill Creek	3-7b	Increasing	No Trend	Increasing
CC-1	3-8a	Increasing	Increasing	Increasing
CC-2	3-8b	Increasing	Increasing	Increasing
CC-3	3-8c	Increasing	Increasing	Increasing
CC-4	3-8d	Increasing	No Trend	Increasing
MC-1	3-8e	Increasing	Increasing	Increasing
MC-2	3-8f	No Trend	No Trend	Increasing
MC-3	3-8g	Increasing	No Trend	Increasing
MC-4	3-8h	Increasing	No Trend	No Trend
MC-5	3-8i	No Trend	No Trend	Increasing
MC-6	3-8j	Increasing	No Trend	Increasing
SAR-1	3-8k	No Trend	No Trend	Increasing
SAR-2	3-8l	Increasing	Decreasing	Increasing
SAR-3	3-8m	Increasing	No Trend	Increasing
LP	3-8n	No Trend	Increasing	No Trend

(a) See Appendix B for a description of the Mann-Kendall statistical trend test and results.

To characterize the short-term trends in NDVI, Table 3-2 summarizes the one-year change in the Average Growing-Season NDVI from 2023 to 2024 at the 18 defined areas and compares to the changes and variability in Average Growing-Season NDVI over the historical period of 1984 to 2023 at each area. During WY 2024, there were slight decreasing trends in the NDVI from 2023 to 2024 at most of the areas: 13 areas decreased; two areas showed no trend; and three areas increased. These one-year changes in the Average Growing-Season NDVI are all minor and within the range of long-term annual variability of the NDVI at each area.

Table 3-2. Characterization of Variability in the Average-Growing Season NDVI for Defined Areas in the Prado Basin				
		Historical NDVI Statistics 1984-2023		
Defined Area	Figure Number	Average One-Year Change in NDVI (Absolute Value)	Maximum One-Year Change in NDVI (Absolute Value)	One-Year Change in NDVI from 2023-2024
Riparian Vegetation Extent	3-5	0.03	0.08	0.00
Chino Creek	3-6	0.02	0.09	-0.02
Mill Creek	3-7a	0.04	0.11	-0.02
Upper Mill Creek	3-7b	0.03	0.12	-0.05
CC-1	3-8a	0.03	0.08	0.01
CC-2	3-8b	0.03	0.11	-0.02
CC-3	3-8c	0.03	0.12	-0.02
CC-4	3-8d	0.03	0.09	-0.01
MC-1	3-8e	0.04	0.12	-0.02
MC-2	3-8f	0.06	0.18	-0.07
MC-3	3-8g	0.03	0.13	0.00
MC-4	3-8h	0.03	0.12	-0.02
MC-5	3-8i	0.04	0.12	-0.07
MC-6	3-8j	0.05	0.22	-0.02
SAR-1	3-8k	0.06	0.48	0.01
SAR-2	3-8l	0.04	0.13	-0.01
SAR-3	3-8m	0.02	0.10	-0.03
LP	3-8n	0.06	0.21	0.05

3.1.2.3 Temporal Analysis of NDVI in Prado Basin

Figure 3-5 is a time-series chart from 1984 to 2024 of the spatial average of all 19,520 NDVI pixels that are within the maximum delineated extent of the riparian habitat in the Prado Basin.[16] The intent of the time series is to characterize the trends in NDVI for the Prado Basin as a whole, which is used as a basis of comparison to the trends in the NDVI for each of the smaller defined areas shown in subsequent figures. Instead of air photos like the time-series chart in Figures 3-6, 3-7a, 3-7b, and 3-8a through 3-8n, Figure 3-5 includes NDVI maps from 2021, 2022, 2023, and 2024, to visually compare to the NDVI time series.

Figure 3-5 and Tables 3-1 and 3-2 show that the Average Growing-Season NDVI for the entire Prado Basin varies from year-to-year by no more than 0.08 with no apparent long-term trends. The Mann-Kendall test result on the Average Growing-Season NDVI indicates “no trend” over the 1984 to 2024 period, “no trend” over the 1984 to 2006 period, and “no trend” over the 2007 to 2024 period.

[16] The maximum extent of the riparian habitat in the Prado Basin is based on 1999 conditions and has been relatively stable since in the Chino Creek, Mill Creek, and SAR reaches, and has been verified by inspection of the 2017 to 2024 high-resolution air photos.

From 2023 to 2024, the Average Growing-Season NDVI remained the same, and within the historical range of the annual Average Growing-Season NDVI variability for the extent of the riparian vegetation.

This time-series analysis of NDVI suggests that the riparian habitat in Prado Basin, analyzed as a whole, has not experienced statistically significant declines in NDVI in the recent water year, nor during the post-Peace II Agreement period from 2007 to 2024.

3.1.2.4 Temporal Analysis of NDVI within Large Areas along Chino Creek and Mill Creek

Figures 3-6, 3-7a, and 3-7b are time-series charts from 1984 to 2024 of the spatial average for NDVI pixels within large areas of riparian habitat located along the reaches of Chino Creek, Mill Creek, and Upper Mill Creek, respectively. These charts characterize trends and changes in NDVI for these northern reaches of the riparian habitat in the Prado Basin and provide a basis for comparison to the NDVI trends and changes for each of the smaller defined areas.

Chino Creek

Figure 3-6 is an NDVI time-series chart for 1984 to 2024 of the spatial average of all 2,134 NDVI pixels along the upper portion of Chino Creek in the Prado Basin. This reach of Chino Creek is susceptible to impacts from declining groundwater levels associated with Peace II implementation.

Figure 3-6 and Tables 3-1 and 3-2 show that over the period of record, the Average Growing-Season NDVI varied from year-to-year by no more than 0.09 with a long-term increasing trend. The Mann-Kendall test result on the Average Growing-Season NDVI indicates an “increasing trend” over the 1984 to 2024 period, an “increasing trend” over the 1984 to 2006 period, and an “increasing trend” over the 2007 to 2024 period.

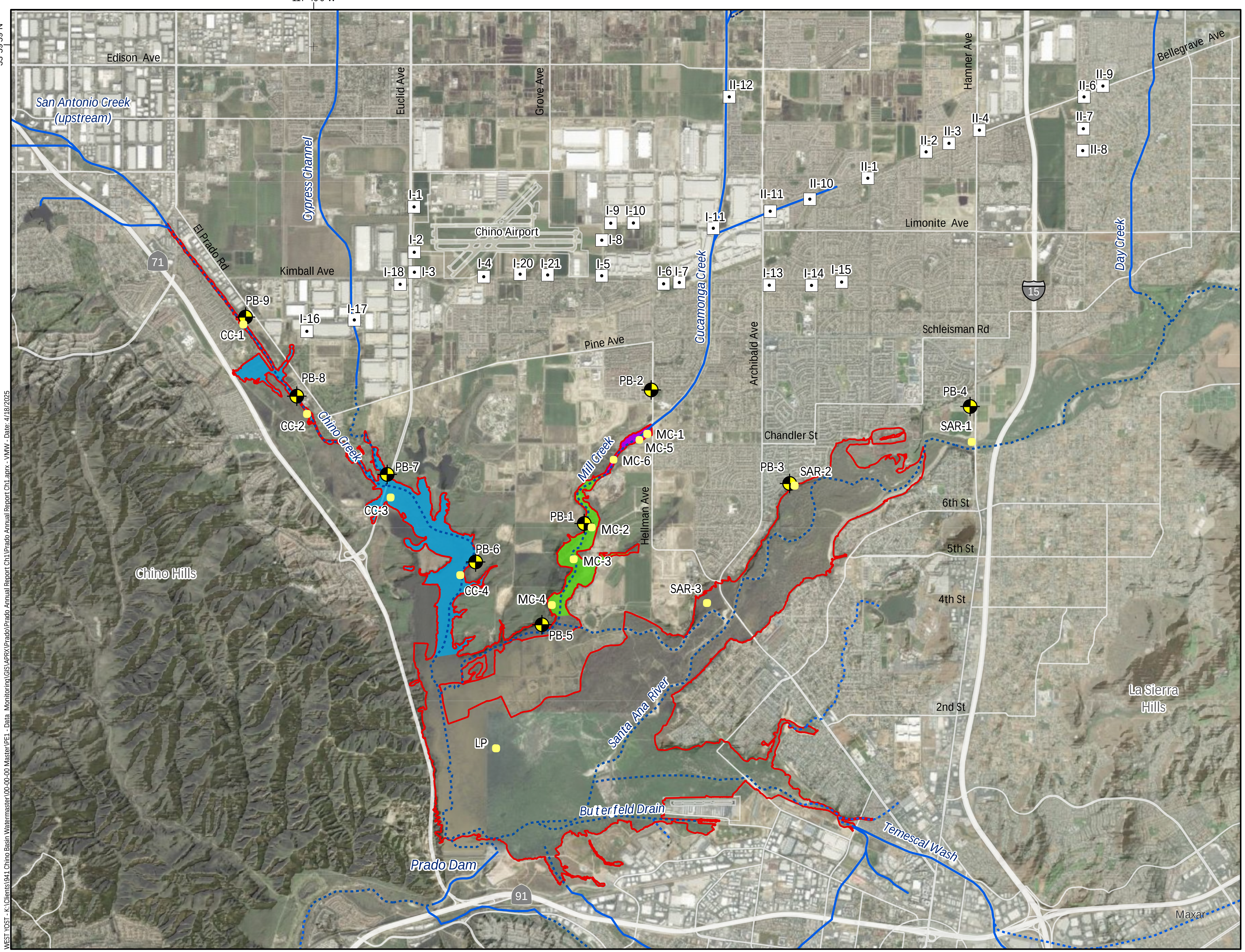
From 2023 to 2024, the Average Growing-Season NDVI decreased by 0.02, which is the same as the historical average one-year change in NDVI and therefore, within the historical range of variability for the annual Average Growing-Season NDVI. Visual inspection of the 2023 and 2024 air photos do not show significant changes in the riparian vegetation along Chino Creek.

Mill Creek

Figure 3-7a and Figure 3-7b are NDVI time-series charts for 1984-2024 of the spatial average for two areas of Mill Creek: the entire reach of Mill Creek in the Prado Basin (759 NDVI pixels) and the upper portion of Mill Creek (92 NDVI pixels). The Upper Mill Creek area is more susceptible to impacts from declining groundwater levels associated with Peace II implementation and was added for the analysis of NDVI time-series in the 2022 Annual Report.

Figure 3-7a and Tables 3-1 and 3-2 show that for the entire Mill Creek extent, the Average Growing-Season NDVI varied from year-to-year by no more than 0.11 over the period of record. The Mann-Kendall test result on the Average Growing-Season NDVI indicates “no trend” over the 1984 to 2024 period, “decreasing trend” over the 1984 to 2006 period, and “increasing” over the 2007 to 2024 period. From 2023 to 2024, the Average Growing-Season NDVI decreased by 0.02 which is within the historical range of the annual Average Growing-Season NDVI variability for the entire Mill Creek and less than the average one-year change in NDVI observed over the historical period. Review of the 2023 and 2024 air photos of Mill Creek area show a decrease in green vegetation throughout this area from 2023 to 2024.

Figure 3-7b and Tables 3-1 and 3-2 show that for the upper Mill Creek reach, the Average Growing-Season NDVI varied from year-to-year by no more than 0.12 over the period of record. The Mann-Kendall test result on the Average Growing-Season NDVI indicates an “increasing trend” over the 1984 to 2024 period, “no trend” over the 1984 to 2006 period, and an “increasing trend” over the 2007 to 2024 period. From 2023 to 2024, the Average Growing-Season NDVI decreased by 0.05 which is within the historical range of the annual Average Growing-Season NDVI variability for the Upper Mill Creek area, but slightly greater than the average one-year change in NDVI observed over the historical period. Comparison of the 2023 and 2024 air photos show a decrease in vegetation in this area from 2023 to 2024.



Defned Area Analyzed for NDVI Temporally in Time-Series Chart

6.8 square-mile area (19,520 pixels) Riparian Vegetat on Extent (Figure 3-5)

0.74 square-mile area (2,134 NDVI pixels) in Chino Creek (Figure 3-6)

0.26 square-mile area (759 NDVI pixels) in Mill Creek, inclusive of 0.03 square-mile area in (92 NDVI pixels) Upper Mill Creek area in purple (Figures 3-7a and 3-7b)

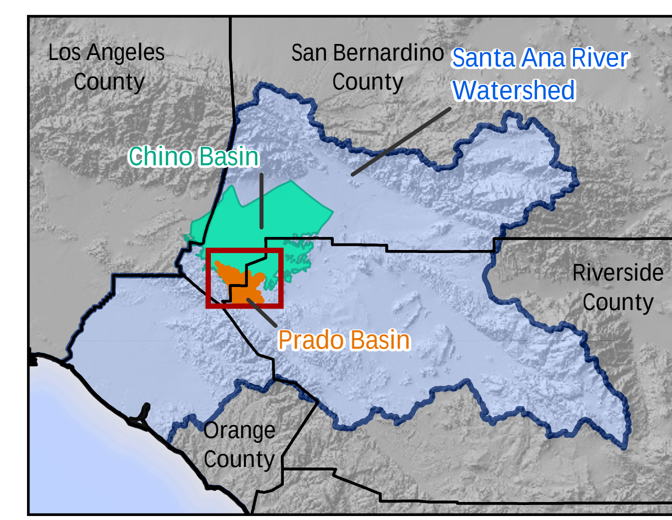
30 x 30-meter area (one NDVI pixel) (Figures 3-8a through 3-8n)

PBHSP Monitoring Well Site

Chino Desalter Well

Concrete-Lined Channels

Unlined Rivers and Streams



Prepared by:

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0 1 2 Miles

0 1 2 Km

N

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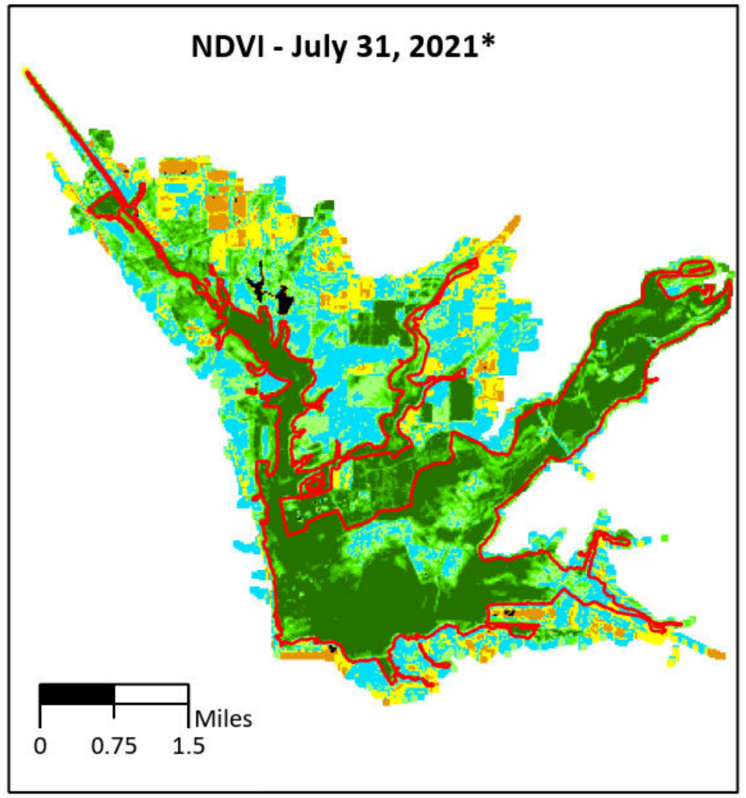
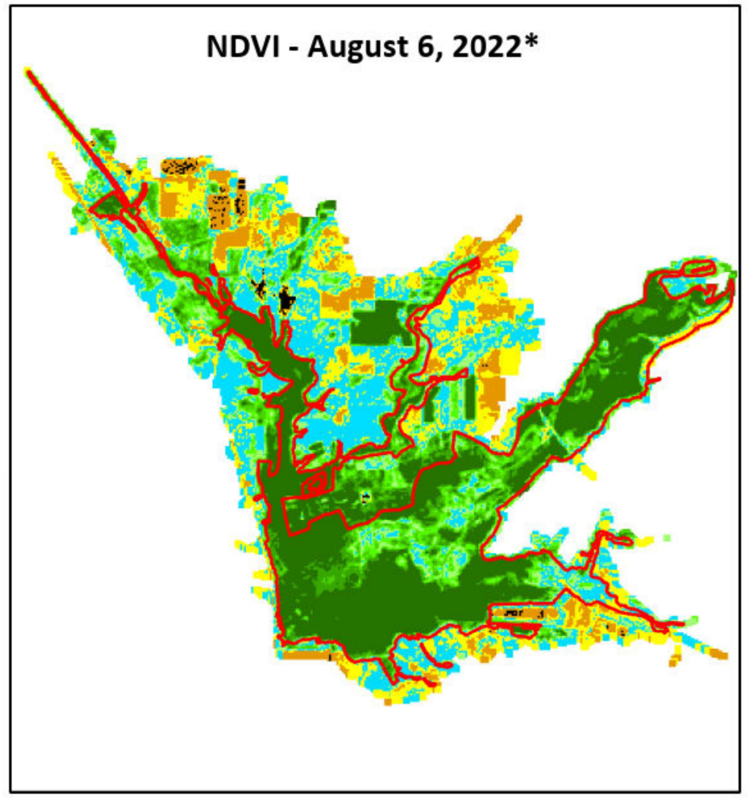
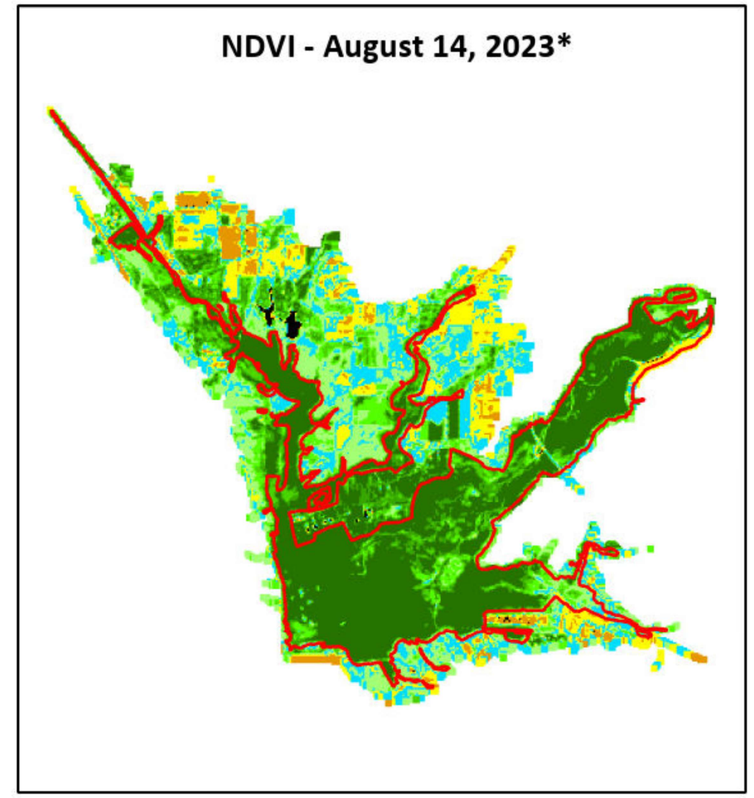
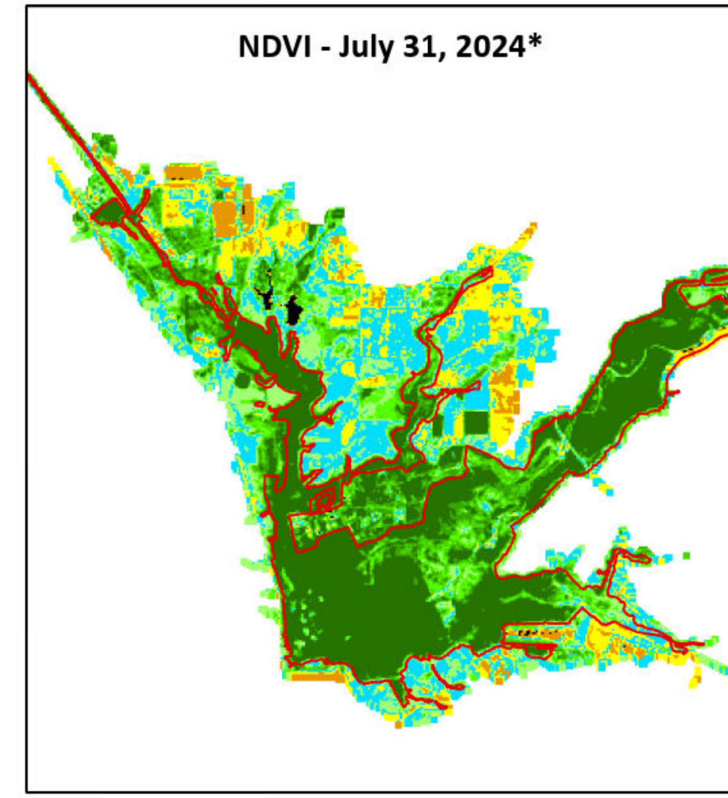
Areas for Analysis of NDVI Time Series

Figure 3-4









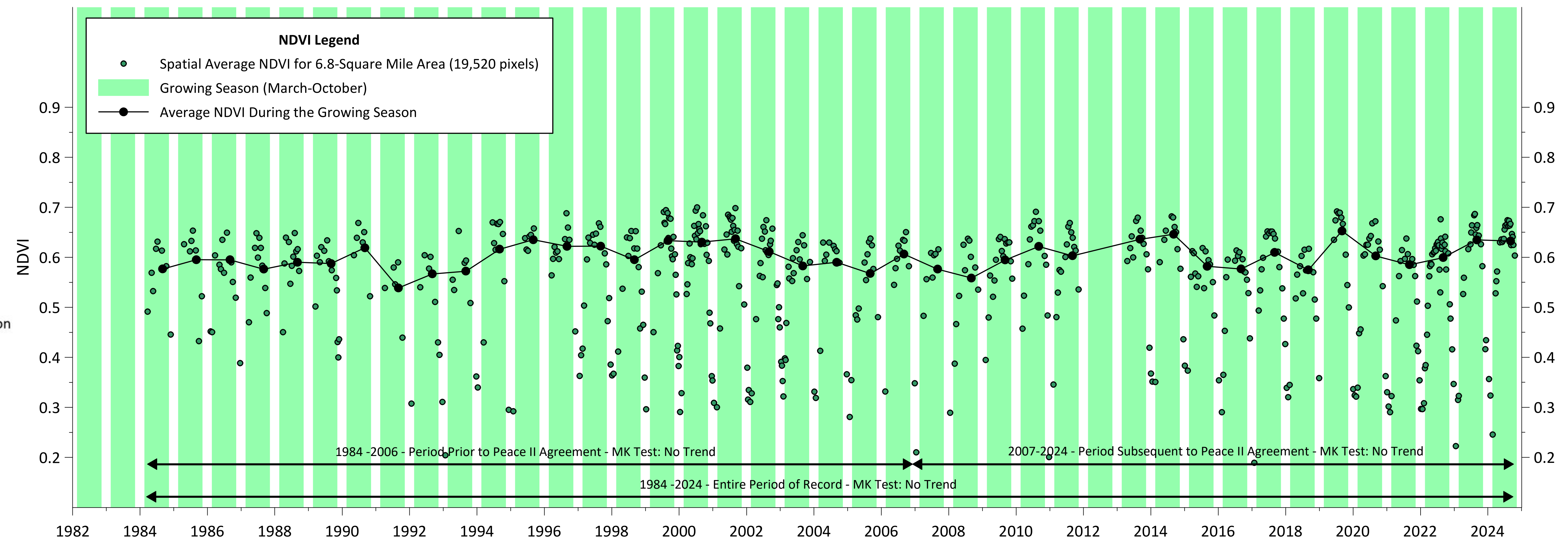
* Maximum Growing-Season NDVI

Map Legend:

NDVI

- > -1 and ≤ 0
- > 0 and ≤ 0.1
- > 0.1 and ≤ 0.2
- > 0.2 and ≤ 0.3
- > 0.3 and ≤ 0.4
- > 0.4 and ≤ 0.5
- > 0.5 and ≤ 0.6
- > 0.6 and ≤ 0.7
- > 0.7 and ≤ 1

Maximum Riparian Vegetation Extent



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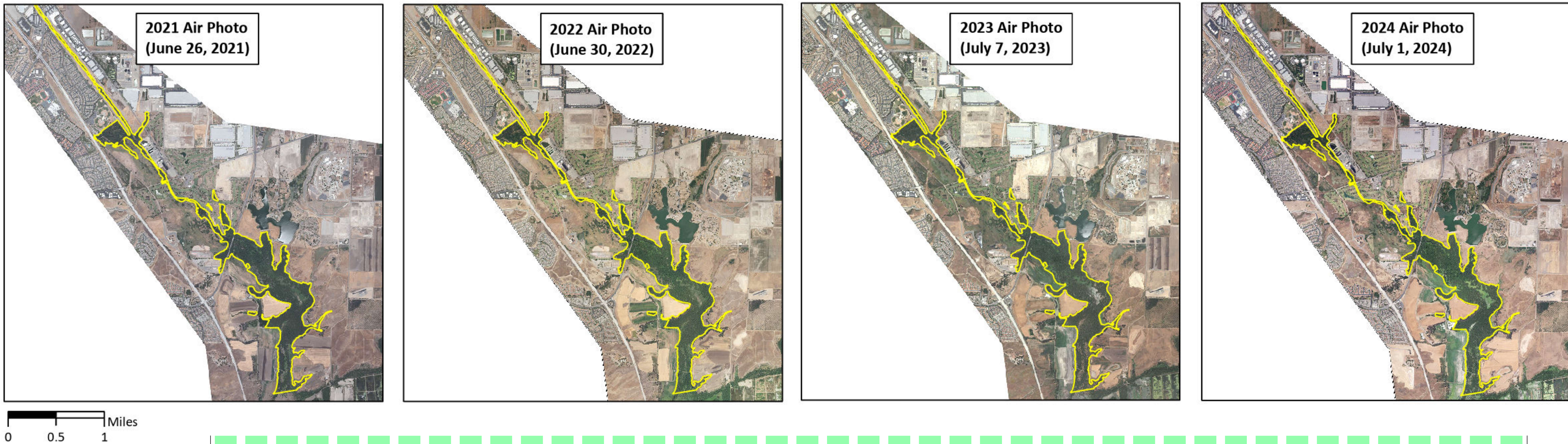
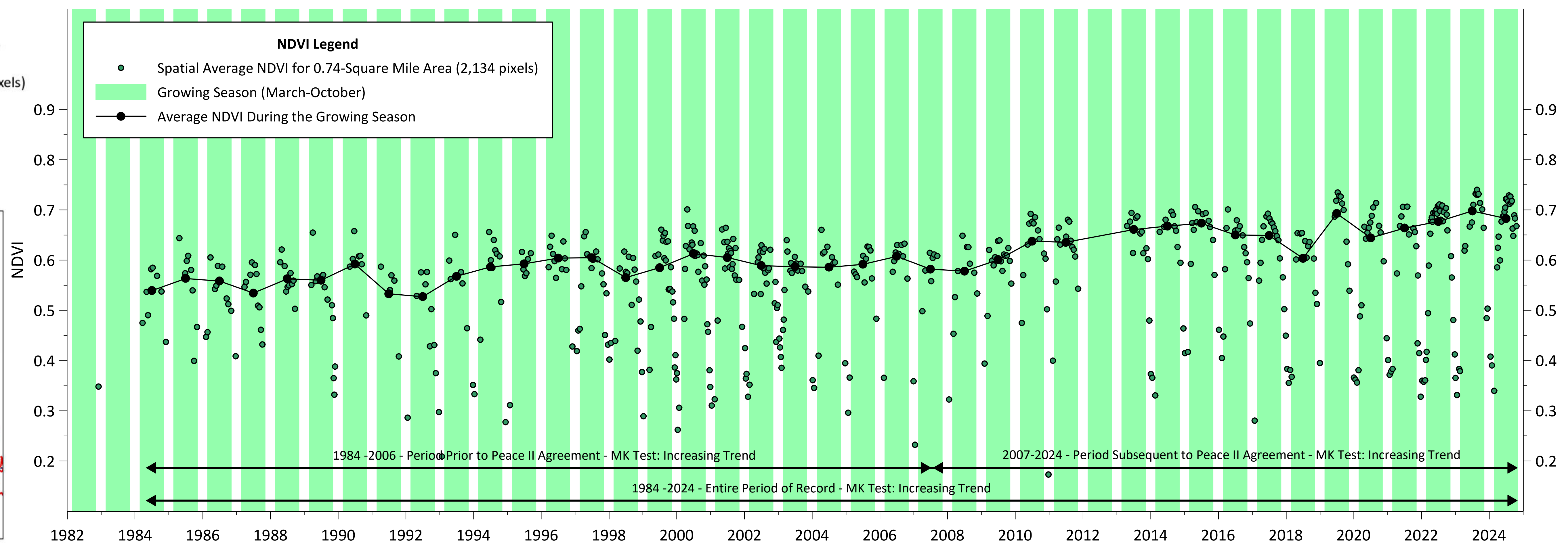
2024 Annual Report

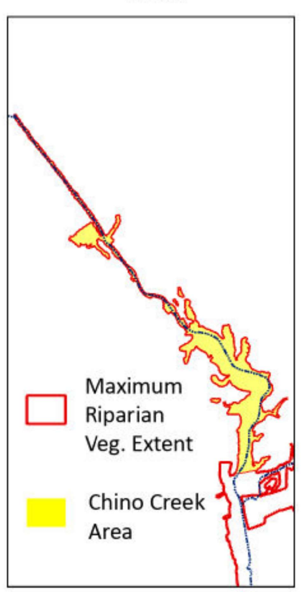
Time Series of NDVI for the Riparian Vegetation Extent
1984 to 2024

Figure 3-5





Location of Chino Creek Area



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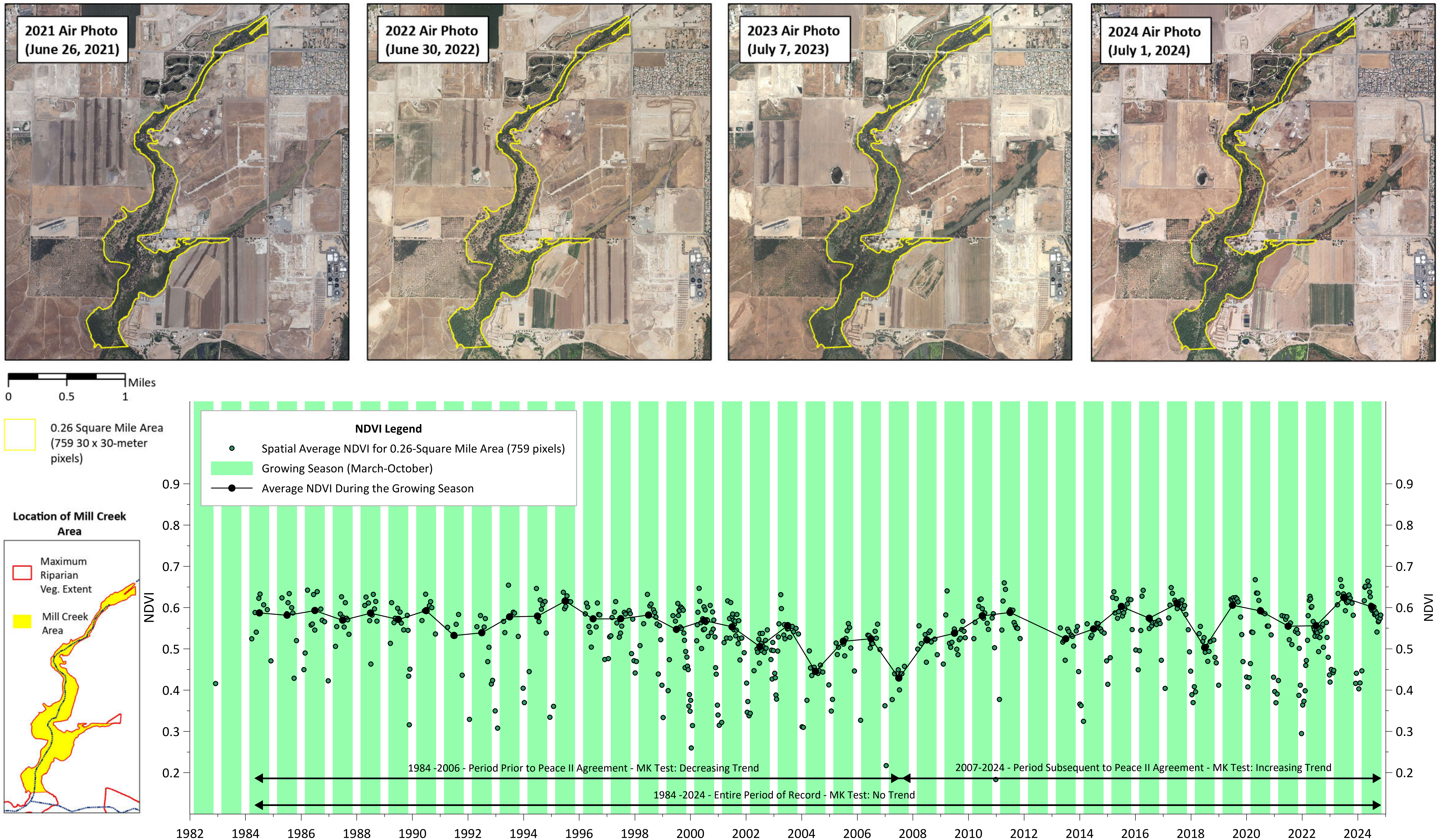
2024 Annual Report

Time Series of NDVI and Air Photos
Along Chino Creek Area for 1984 to 2024

Figure 3-6



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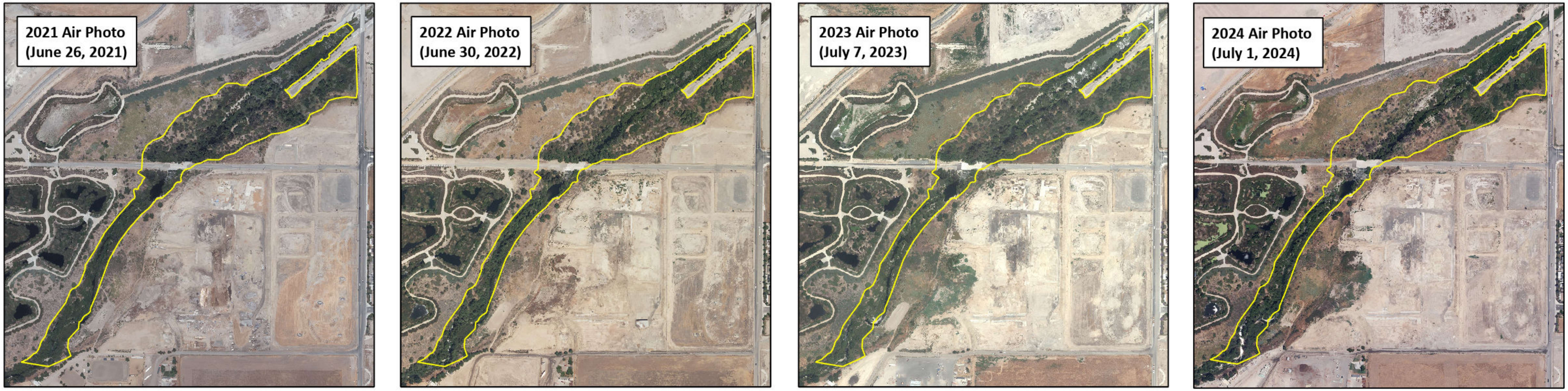
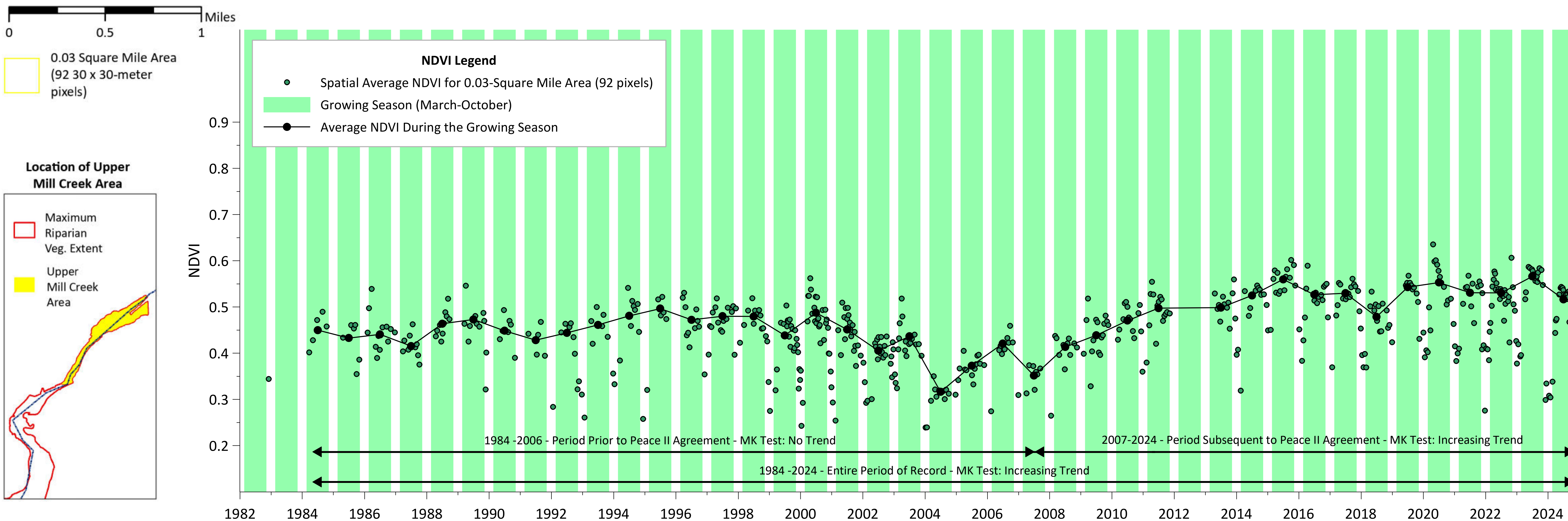
2024 Annual Report

Time Series of NDVI and Air Photos
Along Mill Creek Area for 1984 to 2024

Figure 3-7a





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Time Series of NDVI and Air Photos
Along Upper Mill Creek Area for 1984 to 2024

Figure 3-7b

3.1.2.5 Temporal Analysis of NDVI within Small Areas along Chino Creek, Mill Creek, and the Santa Ana River

Figures 3-8a through 3-8n are time-series charts of the NDVI for one NDVI pixel for the small defined areas located along Chino Creek, Mill Creek, and the SAR near the PBHSP monitoring wells from 1984 to 2024. These areas are located near a PBHSP monitoring well site to facilitate the comparison of changes in groundwater levels versus changes in the riparian habitat. Additionally, these small areas align with a 10-meter radius plot where vegetation surveys are conducted every three years allowing comparison of the field measurements with the NDVI.

The purpose of these charts is to characterize long-term trends and short-term changes in NDVI for smaller areas primarily located along the northern stream reaches of the Prado Basin riparian habitat—areas that are most susceptible to potential impacts from declining groundwater levels associated with Peace II implementation and provide a basis for comparison to the NDVI trends and changes for each of the larger defined areas.

Chino Creek **(Figures 3-8a to 3-8d)**. Four vegetated areas were analyzed along Chino Creek: CC-1, CC-2, CC-3, and CC-4 (see Figure 3-4 for locations). These figures, and Tables 3-1 and 3-2, show that over the period of record the Average Growing-Season NDVI varied from year-to-year by up to 0.12 with no long-term declining trends. For all four areas, the Mann-Kendall test result on the Average Growing-Season NDVI indicates an “increasing trend” over the 1984 to 2024 period, “no trend” or “increasing trend” over the 1984 to 2006 period, and an “increasing trend” over the 2007 to 2024 period.

For these four areas along Chino Creek, the Average Growing-Season NDVI from 2023 to 2024 increased slightly at one area in the upper reach (CC-1) and decreased slightly for the 3 sites in the middle Chino Creek reach. At all the areas, these one-year changes in the Average Growing-Season NDVI are relatively minor and within the historical ranges of one-year NDVI variability (see Table 3-2). Visual inspection of the 2023 and 2024 air photos do not show significant changes in the riparian vegetation at these four areas.

The overall trend in the Average Growing-Season NDVI align with the percent canopy cover measurements from the vegetation surveys for all the areas along Chino Creek.

Mill Creek **(Figures 3-8e to 3-8j).** Six vegetated areas were analyzed along Mill Creek just south of the CDA well field: MC-1, MC-2, MC-3, MC-4, MC-5, and MC-6 (see Figure 3-4 for locations). The MC-5 and MC-6 areas were incorporated starting with the 2022 Annual Report. These areas correspond to two new 10-meter radius plots added during the 2022 field vegetation surveys. This addition aims to enhance monitoring in a region where there has been observed drawdown of groundwater levels since the commencement of PBHSP monitoring. These figures, and Tables 3-1 and 3-2, show that over the period of record the Average Growing-Season NDVI varied year-to-year by up to 0.22 with no long-term declining trends. For all six areas, the Mann-Kendall test result on the Average Growing-Season NDVI indicates an “increasing trend” or “no trend” for the 1984 to 2024 period, an “increasing trend” or “no trend” for the 1984 to 2006 period, and an “increasing trend” or “no trend” for the 2007 to 2024 period.

The Average Growing-Season NDVI from 2023 to 2024 decreased in five of the six areas and remained unchanged for one area (MC-3). At the five areas where NDVI decreased, the one-year decrease remained within the historical ranges of one-year NDVI variability (see Table 3-2), however, the decreases at MC-2 and MC-5 are greater than the average one-year change in NDVI observed over the historical period. Visual inspection of the 2023 and 2024 air photos for MC-2 and MC-5 reveals notable changes in the riparian vegetation, including reductions in coverage and browning of the vegetation.

The overall trend in the Average Growing-Season NDVI align with the percent canopy cover measurements from the vegetation surveys for all the areas along Mill Creek.

Santa Ana River **(Figures 3-8k to 3-8n).** Four vegetated areas were analyzed along the floodplain of the SAR: SAR-1, SAR-2, SAR-3, and LP (see Figure 3-4 for locations). These figures, and Tables 3-1 and 3-2, show that over the period of record the Average Growing-Season NDVI varied by up to 0.48 from year-to-year. For all four areas, the Mann-Kendall test result on the Average Growing-Season NDVI indicates an "increasing trend" or "no trend" for the 1984 to 2024 period, an "increasing trend", "no trend" or "decreasing trend" for the 1984 to 2006 period, and an "increasing trend" or "no trend" for the 2007 to 2024 period.

The Average Growing-Season NDVI from 2023 to 2024 decreased at two of the sites (SAR-2 and SAR-3) and increased at two of the sites (SAR-1 and LP). These one-year changes in the Average Growing-Season NDVI are relatively minor and within the historical ranges of one-year NDVI variability (see Table 3-2), although the decrease in Average Growing-Season NDVI from 2023 to 2024 at SAR-3 was slightly greater than the average one-year change in NDVI over the historical period. Visual inspection of the 2023 and 2024 air photos do not show significant changes in the riparian vegetation at the SAR-1, SAR-2, SAR-3, and LP areas.

The overall trend in the Average Growing-Season NDVI align with the percent canopy cover measurements from the vegetation surveys for two areas (SAR-1 and SAR-3). The trend in the Average Growing-Season NDVI compared to the trend in the percent canopy cover measurements in 2022 do not align for the other two areas (SAR-2 and LP):

- At the X13 plot within SAR-2, there were multiple dead trees noted in 2022 due to grapevine competition (reduced canopy cover to 46%). The NDVI did not show a related decrease, likely due to the greenness of the grapevines.
- At the X1 plot within LP, there was an increase in dead trees noted in 2022 due to a fire in December 2020 (reduced canopy cover to 19%). The NDVI decreased in 2021 as a result of the fire and began to rebound in 2022. The NDVI increase in 2022 is likely from the rebound in the green perennial ground cover and not from the regrowth of trees.

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

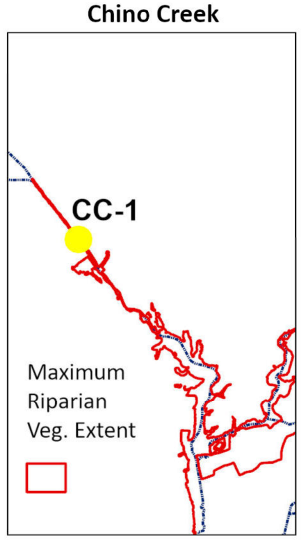
2024 Air Photo (July 1, 2024)

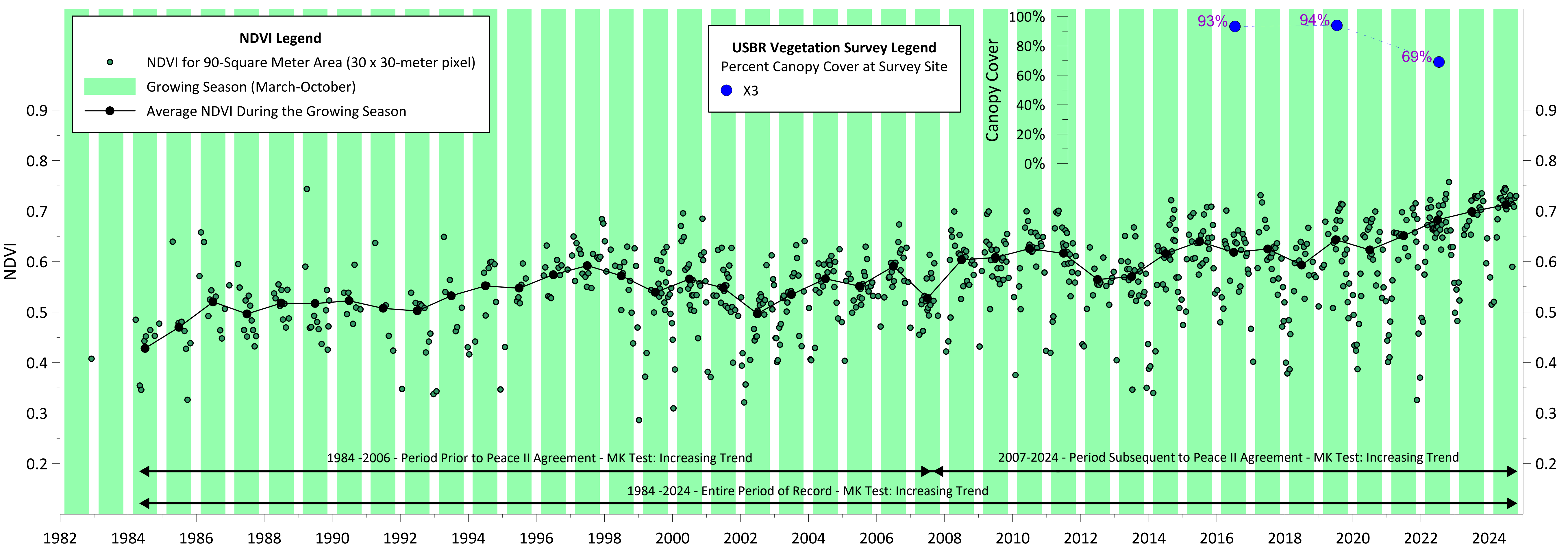
Meters
0 5 10

CC-1 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Chino Creek





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2024 Annual Report

Time Series of NDVI and Air Photos
CC-1 Area for 1984 to 2024

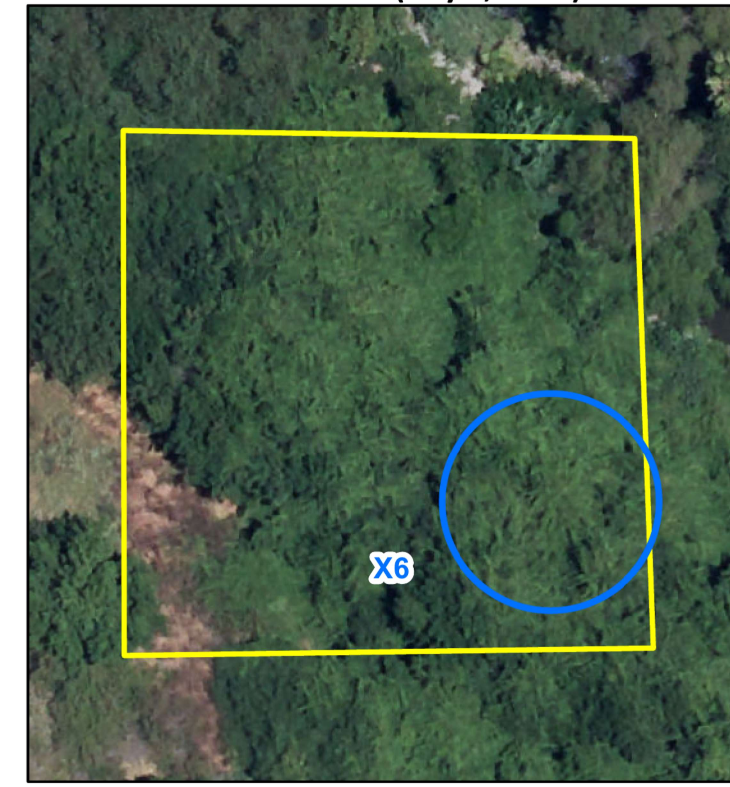
Figure 3-8a

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

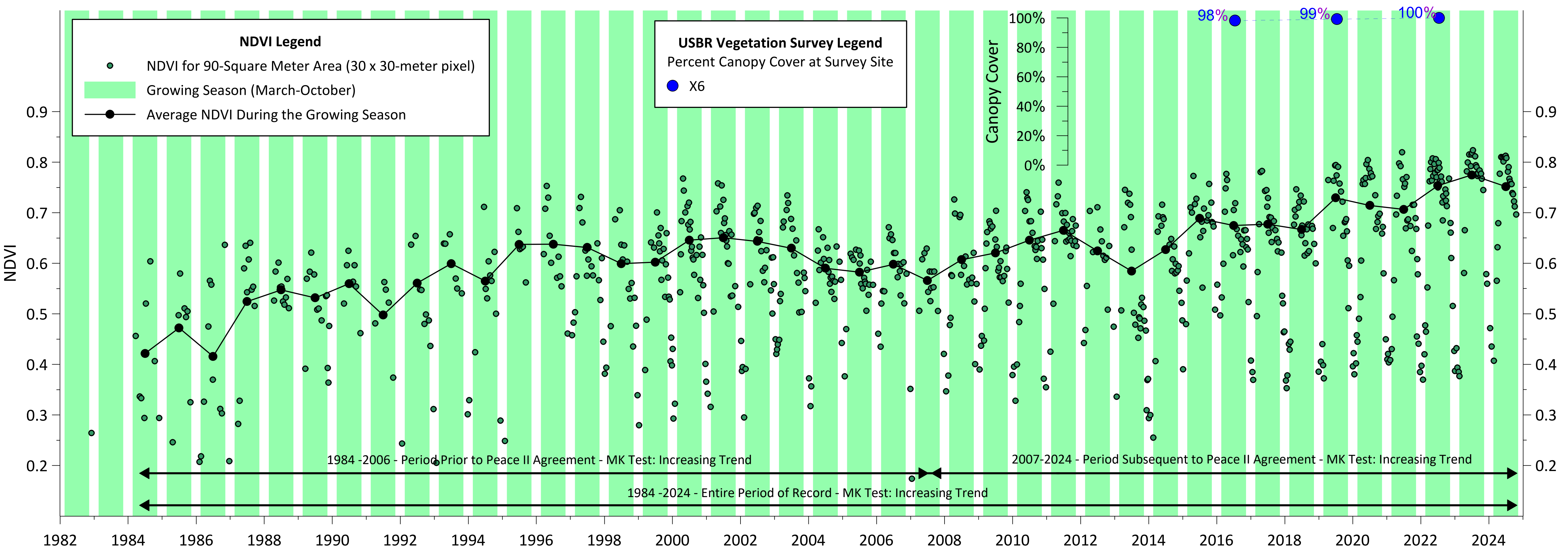
2024 Air Photo (July 1, 2024)



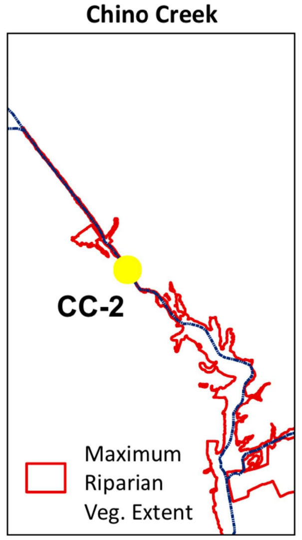
Meters
0 5 10

CC-2 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius



Location Along Chino Creek



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Time Series of NDVI and Air Photos

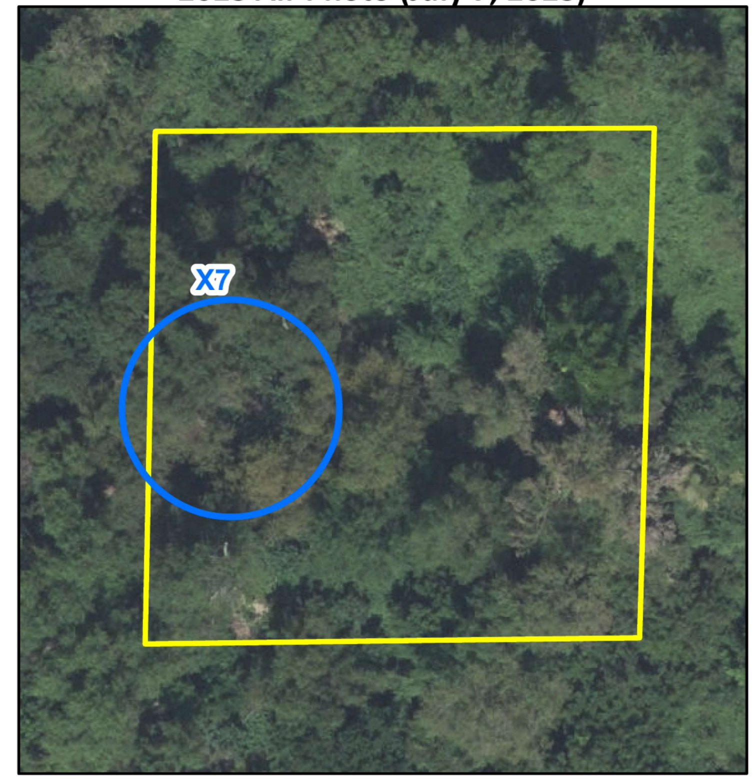
CC-2 Area for 1984 to 2024

Figure 3-8b

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

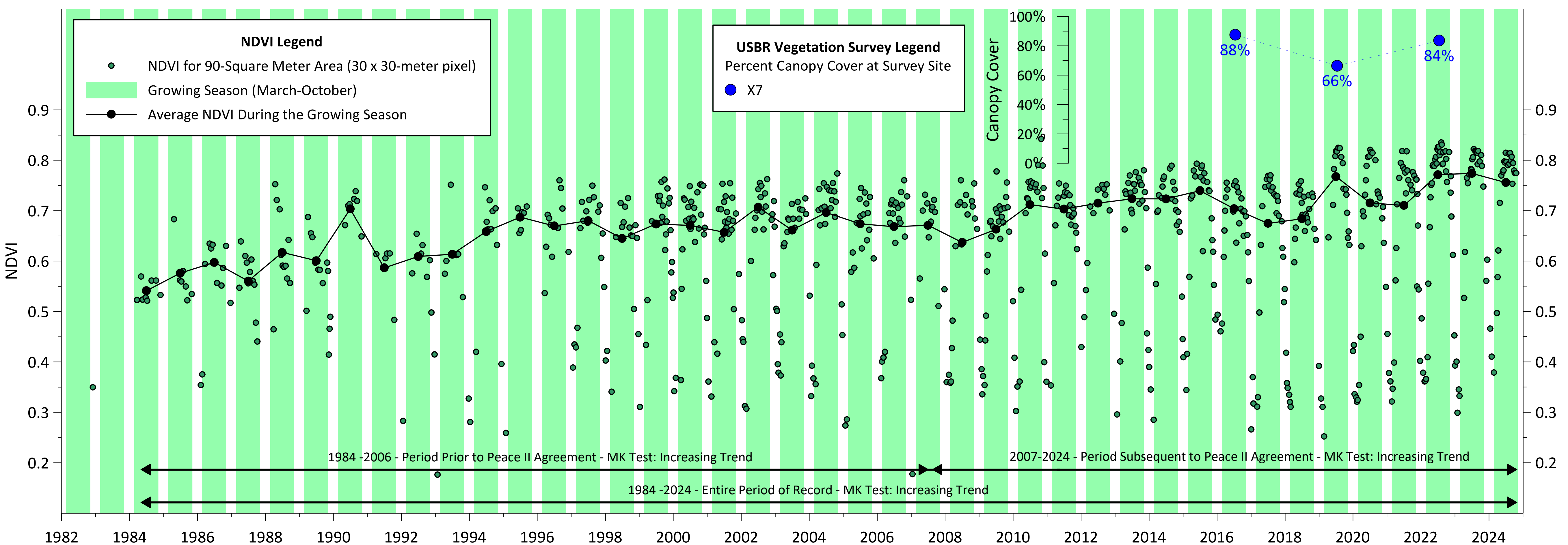


2024 Air Photo (July 1, 2024)

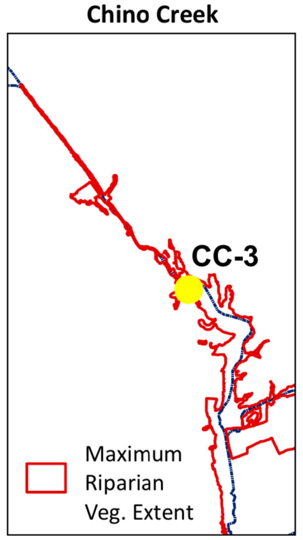
Meters
0 5 10

CC-3 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius



Location Along Chino Creek



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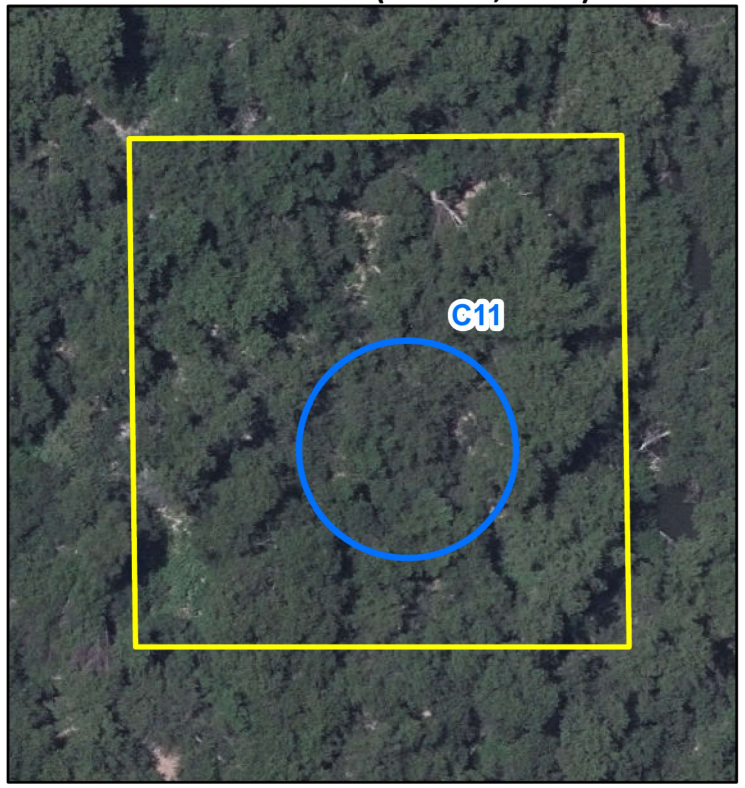
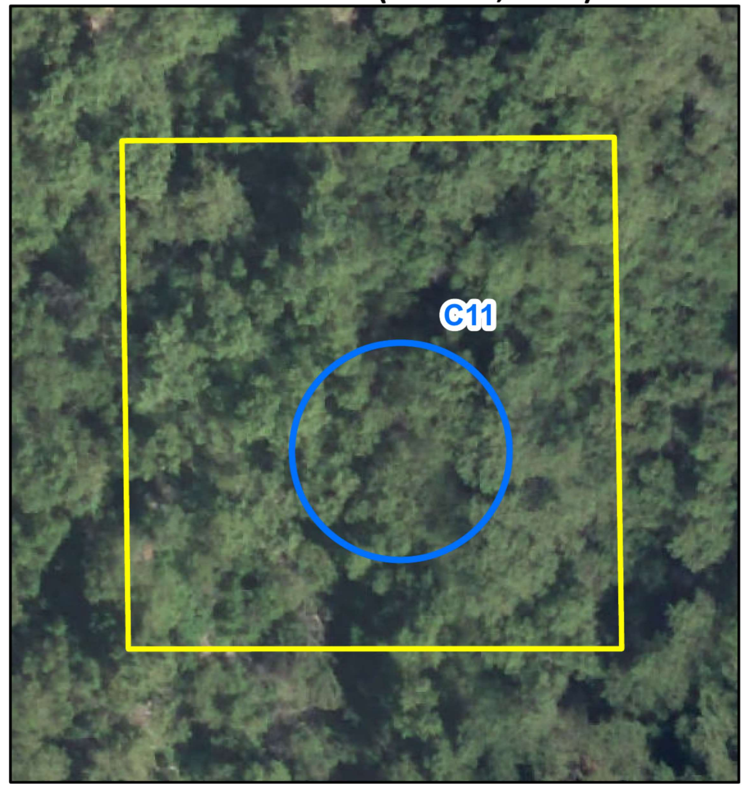
Time Series of NDVI and Air Photos
CC-3 Area for 1984 to 2024

Figure 3-8c

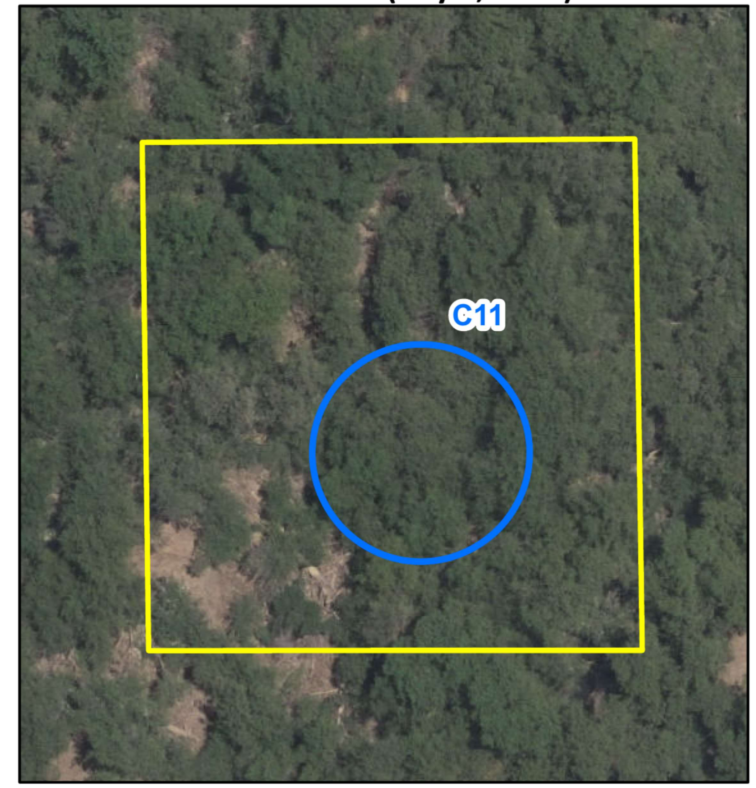
2021 Air Photo (June 26, 2021)



2022 Air Photo (June 30, 2022)



2023 Air Photo (July 7, 2023)

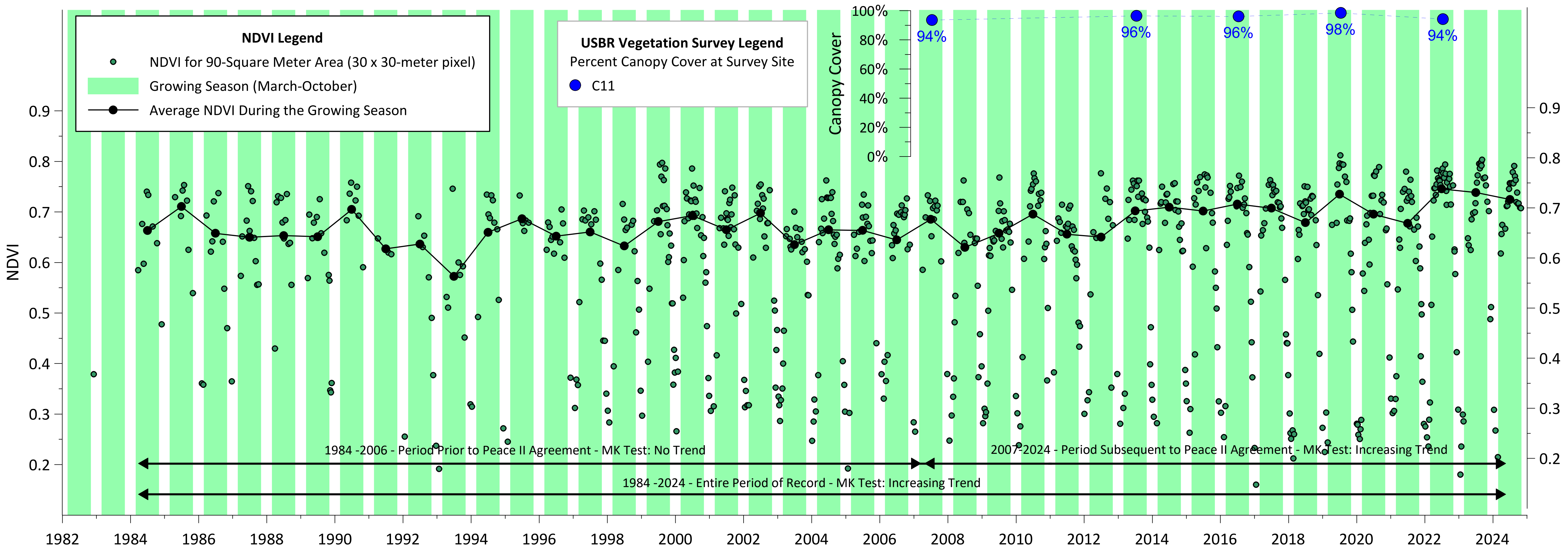


2024 Air Photo (July 1, 2024)

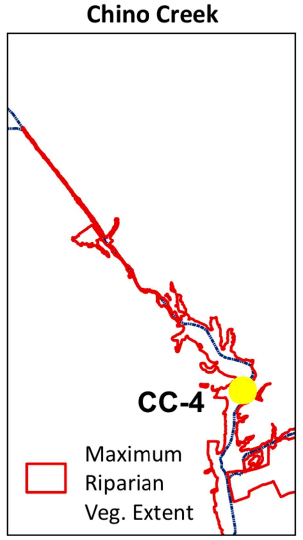
Meters
0 5 10

CC-4 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius



Location Along Chino Creek



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Time Series of NDVI and Air Photos
CC-4 Area for 1984 to 2024

Figure 3-8d

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

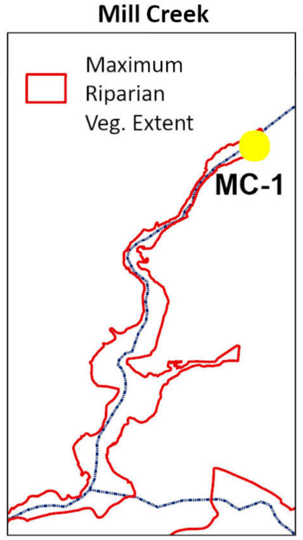
2024 Air Photo (July 1, 2024)

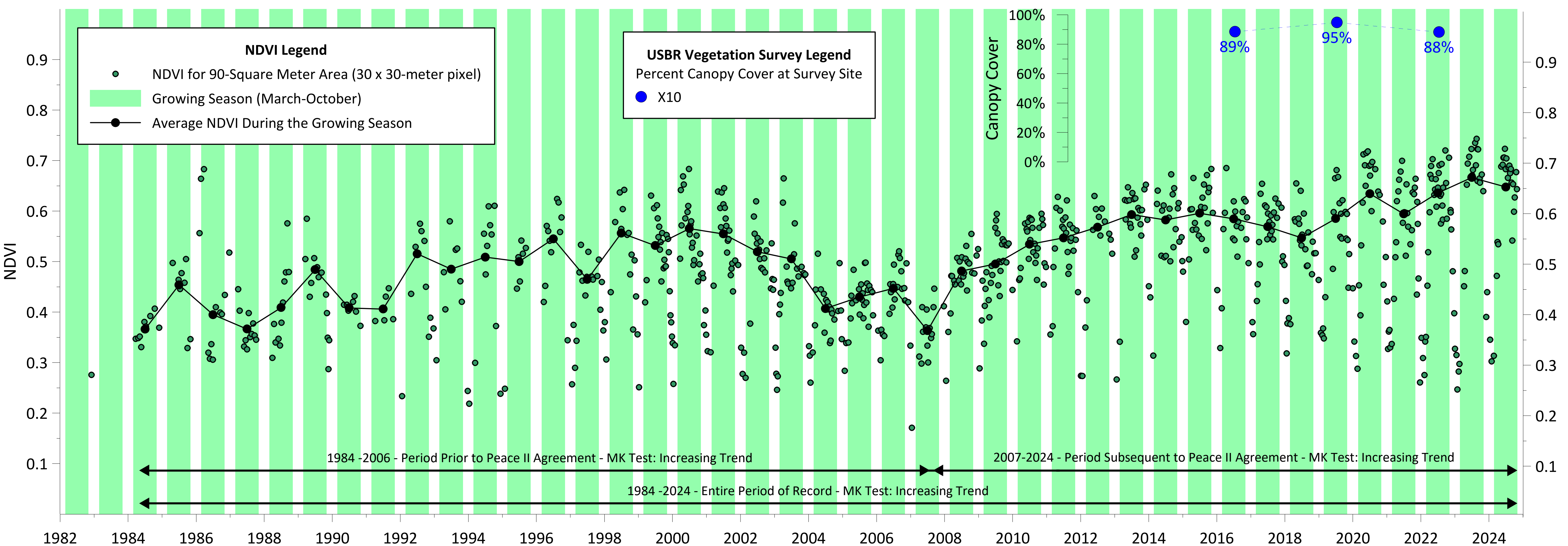
0 5 10 Meters

MC-1 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Mill Creek





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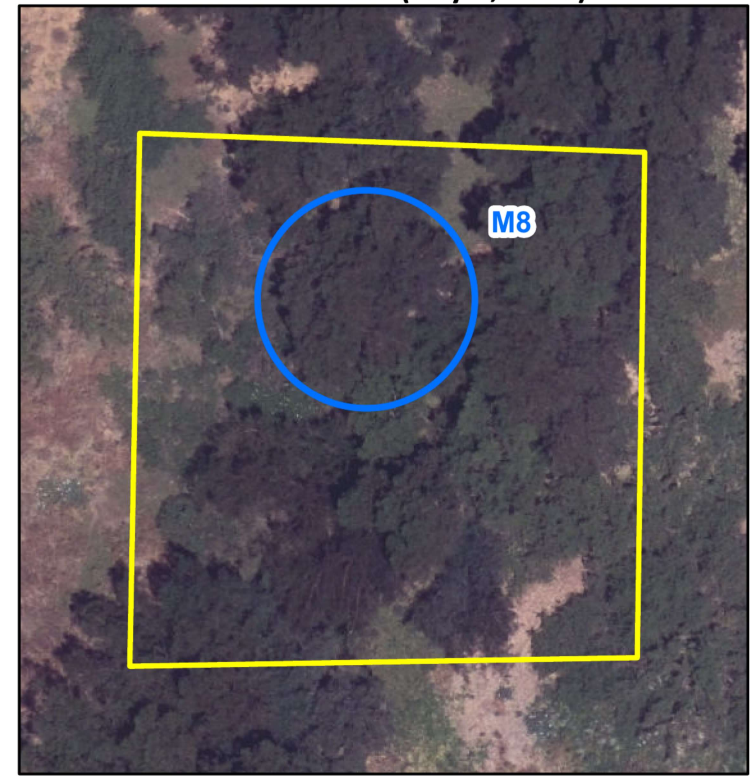
Time Series of NDVI and Air Photos
MC-1 Area for 1984 to 2024

Figure 3-8e

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)



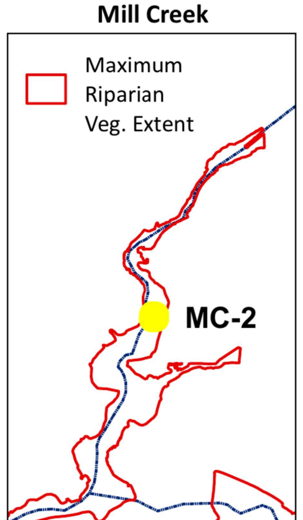
2024 Air Photo (July 1, 2024)

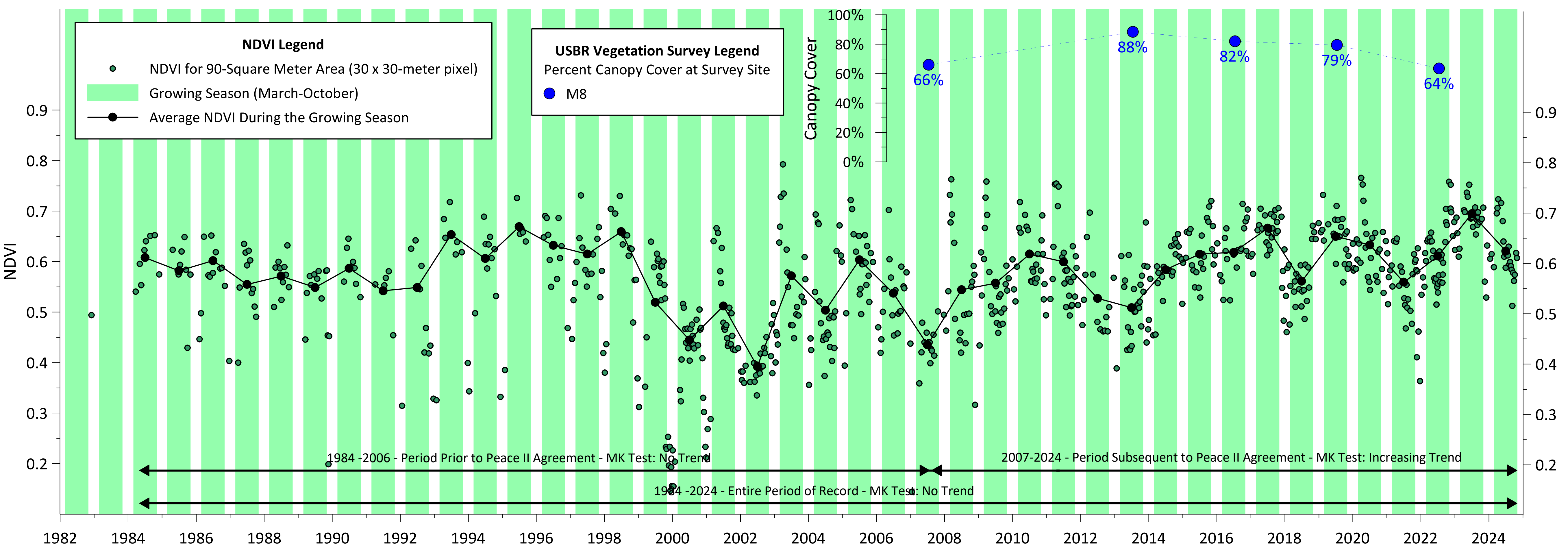
Meters
0 5 10

MC-2 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Mill Creek





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Time Series of NDVI and Air Photos
MC-2 Area for 1984 to 2024

Figure 3-8f

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

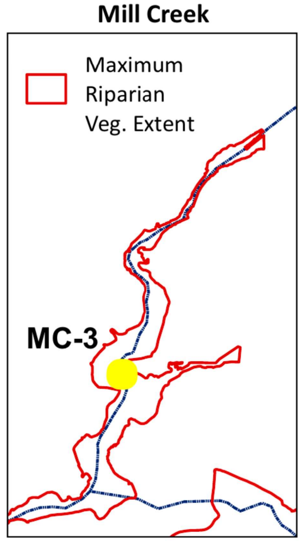
2024 Air Photo (July 1, 2024)

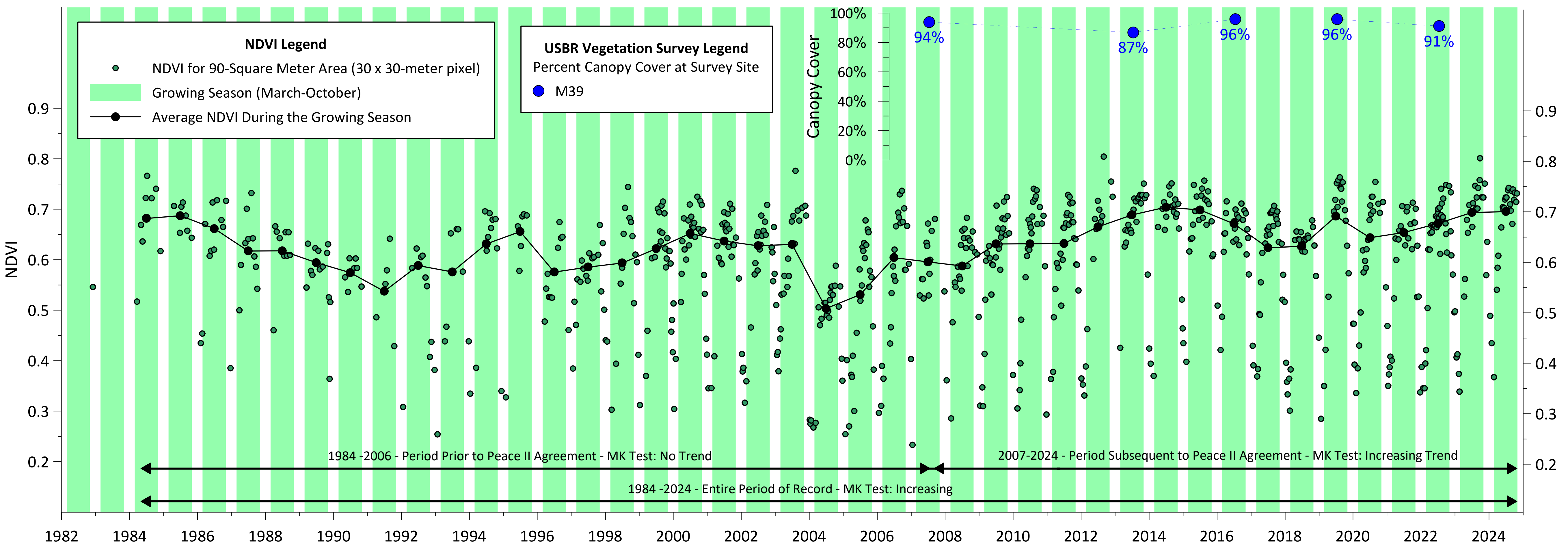
Meters
0 5 10

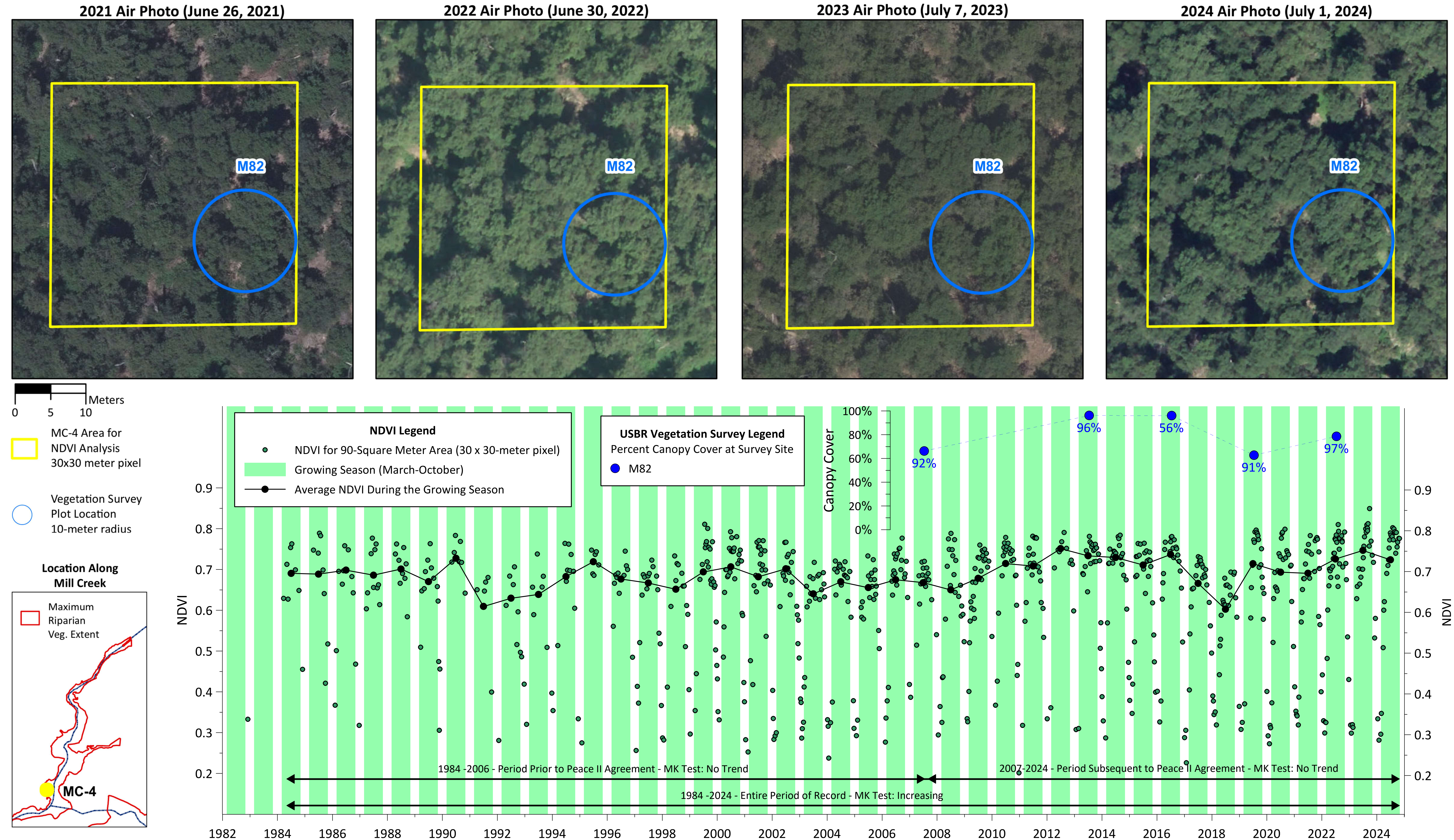
MC-3 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Mill Creek







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Time Series of NDVI and Air Photos

MC-4 Area for 1984 to 2024

Figure 3-8h

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

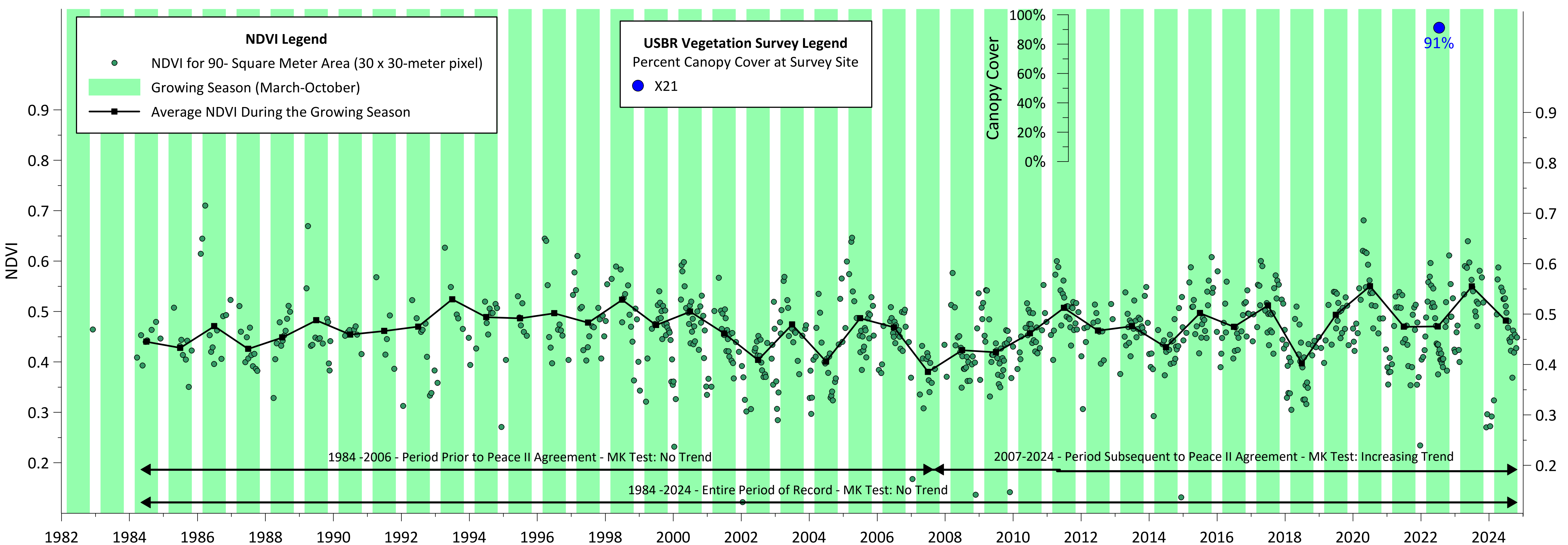
2023 Air Photo (July 7, 2023)

2024 Air Photo (July 1, 2024)

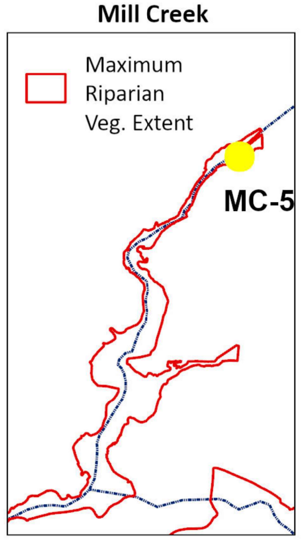
Meters
0 5 10

MC-5 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius



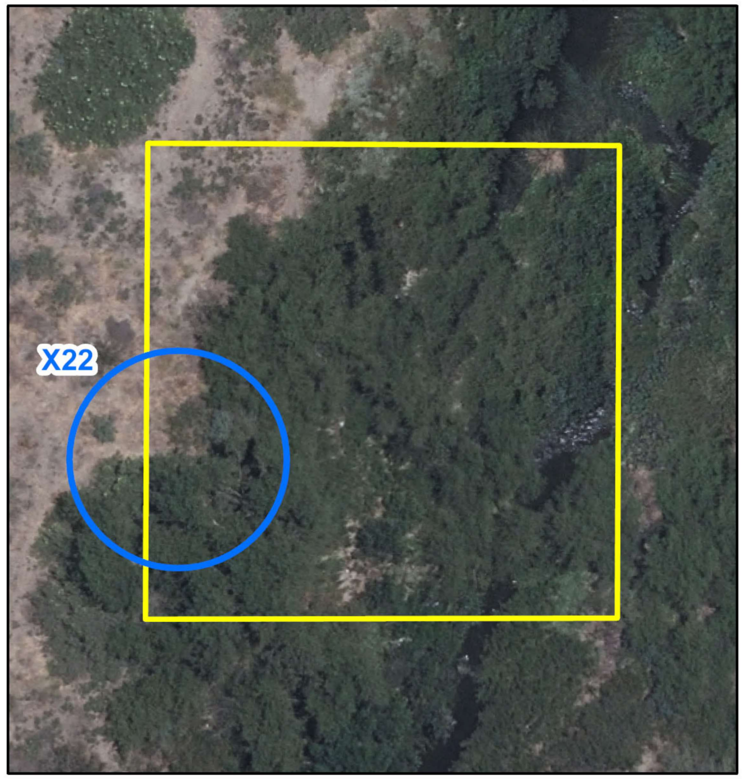
Location Along Mill Creek



Time Series of NDVI and Air Photos
MC-5 Area for 1984 to 2024

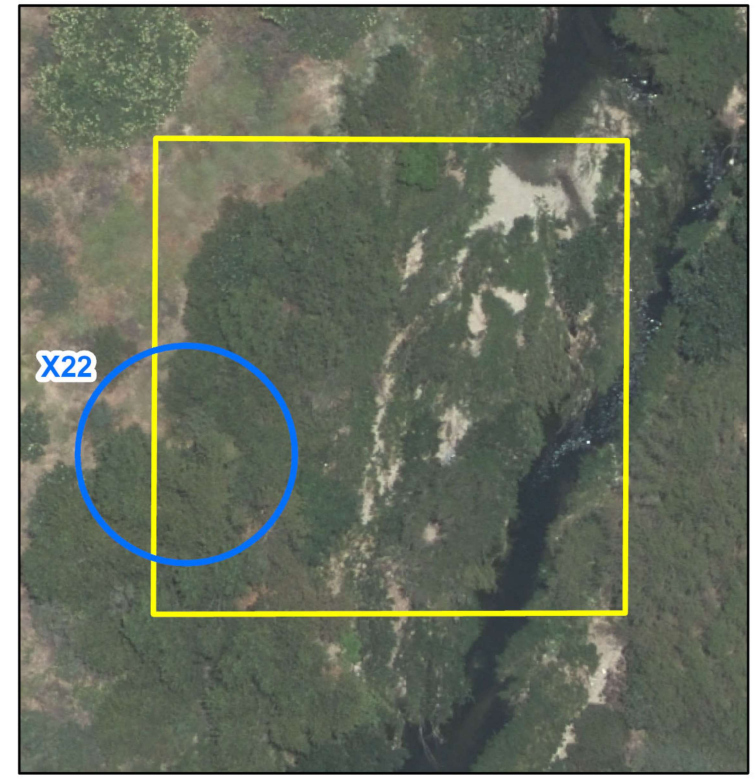
Figure 3-8i

2021 Air Photo (June 26, 2021)



2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)



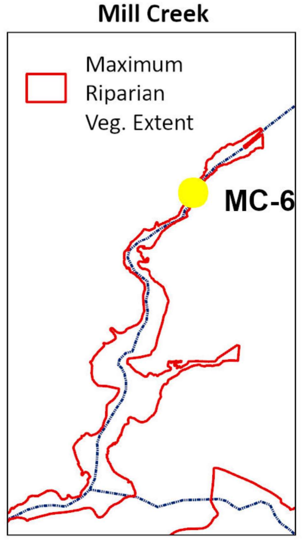
2024 Air Photo (July 1, 2024)

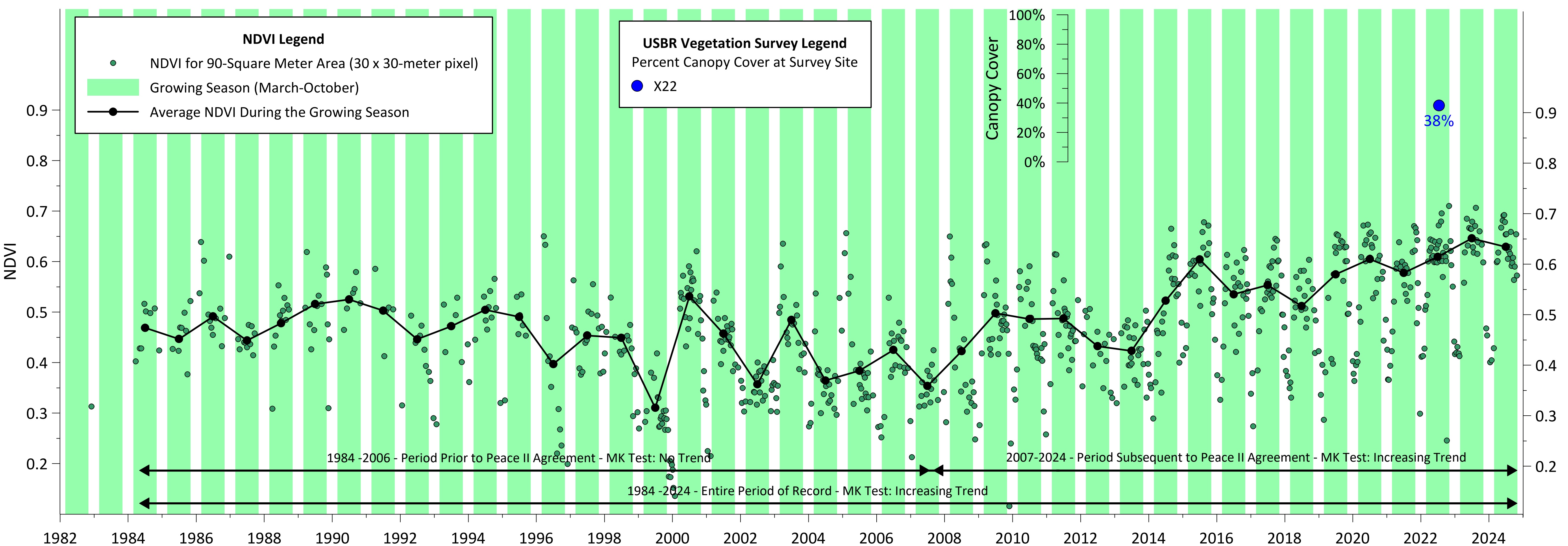
0 5 10 Meters

MC-6 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Mill Creek





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Time Series of NDVI and Air Photos
MC-6 Area for 1984 to 2024

Figure 3-8j

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

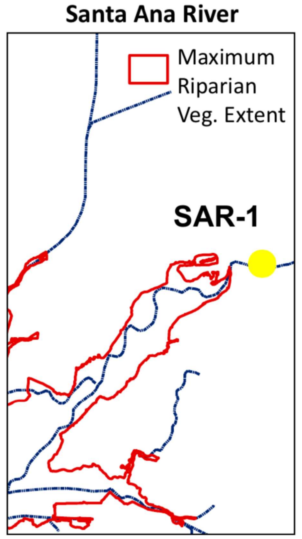
2024 Air Photo (July 1, 2024)

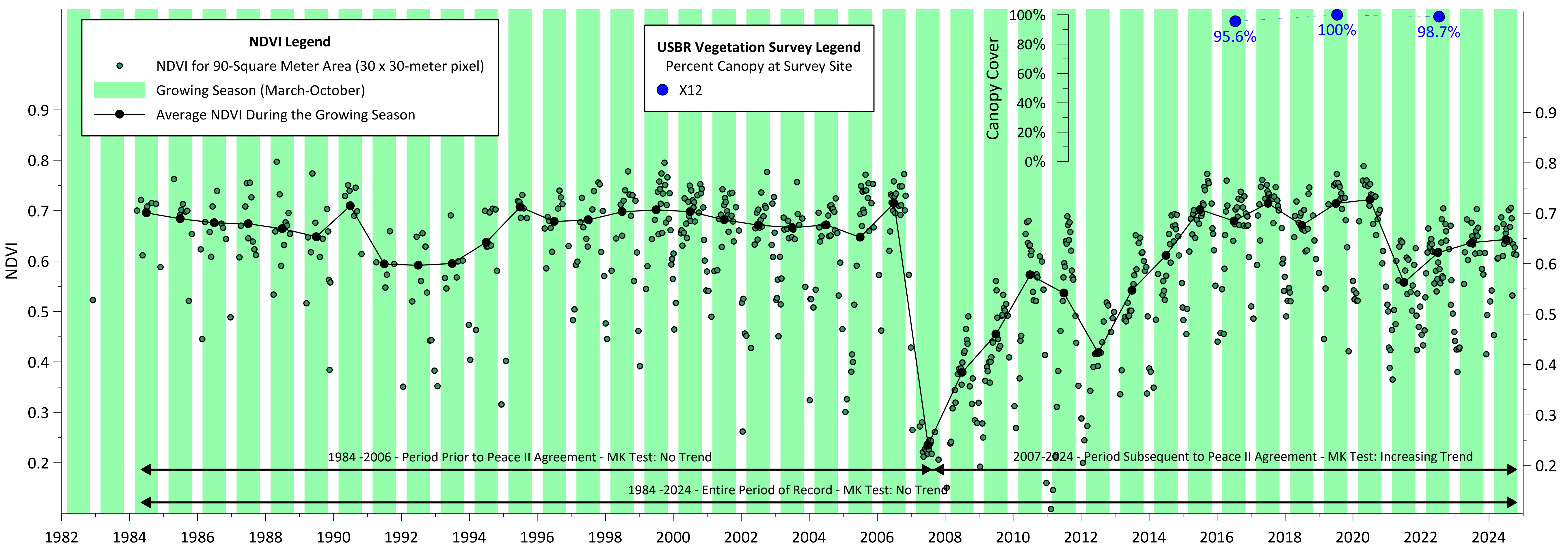
Meters
0 5 10

SAR-1 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Santa Ana River



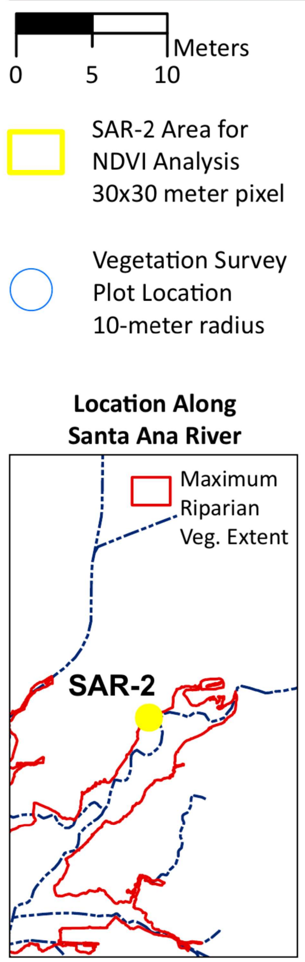


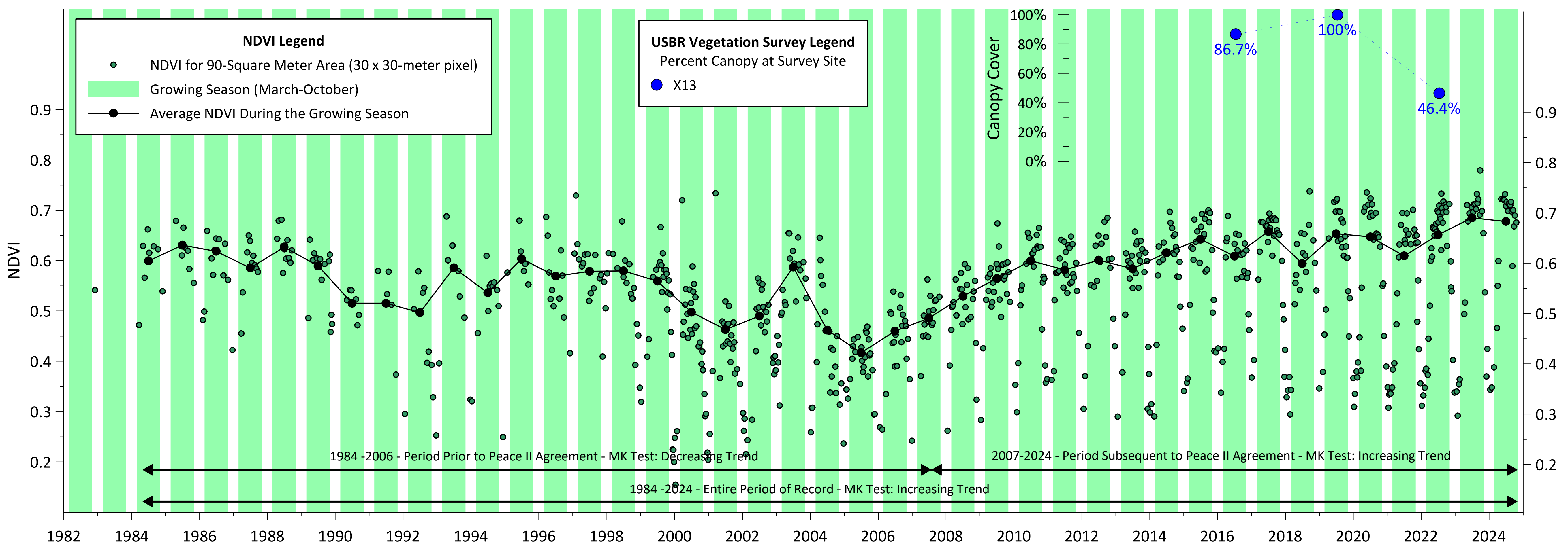
2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

2024 Air Photo (July 1, 2024)





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Time Series of NDVI and Air Photos
SAR-2 Area for 1984 to 2024

Figure 3-8l

2021 Air Photo (June 26, 2021)

2022 Air Photo (June 30, 2022)

2023 Air Photo (July 7, 2023)

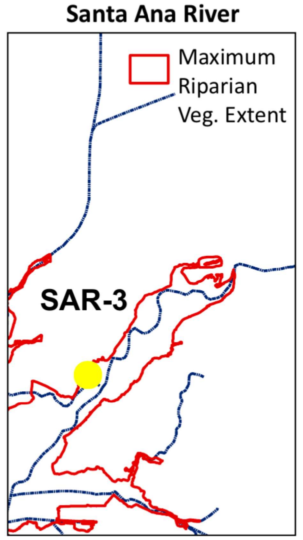
2024 Air Photo (July 1, 2024)

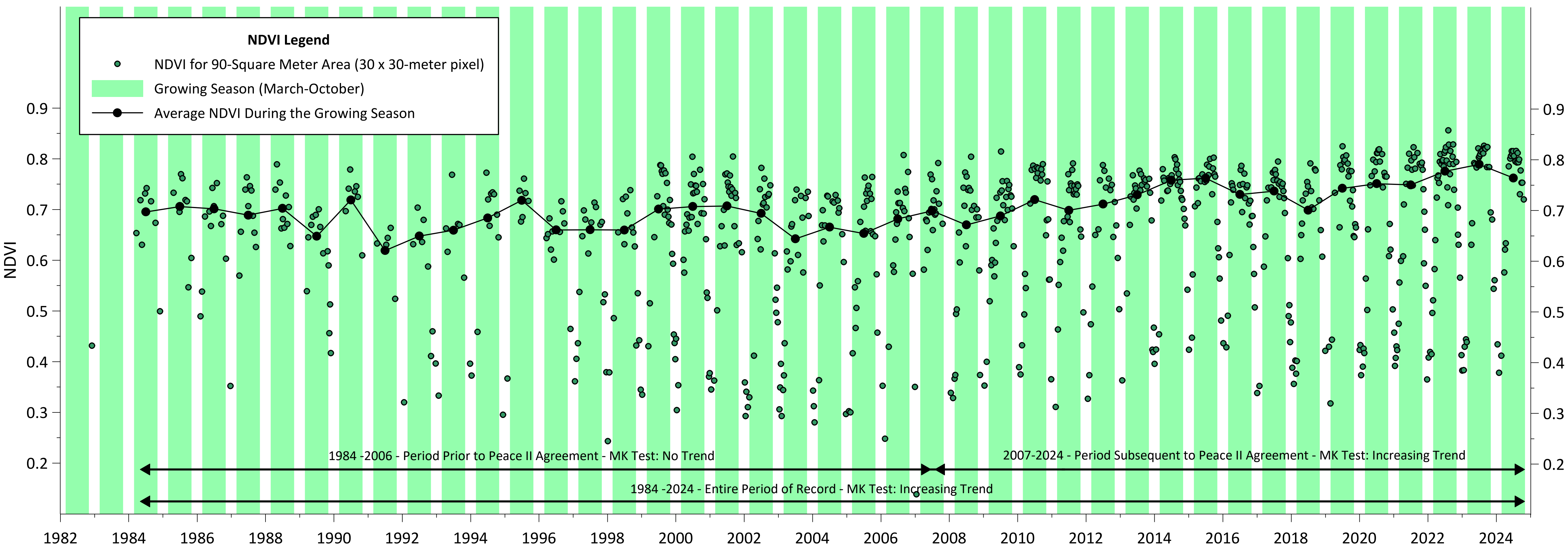
Meters
0 5 10

SAR-3 Area for NDVI Analysis 30x30 meter pixel

Vegetation Survey Plot Location 10-meter radius

Location Along Santa Ana River





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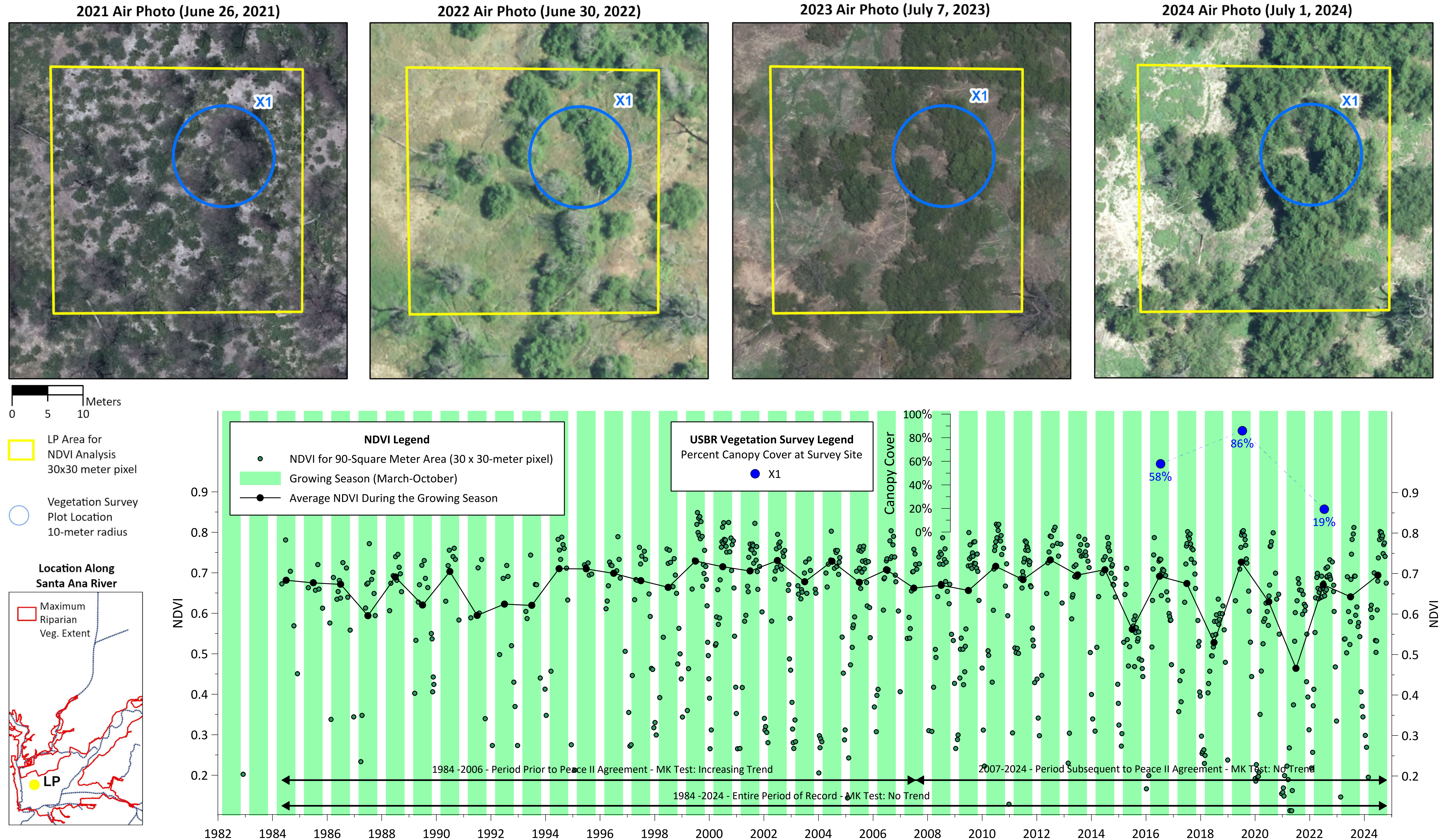
Time Series of NDVI and Air Photos
SAR-3 Area for 1984 to 2024

Figure 3-8m



2021 Air Photo (June 26, 2021)
2022 Air Photo (June 30, 2022)
2023 Air Photo (July 7, 2023)
2024 Air Photo (July 1, 2024)
X1
Meters
0 5 10
LP Area for NDVI Analysis 30x30 meter pixel
Vegetation Survey Plot Location 10-meter radius
Location Along Santa Ana River
Maximum Riparian Veg. Extent
LP
NDVI Legend
NDVI for 90-Square Meter Area (30 x 30-meter pixel)
Growing Season (March-October)
Average NDVI During the Growing Season
USBR Vegetation Survey Legend
Percent Canopy Cover at Survey Site
X1
Canopy Cover
100%
80%
60%
40%
20%
0%
58%
86%
19%
NDVI
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
1984 -2006 - Period Prior to Peace II Agreement - MK Test: Increasing Trend
2007-2024 - Period Subsequent to Peace II Agreement - MK Test: No Trend
1984 -2024 - Entire Period of Record - MK Test: No Trend
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

3.1.3 Analysis of Vegetation Surveys

Vegetation surveys are performed for the PBHSP once every three years. The most recent vegetation survey was performed in 2022 by the USBR and was a continuation of the surveys performed in 2007, 2013, 2016, and 2019. During the 2022 vegetation surveys 39 sites were monitored, including two new sites in the northern portion of Mill Creek. Preliminary findings and results from the 2022 vegetation surveys were published in a final report in June 2023, which is included as Appendix C to this Annual Report.

Table 3-3 summarizes the following for all sites surveyed in 2007, 2013, 2016, 2019, and 2022: the percent canopy cover; percent live, dead, and stressed trees; and percent trees with the presence of the invasive pest PSHB observed. The measurements of percent canopy cover from the USBR vegetation surveys are the most appropriate measured data for ground-truthing the NDVI. The USBR indicates that “the observed canopy cover can be compared to NDVI data for each plot to provide a measure of ground truthing” (USBR, 2023). Percent canopy cover is a measurement of the percentage of the ground surface area that is directly covered by the vertical projections of tree crowns (USDA, 1999). Although there is no direct quantitative relationship between percent canopy cover and NDVI, percent canopy cover is a metric of the areal density of the vegetation that is reflecting visible and near-infrared light and therefore can be used for comparison with the NDVI analysis. The percent canopy cover at the survey location (10-meter radius plot) within the small areas of NDVI analysis (30x30-meter pixel) in Figures 3-8a through 3-8n are charted with the NDVI time-series data. For the areas on Figures 3-8a through 3-8n, the percent canopy cover measurements show variability over the years and no clear increasing or decreasing trends. For most of the areas the trends in the NDVI time-series data align with the percent canopy cover measurements. There are a few notable exceptions for the areas along the SAR which are described in Section 3.1.2.1.4.

Table 3-3 shows that in 2022 the mean percent canopy cover was 81 percent along Chino Creek, 76 percent along Mill Creek, and 73 percent along the SAR; this was a slight increase along Mill Creek from 2019, and slight decrease along Chino Creek and the SAR from 2019.

As shown in Table 3-3, the USBR vegetation surveys in 2016, 2019, and 2022 included the documentation of the presence of the invasive pest—the PSHB. Overall, the number of sites with the presence of the PSHB noted in 2016 (30) decreased in 2019 (7) and 2022 (11). In 2022, the percentage of tress with the PSHB observed along each stream reach was 5 percent along Chino Creek sites, 11 percent along Mill Creek, and 2 percent along the SAR. The vegetation surveys provide a measurement of the change in riparian habitat health from 2016 to 2022 for those survey locations impacted by the PSHB. This is discussed in further detail in Section 3.6.2.

Table 3-3. Summary of USBR Vegetation Surveys in 2007, 2013, 2016, 2019, and 2022 in the Prado Basin - Canopy Cover, Tree Condition, and Occurrence of Polyphagous Shot-Hole Borer

	Canopy Cover (%) [1]						Tree Condition (% trees surveyed per plot) [2]																		Polyphagous Shot-Hole Borer [3]						
							Not Stressed (Live)						Stressed						Dead												
Site	2007	2013	2016	2019	2022	Change 2019- 2022	2007	2013	2016	2019	2022	Change 2019- 2022	2007	2013	2016	2019	2022	Change 2019- 2022	2007	2013	2016	2019	2022	Change 2019- 2022	Present in 2016	% of Trees in 2016	Present in 2019	% of Trees in 2019	Present in 2022	% of Trees in 2022	% Change from 2019 to 2022
Chino Creek Sites																															
Chino 3	59%	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Chino 3B	NM	97%	96%	96%	100%	4%	NM	100%	0%	33%	43%	10%	NM	0%	100%	44%	43%	-1%	NM	0%	0%	22%	14%	-8%	no	0%	no	0%	no	0%	0%
Chino 4	80%	94%	98%	84%	86%	2%	NM	100%	7%	55%	63%	8%	NM	0%	80%	40%	5%	-35%	NM	0%	13%	5%	32%	27%	no	0%	no	0%	no	0%	0%
Chino 9	92%	96%	95%	96%	99%	3%	NM	100%	0%	23%	50%	27%	NM	0%	100%	59%	33%	-26%	NM	0%	0%	18%	17%	-1%	no	0%	no	0%	no	0%	0%
Chino 11	94%	96%	96%	98%	94%	-4%	NM	100%	50%	69%	73%	4%	NM	0%	42%	0%	9%	9%	NM	0%	8%	31%	18%	-13%	no	0%	no	0%	no	0%	0%
Chino 16	46%	61%	81%	52%	27%	-25%	NM	NM	27%	50%	50%	0%	NM	NM	64%	50%	29%	-21%	NM	NM	9%	0%	21%	21%	no	0%	no	0%	no	0%	0%
Chino 18	38%	87%	90%	77%	81%	4%	NM	100%	7%	15%	100%	85%	NM	0%	67%	69%	0%	-69%	NM	0%	27%	15%	0%	-15%	yes	40%	no	0%	no	0%	0%
Chino 21	98%	94%	88%	17%	4%	-13%	NM	100%	0%	73%	75%	2%	NM	0%	100%	0%	0%	0%	NM	0%	0%	27%	25%	-2%	yes	17%	no	0%	no	0%	0%
Chino 24	93%	93%	98%	94%	99%	5%	NM	100%	6%	32%	64%	32%	NM	0%	94%	56%	27%	-29%	NM	0%	0%	12%	9%	-3%	yes	6%	no	0%	no	0%	0%
Chino 30	79%	88%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Chino 30B	NM	NM	89%	74%	98%	24%	NM		0%	20%	50%	30%	NM	NM	89%	50%	25%	-25%	NM	NM	11%	30%	25%	-5%	yes	100%	no	0%	no	0%	0%
Chino 31	82%	93%	97%	91%	98%	7%	NM	100%	7%	4%	68%	64%	NM	0%	93%	72%	16%	-56%	NM	0%	0%	24%	16%	-8%	yes	7%	no	0%	yes	11%	11%
Chino 34	96%	97%	89%	75%	91%	16%	NM	100%	0%	33%	0%	-33%	NM	0%	67%	33%	100%	67%	NM	0%	33%	33%	0%	-33%	no	0%	no	0%	no	0%	0%
Chino 78	95%	98%	87%	98%	95%	-3%	NM	100%	0%	45%	33%	-12%	NM	0%	80%	55%	42%	-13%	NM	0%	20%	0%	25%	25%	yes	80%	no	0%	no	0%	0%
Chino 81	92%	0%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Chino 85	89%	0%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Chino X3	NM	NM	93%	94%	69%	-25%	NM	NM	25%	83%	100%	17%	NM	NM	75%	17%	0%	-17%	NM	NM	0%	0%	0%	0%	no	0%	no	0%	no	0%	0%
Chino X4	NM	NM	92%	94%	45%	-49%	NM	NM	0%	43%	40%	-3%	NM	NM	100%	14%	60%	46%	NM	NM	0%	43%	0%	-43%	yes	100%	yes	71%	yes	40%	-31%
Chino X5	NM	NM	96%	95%	96%	1%	NM	NM	75%	89%	78%	-11%	NM	NM	25%	11%	22%	11%	NM	NM	0%	0%	0%	0%	yes	25%	no	0%	no	0%	0%
Chino X6	NM	NM	98%	99%	100%	1%	NM	NM	87%	47%	50%	3%	NM	NM	13%	47%	29%	-18%	NM	NM	0%	7%	21%	14%	yes	13%	no	0%	no	0%	0%
Chino X7	NM	NM	88%	66%	84%	18%	NM	NM	0%	43%	33%	-10%	NM	NM	70%	43%	67%	24%	NM	NM	30%	14%	0%	-14%	yes	70%	no	0%	yes	33%	33%
Chino X8	NM	NM	85%	99%	100%	1%	NM	NM	0%	71%	39%	-32%	NM	NM	62%	24%	33%	9%	NM	NM	38%	6%	28%	22%	yes	46%	yes	6%	yes	6%	0%
Average	**81%**	**78%**	**92%**	**83%**	**81%**	**-2%**	**--**	**100%**	**16%**	**46%**	**56%**	**10%**	**--**	**0%**	**73%**	**38%**	**30%**	**-8%**	**--**	**0%**	**11%**	**16%**	**14%**	**-2%**	**--**	**28%**	**--**	**4%**	**--**	**5%**	**1%**
Mill Creek Sites																															
Mill 1	40%	0%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 3	8%	13%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 4	38%	6%	0%	0%	0%	0%	NM	0%	0%	100%	0%	-100%	NM	63%	50%	0%	50%	50%	NM	37%	50%	0%	50%	50%	yes	50%	no	0%	YES	50%	50%
Mill 8	66%	88%	82%	79%	64%	-15%	NM	33%	33%	0%	0%	0%	NM	67%	0%	50%	100%	50%	NM	0%	67%	50%	0%	-50%	yes	33%	no	0%	NO	0%	0%
Mill 11	75%	80%	NM	NM	NM	--	NM	90%	NM	NM	NM	--	NM	0%	NM	NM	NM	--	NM	10%	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 18	62%	68%	78%	90%	98%	8%	NM	100%	38%	10%	40%	30%	NM	0%	38%	80%	30%	-50%	NM	0%	25%	10%	30%	20%	yes	38%	no	0%	YES	10%	10%
Mill 22	89%	93%	96%	93%	94%	1%	NM	86%	0%	43%	0%	-43%	NM	0%	79%	43%	67%	24%	NM	14%	21%	14%	33%	19%	yes	64%	no	0%	YES	50%	50%
Mill 30	63%	63%	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 35	81%	95%	NM	NM	NM	--	NM	100%	NM	NM	NM	--	NM	0%	NM	NM	NM	--	NM	0%	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 39	94%	87%	96%	96%	91%	-5%	NM	92%	0%	13%	33%	20%	NM	0%	67%	63%	33%	-30%	NM	8%	33%	25%	33%	8%	yes	44%	yes	38%	NO	0%	-38%
Mill 60	76%	90%	83%	51%	45%	-6%	NM	86%	0%	0%	11%	11%	NM	0%	93%	69%	67%	-2%	NM	14%	7%	31%	22%	-9%	yes	29%	no	0%	NO	0%	0%
Mill 62	66%	96%	96%	63%	79%	16%	NM	100%	0%	6%	40%	34%	NM	0%	94%	25%	20%	-5%	NM	0%	6%	69%	40%	-29%	yes	94%	yes	25%	YES	20%	-5%
Mill 63	70%	97%	78%	43%	100%	57%	NM	100%	0%	15%	0%	-15%	NM	0%	68%	23%	0%	-23%	NM	0%	32%	62%	100%	38%	yes	41%	yes	23%	NO	0%	-23%
Mill 67	75%	95%	NM	NM	NM	--	NM	100%	NM	NM	NM	--	NM	0%	NM	NM	NM	--	NM	0%	NM	NM	NM	--	NM	NM	NM	NM	NM	NM	--
Mill 69	92%	84%	75%	98%	70%	-28%	NM	90%	0%	67%	83%	16%	NM	0%	64%	0%	17%	17%	NM	10%	36%	33%	0%	-33%	yes	64%	yes	22%	NO	0%	-22%
Mill 82	92%	96%	56%	91%	97%	6%	NM	100%	0%	69%	55%	-14%	NM	0%	75%	15%	27%	12%	NM	0%	25%	15%	18%	3%	yes	25%	yes	8%	NO	0%	-8%
Mill 101	90%	94%	83%	88%	94%	6%	NM	96%	0%	26%	57%	31%	NM	0%	87%	48%	30%	-18%	NM	4%	13%	26%	13%	-13%	yes	83%	no	0%	YES	4%	4%
Mill X9	NM	NM	94%	94%	94%	0%	NM	NM	70%	42%	50%	8%	NM	NM	30%	58%	50%	-8%	NM	NM	0%	0%	0%	0%	yes	10%	no	0%	YES	8%	8%
Mill X10	NM	NM	89%	95%	88%	-7%	NM	NM	0%	70%	73%	3%	NM	NM	50%	30%	18%	-12%	NM	NM	50%	0%	9%	9%	yes	50%	no	0%	YES	18%	18%
Mill X21	NM	NM	NM	NM	91%	--	NM	NM	NM	NM	80%	--	NM	NM	NM	NM	20%	--	NM	NM	NM	NM	0%	--	NM	NM	NM	NM	NO	0%	--
Mill X22	NM	NM	NM	NM	38%	--	NM	NM	NM	NM	78%	--	NM	NM	NM	NM	22%	--	NM	NM	NM	NM	0%	--	NM	NM	NM	NM	NO	0%	--
Average	**69%**	**73%**	**77%**	**75%**	**76%**	**1%**	**--**	**84%**	**11%**	**35%**	**40%**	**4%**	**--**	**9%**	**61%**	**39%**	**37%**	**-2%**	**--**	**7%**	**28%**	**26%**	**23%**	**-2%**	**--**	**48%**	**--**	**9%**	**--**	**11%**	**2%**
Santa Ana River Sites																															
SAR X1	NM	NM	58%	86%	19%	-67%	NM	NM	76%	75%	44%	-31%	NM	NM	5%	13%	0%	-13%	NM	NM	19%	13%	56%	43%	yes	3%	no	0%	NO	0%	0%
SAR X2	NM	NM	93%	79%	79%	0%	NM	NM	11%	60%	33%	-27%	NM	NM	89%	30%	61%	31%	NM	NM	0%	10%	6%	-4%	yes	17%	no	0%	YES	11%	11%
SAR X11	NM	NM	88%	94%	95%	1%	NM	NM	27%	44%	67%	23%	NM	NM	64%	11%	17%	6%	NM	NM	9%	44%	17%	-27%	yes	82%	no	0%	NO	0%	0%
SAR X12	NM	NM	96%	100%	99%	-1%	NM	NM	9%	44%	53%	9%	NM	NM	91%	44%	0%	-44%	NM	NM	0%	13%	47%	34%	yes	91%	no	0%	NO	0%	0%
SAR X13	NM	NM	87%	100%	46%	-54%	NM	NM	0%	17%	20%	3%	NM	NM	67%	67%	0%	-67%	NM	NM	33%	17%	80%	63%	yes	67%	no	0%	NO	0%	0%
SAR X14	NM	NM	88%	97%	97%	0%	NM	NM	0%	75%	50%	-25%	NM	NM	100%	25%	0%	-25%	NM	NM	0%	0%	50%	50%	yes	100%	no	0%	NO	0%	0%
Average	**-**	**-**	**85%**	**93%**	**73%**	**-20%**	**-**	**-**	**21%**	**53%**	**45%**	**-8%**	**-**	**-**	**69%**	**32%**	**13%**	**-19%**	**-**	**-**	**10%**	**16%**	**42%**	**26%**	**-**	**60%**	**-**	**0%**	**-**	**2%**	2%
Average all Sites	**75%**	**76%**	**86%**	**82%**	**78%**	**-4%**	**-**	**91%**	**15%**	**43%**	**48%**	**5%**	**-**	**5%**	**68%**	**37%**	**30%**	**-7%**	**-**	**4%**	**17%**	**19%**	**22%**	**4%**	**-**	**40%**	**-**	**5%**	**-**	**7%**	**1%**

Notes:

NM - Not Measured

1- Canopy cover is a measurement of the percentage of a ground area directly covered by vertical projections of tree crowns. In the field, canopy cover is measured using a spherical densiometer standing five meters from the center of the plot in the four cardinal directions (north, south, east, west). Canopy Cover percent herein is the average of the four measurements.

2- Tree condition is a qualitative measurement of the health of the tree. Trees were assessed and classified as "live," "stressed," or "dead". The percentage of each classification per plot is shown here.

3- In 2016 and 2019 trees were assessed for the presence of polyphagous shot-hole borers (PSHB). If a tree showed signs of the beetle it was noted. The percent of trees in each plot that showed signs of beetle infestation was then calculated.

3.1.4 Summary

The extent of the riparian habitat in the Prado Basin has been delineated from air photos and maps of NDVI. The extent increased from about 1.85 mi^2 in 1960 to about 6.7 mi^2 by 1999 and has remained relatively constant through 2024 along the Chino Creek, Mill Creek, and SAR reaches.

The quality of riparian habitat has been characterized through the analysis of air photos, maps of NDVI, and time-series charts of NDVI for large and small areas located throughout the Prado Basin:

- The NDVI change map shows mostly no change with some patches of NDVI increases and decreases throughout the riparian vegetation in the Prado Basin. Notable increases in the NDVI spatially are observed along the middle portion of Chino Creek northwest of the OCWD wetlands and just above Prado Dam. Notable decreases in the NDVI spatially are observed along the SAR and below the OCWD wetlands in lower Prado Basin, and the lower portion of Chino Creek behind Prado Dam.
- The analysis of NDVI time series indicate that over the last year from 2023 to 2024, there was no change in the greenness of the riparian vegetation across the Prado Basin when analyzed as a whole. However, there were decreases in the greenness along the Chino Creek, Mill Creek and Upper Mill Creek reaches when analyzed as a whole. These decreases fall within the historical ranges of one-year NDVI variability for these areas, except for the Upper Mill Creek area where the decrease is notable because it is slightly more than the average one-year change over the historical period.

  The NDVI time series at the 14 small defined areas indicate that over the last year from 2023 to 2024, most areas experienced a decrease in greenness, while four areas showed a slight increase or stable trend. At all areas, these one-year changes in the Average Growing-Season NDVI are within the historical ranges of one-year NDVI variability presented in Table 3-2. However, at the MC-2, MC-5, and SAR-3 areas, where NDVI decreased the most from 2023 to 2024, the decreases are greater than the average one-year change in NDVI observed over the historical period.
- The visual inspection of the 2023 and 2024 air photos reveals no significant changes in the riparian vegetation along Chino Creek and the SAR reaches. However, the air photos indicate a decrease in green vegetation along Mill Creek from 2023 to 2024. In some of these areas along Mill Creek (MC-2, MC-5, and Upper Mill Creek) the air photos show notable changes in the vegetation, including reductions in coverage and browning.
- The Mann-Kendall test result on the Average Growing-Season NDVI for the post Peace II Agreement period from 2007 to 2024 indicates an “increasing trend” or “no trend” for the Prado Basin riparian vegetation as a whole and all the other areas analyzed through the Prado Basin.

The remainder of Section 3.0 describes the factors that can affect the riparian habitat, how these factors have changed over time, and how the changes in these factors may explain the changes that are being observed in the riparian habitat described above.

3.2 Groundwater and Its Relationship to Riparian Habitat

Peace II Agreement implementation was projected to change groundwater pumping patterns and reduce groundwater replenishment through 2030, both of which would change groundwater levels in the Chino Basin. These groundwater level changes caused by Peace II Agreement implementation and other unrelated water management activities[17] have the potential to impact the extent and quality of Prado Basin riparian habitat.

This section characterizes the history of groundwater pumping and changes in groundwater levels in the GMP study area and compares this history to the trends in the extent and quality of the riparian habitat described in Section 3.1.

3.2.1 Groundwater Pumping

Table 3-4 lists the groundwater pumping estimates for the GMP study area for WY 1961 to 2024.[18] Figure 3-9 is a map that illustrates the spatial distribution of groundwater pumping from wells within the GMP study area for WY 2024. This figure includes a bar chart of the annual groundwater pumping in the GMP study area (from Table 3-4 below). Figure 3-9 illustrates the following history of groundwater pumping within the GMP study area:

- From 1961 to 1990, groundwater pumping averaged about 45,900 afy. Pumping mainly occurred at private domestic and agricultural wells distributed throughout the area.
- From 1991 to 1999, groundwater pumping steadily declined, primarily due to conversions of agricultural land uses to urban. By WY 1999, groundwater pumping was estimated to be about 23,600 afy, about 49 percent less than average annual pumping from 1961 to 1990.
- From 2000 to 2024, CDA pumping commenced and increased to replace the declining agricultural groundwater pumping, as envisioned in the OBMP/Peace Agreement and Peace II Agreement. In WY 2024, total groundwater pumping in the GMP study area was about 40,600 afy—an increase of about 72 percent from 1999.
- From WY 2016 to WY 2020, the annual CDA pumping increased by about 12,000 afy and in mid-2020 the CDA pumping reached its intended pumping rate of 40,000 afy to maintain hydraulic control of the Chino Basin.
- In WY 2024, the CDA pumping maintained its intended pumping rate of 40,000 afy. The total CDA pumping in the GMP study area was 37,002 af because the CDA well II-12 that came online in August 2021 is outside of the GMP study area. Total CDA pumping in WY 2024 was 40,396 af.

[17] Other water management activities unrelated to Peace II Agreement implementation include changes in wastewater discharge to the SAR due to conservation, recycling, and drought response; increases in storm water diverted and recharged; increases in recycled water recharge; management of groundwater in storage; and the implementation of the Dry-Year Yield Program with MWD.

[18] Production for years prior to WY 2001 were estimated in the calibration of the 2013 Chino Basin groundwater model (WEI, 2015). Production estimates for WY 2001 and thereafter are based on metered production data and water-duty estimates compiled by Watermaster.

Table 3-4. Annual Groundwater Pumping in the Groundwater Monitoring Program Study Area			
Water Year	Non-CDA Pumping, afy[(a)]	CDA Pumping, afy	Total Pumping, afy[(a)]
1961	48,577	0	48,577
1962	43,811	0	43,811
1963	43,293	0	43,293
1964	45,170	0	45,170
1965	43,294	0	43,294
1966	46,891	0	46,891
1967	42,709	0	42,709
1968	47,180	0	47,180
1969	37,754	0	37,754
1970	45,849	0	45,849
1971	45,492	0	45,492
1972	47,541	0	47,541
1973	38,427	0	38,427
1974	47,014	0	47,014
1975	44,606	0	44,606
1976	44,847	0	44,847
1977	45,710	0	45,710
1978	46,881	0	46,881
1979	48,829	0	48,829
1980	46,402	0	46,402
1981	53,326	0	53,326
1982	41,719	0	41,719
1983	42,200	0	42,200
1984	52,877	0	52,877
1985	46,876	0	46,876
1986	54,501	0	54,501
1987	46,875	0	46,875
1988	46,277	0	46,277
1989	46,835	0	46,835
1990	45,732	0	45,732
1991	42,266	0	42,266
1992	44,617	0	44,617
1993	43,186	0	43,186
1994	37,390	0	37,390
1995	32,604	0	32,604
1996	35,200	0	35,200

Water Year	Non-CDA Pumping, afy[a]	CDA Pumping, afy	Total Pumping, afy[a]
1997	33,340	0	33,340
1998	22,366	0	22,366
1999	23,632	0	23,632
2000	24,299	523	24,822
2001	21,249	9,470	30,719
2002	20,271	10,173	30,445
2003	18,600	10,322	28,922
2004	18,606	10,480	29,086
2005	13,695	10,595	24,290
2006	14,261	19,819	34,079
2007	12,988	28,529	41,517
2008	12,293	30,116	42,409
2009	11,694	28,456	40,150
2010	10,452	28,964	39,416
2011	10,460	28,941	39,401
2012	11,193	28,230	39,423
2013	11,433	27,380	38,813
2014	9,059	29,626	38,685
2015	6,985	29,877	36,862
2016	5,900	28,249	34,148
2017	5,899	28,351	34,250
2018	7,504	29,191	36,695
2019	5,348	32,004	37,352
2020	5,875	37,973	43,848
2021	6,155	40,501[b]	46,656
2022	6,066	38,277[c]	44,342
2023	4,462	36,687[d]	41,149
2024	3,597	37,002[e]	40,598
Average: 1961-1990	45,917	0	45,917
Average: 1991-1999	34,956	0	34,956
Average: 2000-2024	11,134	25,589	36,723

Table 3-4. Annual Groundwater Pumping in the Groundwater Monitoring Program Study Area

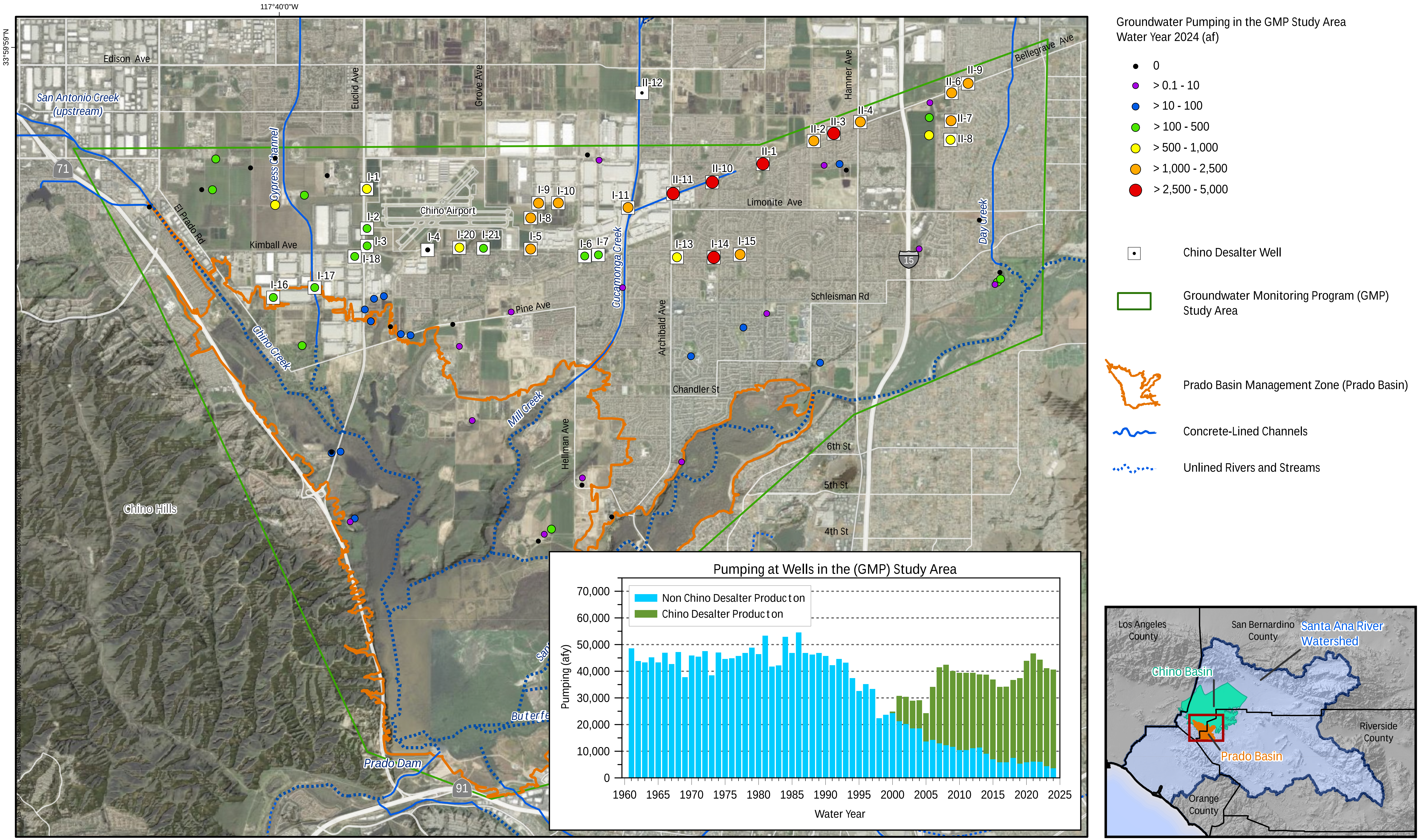
(a) Prior to WY 2001 production is estimated with the calibrated 2013 Chino Basin groundwater model (WEI, 2015).

(b) Total CDA production in WY 2021 was 40,649 af; active CDA well II-12 is outside of the GMP study area and not included in the total annual pumping for the GMP study area.

(c) Total CDA production in WY 2022 was 40,684 af; active CDA well II-12 is outside of the GMP study area and not included in the total annual pumping for the GMP study area.

(d) Total CDA production in WY 2023 was 39,814 af; active CDA well II-12 is outside of the GMP study area and not included in the total annual pumping for the GMP study area.

(e) Total CDA production in WY 2024 was 40,396 af; active CDA well II-12 is outside of the GMP study area and not included in the total annual pumping for the GMP study area.



Prepared by:

WEST YOST

Prepared for:

Prado Basin Sustainability Committee
2024 Annual Report

Groundwater Pumping
Water Year 2024
Figure 3-9

3.2.2 Groundwater Levels

Figures 3-10a and 3-10b are groundwater-elevation contour maps of the GMP study area for the shallow aquifer system in September 2016 (first Annual Report condition) and September 2024 (current condition).[19] The contours were created from rasterized surfaces of groundwater elevations that were created from measured groundwater elevations at wells. The raster of groundwater elevation for September 2016 was subtracted from the raster of groundwater elevation for September 2024 to create a raster of change in groundwater elevation from 2016 to 2024 (Figure 3-11).

Figure 3-11 shows that with a few exceptions, groundwater levels changed by about +/- 5 feet across most of the GMP study area from 2016 to 2024. The greatest areas of change occurred in the northern portion of the GMP study area near the Chino Desalter well field. Groundwater levels declined by about 10 feet around the upper central portion of the Chino Desalter well field north of Mill Creek (Wells I-8, I-9, and I-10) and increased by about 20 feet near the northern reach of Chino Creek at the Chino Desalter well field (Wells I-16 and I-17).

Since the PBHSP began in 2016, the largest groundwater levels declines observed have occurred in the riparian vegetation areas in the northern reach of Mill Creek (just south of PB-2). From 2016 to 2024 groundwater levels declined about 2.5 feet in this area. At well PB-2 just to the north of Mill Creek, groundwater levels declined by about four feet since 2016. This north portion of Mill Creek is where previous Annual Reports have observed the most declines in groundwater levels in the riparian vegetation area (West Yost 2022; 2023; 2024) and is part of the regional pumping depression expanding around the Chino Desalter well field to the north. Over this last year, groundwater levels increased about one foot in this area, continuing to increase from the historical low levels in the 2022 (West Yost 2023; 2024). Additionally, there is a small area in the southern portion of Prado Basin in the OCWD wetlands where groundwater levels have declined 5 feet from 2016 to 2024. Groundwater level changes in this area are unlikely to be influenced by the implementation of the Peace II Agreement.

Since 2016, groundwater levels have increased the most within the extent of the riparian vegetation area along northern Chino Creek. From 2016 to 2024, groundwater levels increased by about 10 feet in this area. Section 3.2.3 describes a decrease in pumping in the area near Chino Creek.

Figure 3-12 is a map of depth-to-groundwater in September 2024. It was created by subtracting a one-meter horizontal resolution 2020 digital-elevation model (DEM)[20] of the ground surface from the raster of groundwater elevation for September 2024. An outline of the Prado Basin riparian habitat extent is superimposed on the depth-to-groundwater raster. With few exceptions, the riparian habitat generally overlies areas where the depth-to-groundwater is less than 15 feet below the ground surface (ft-bgs). The shallow groundwater could exit the Prado Basin via rising groundwater discharge to the SAR and its tributaries and/or evapotranspiration by the riparian vegetation.

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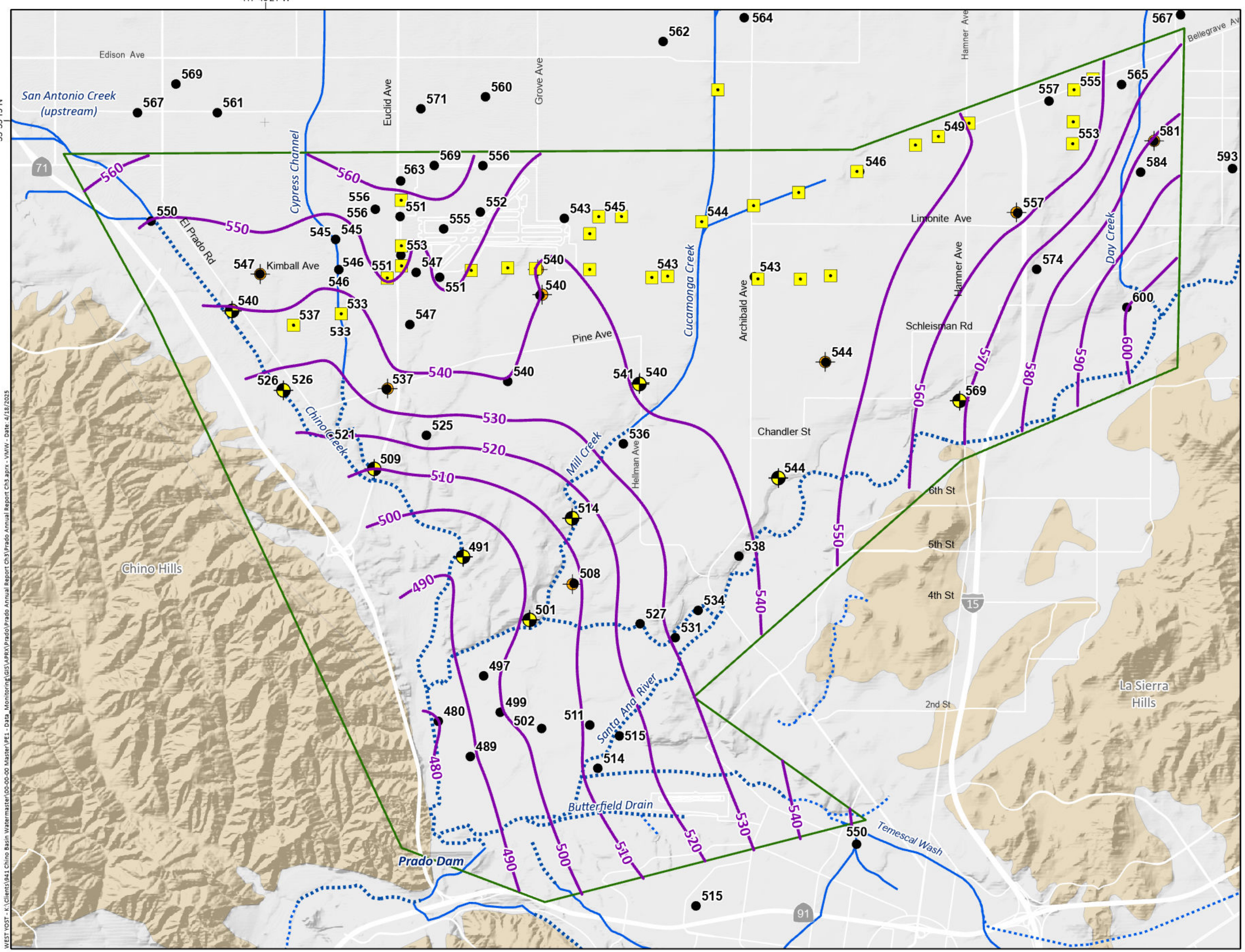
[19] Historical groundwater elevation data for the Prado Basin are scarce due to a lack of wells and/or monitoring. As such, the discussion and interpretation of measured groundwater elevations focuses on the GMP's period of record.

[20] The 2020 DEM is from LiDAR data collected of the Prado Basin and along the SAR during July 2020 when Watermaster, IEUA, OCWD, and San Bernadino Valley Water District collaborated and cost-shared the collection of the 2022 air photo of the Prado Basin.



500	Equal Elevation Contour of Groundwater Elevation (feet above mean sea level)
505	Measured Groundwater Elevation in September 2016 used to draw contours (feet above mean sea level)
	PBHSP Monitoring Well
	HCMP Monitoring Well
	Other Well
	Chino Desalter Well
	Groundwater Monitoring Program (GMP) Study Area
	Concrete-Lined Channels
	Unlined Rivers and Streams

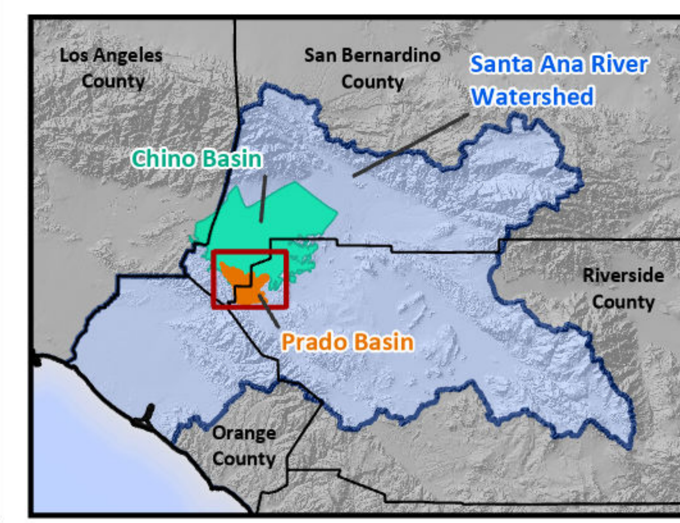
Surface Geology

Water-Bearing Sediments

Quaternary Alluvium

Consolidated Bedrock

Undifferentiated Pre-Tertiary to Early Pleistocene Igneous, Metamorphic, and Sedimentary Rocks



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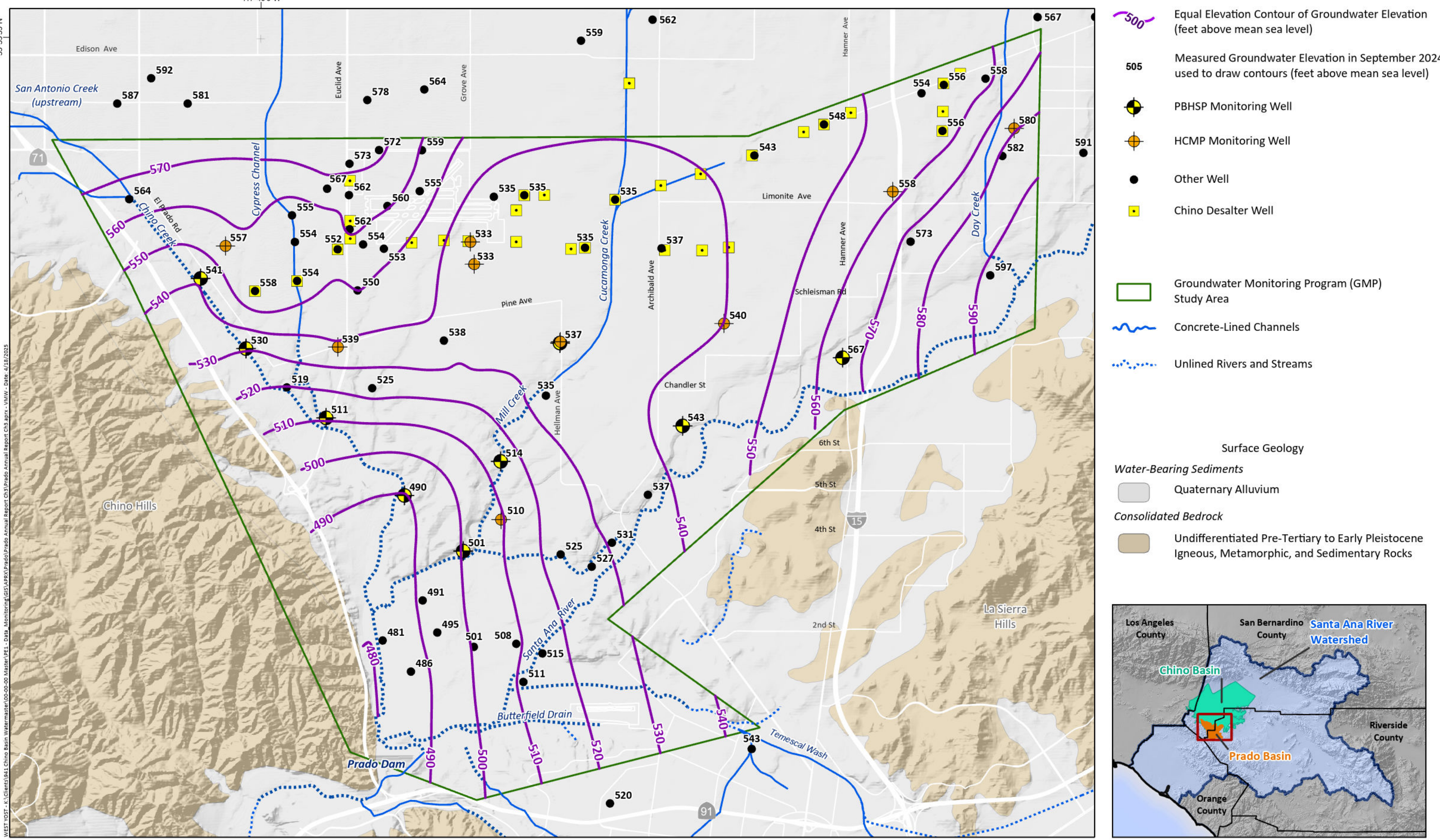
Map of Groundwater Elevation

September 2016 - Shallow Aquifer System

Figure 3-10a



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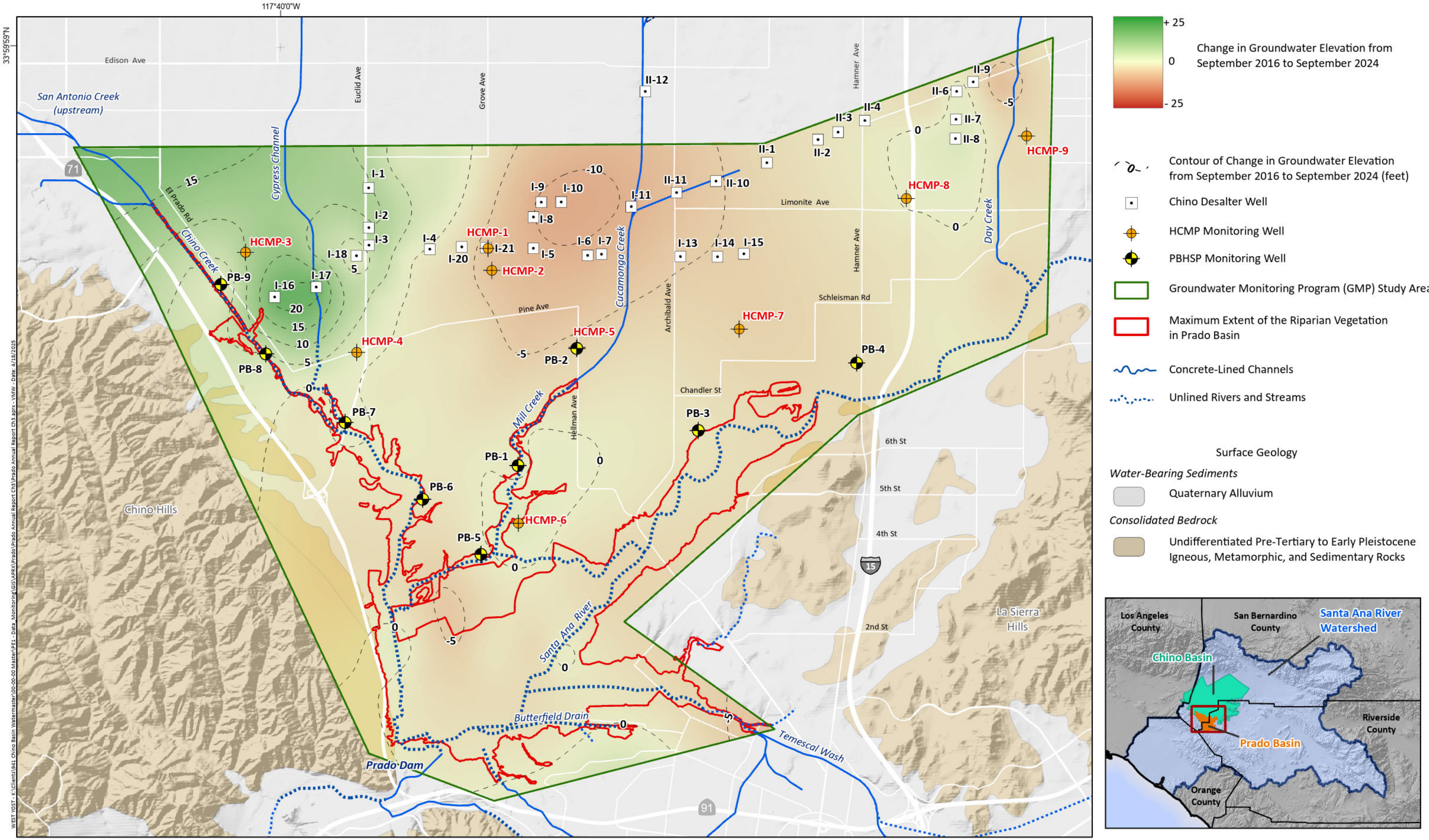
Map of Groundwater Elevation

September 2024 - Shallow Aquifer System

Figure 3-10b



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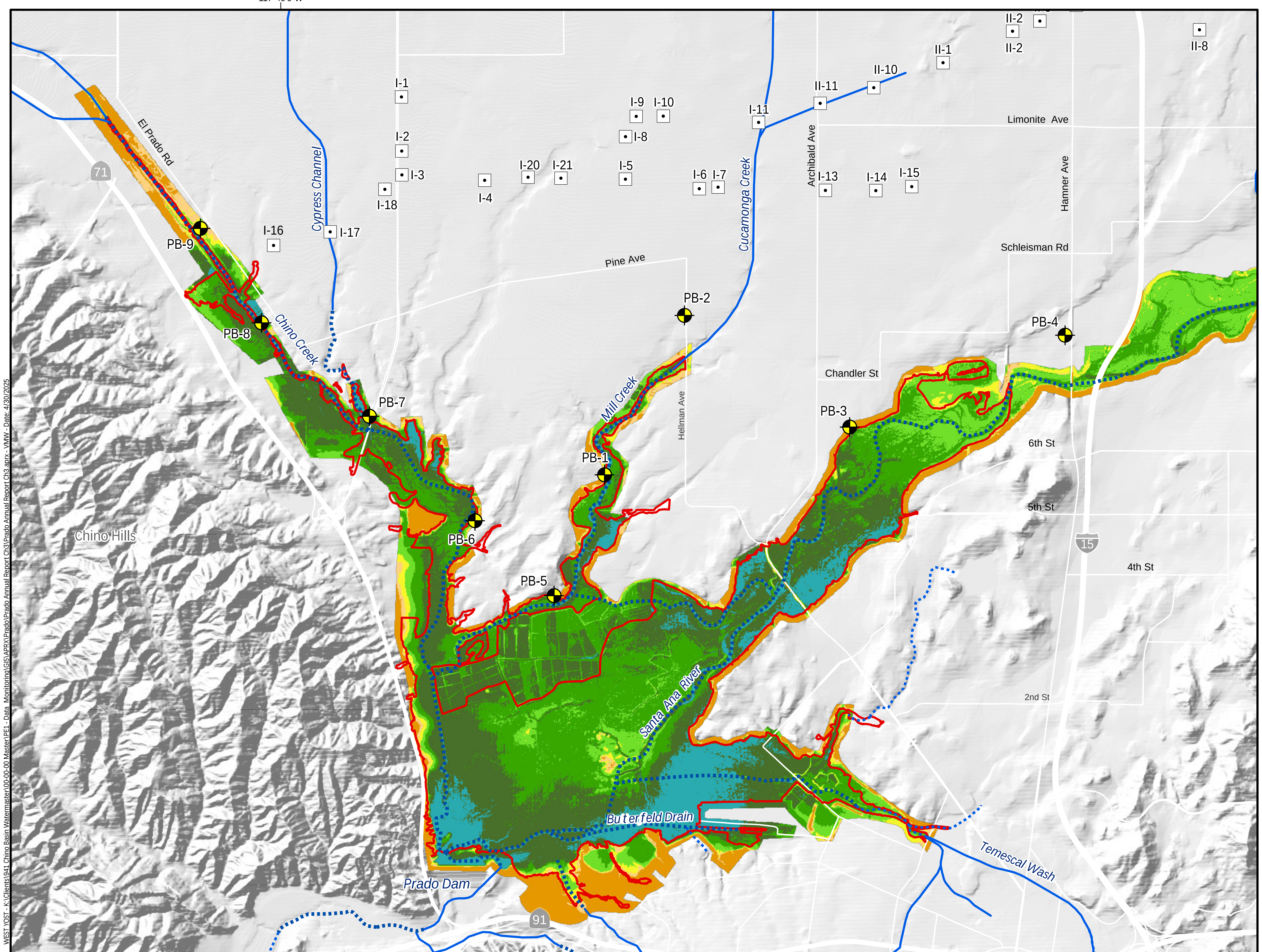
Change in Groundwater Elevation
September 2016 to September 2024

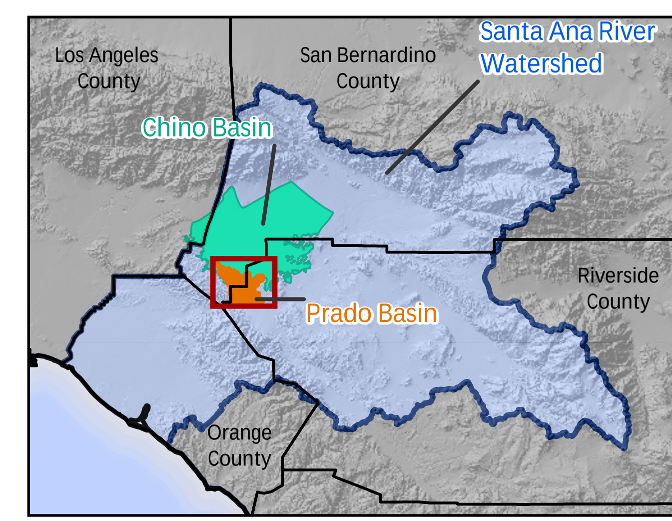
Figure 3-11



Depth to Groundwater (feet below ground surface)

- Area of Groundwater at the Ground Surface
- > 0 and ≤ 5
- > 5 and ≤ 10
- > 10 and ≤ 15
- > 15 and ≤ 20
- > 20 and ≤ 25
- > 25

- Maximum Extent of the Riparian Vegetation in Prado Basin
- Chino Desalter Well
- PBHSP Monitoring Well
- Concrete-Lined Channels
- Unlined Rivers and Streams



WEST YOST - K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE1 - Data Monitoring\GIS\APRX\Prado\Prado Annual Report Ch3\Prado Annual Report Ch3.aprx - VMW - Date: 4/30/2025

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0 1 2 Miles

0 1 2 Km

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Depth to Groundwater
September 2024

Figure 3-12

3.2.3 Groundwater Levels Compared to NDVI

Figures 3-13a through 3-13c are time-series charts that compare long-term trends in groundwater pumping and groundwater elevations to the trends in the quality of the riparian vegetation as indicated by the NDVI for three reaches in the Prado Basin: Chino Creek, Mill Creek, and the SAR. The period of analysis for these charts is 1984 to 2024—the period of NDVI availability. The upper chart in these figures compares changes in groundwater levels for each respective area to long-term trends in groundwater pumping within the respective regions of the GMP study area (Chino Creek, Mill Creek, and SAR). The annual groundwater pumping for wells within the respective regions is presented as a stacked bar chart, differentiating between Chino Desalter wells and non-Chino Desalter wells. Model-generated groundwater-elevation estimates for 1984 to 2018 were extracted from Watermaster's 2020 calibration of its groundwater-flow model at the monitoring well locations (WEI, 2020). The more recent groundwater-elevation data shown on these charts were measured at monitoring wells constructed by Watermaster and the IEUA to support the Hydraulic Control Monitoring Program (HCMP) (beginning in 2005) and the PBHSP (beginning in 2015). Where the measured and model-estimated groundwater elevations overlap in time, the model-estimated elevations mimic the seasonal fluctuations and longer-term trends of the measured elevations, typically differing by no more than 10 feet. This alignment supports the use of these model-estimated groundwater elevations in this analysis to evaluate historic trends prior to the availability of actual water level measurements.

The lower chart in Figures 3-13a through 3-13c displays the time series of the Average Growing-Season NDVI for the defined areas (discussed in Section 3.1) along Chino Creek, Mill Creek, and the SAR. For reference, the Mann-Kendall test results for trends in the Average Growing-Season NDVI for 1984 to 2024, 1984 to 2006, and 2007 to 2024 are shown in the legend.

The NDVI observations and interpretations below focus on recent changes in Average Growing-Season NDVI (Section 3.1) and whether observed groundwater level trends may be contributing to recent NDVI changes.

Chino Creek (Figure 3-13a). During the late 1990s, groundwater levels along Chino Creek increased, particularly along the north reach of Chino Creek, where groundwater levels increased by over 30 feet. The increase in groundwater levels was most likely due to reduced pumping in the area. Since 2000, groundwater levels have remained relatively stable, even as Chino Basin Desalter pumping commenced and increased at CDA wells I-I, I-2, I-3, I-4, I-16, I-17, and I-18 to the north of Chino Creek (see inset map on Figure 3-13a). From 2017 to 2023, pumping at these Chino Desalter wells was at historically low volumes, contributing to a decrease in pumping in this area.

From 2015-2024, the measured groundwater levels at the PBHSP monitoring wells along Chino Creek show an increasing trend along the northern portion of Chino Creek (PB-9/1, PB-8, and RP2-MW3) and stable trend along the central reach, (PB-7/1 and PB-6/1). Groundwater levels fluctuate seasonally, in some cases by more than 15 feet, under the seasonal stresses of pumping and recharge. During the winter months of WY 2017, 2019, 2023, and 2024, groundwater levels at the PBHSP monitoring wells increased to their highest recorded levels, likely in response to the recharge of stormwater discharge in unlined creeks and the associated surface-water reservoir that ponds behind Prado Dam. Over the last year (September 2023 to September 2024) groundwater levels stayed about the same along the upper northern reach of Chino Creek (PB-9/1), decreased by less than one foot along the lower northern reach (PB-8, and RP3-MW3), stayed about the same (PB-7/1), or decreased by about 1 foot (PB-6/1) in the middle reach of Chino Creek.

The Average Growing-Season NDVI and the air photo analyses along Chino Creek show that changes in the vegetation were relatively minor during 2023 to 2024 (discussed in Section 3.1), and the NDVI increased slightly at the northern-most reach of the Creek (CC-1) and decreased slightly at the other three areas. Hence, the main observations and conclusions for the period of 2023 to 2024 for the Chino Creek reach are that overall, groundwater levels remained stable or slightly decreased and the riparian vegetation did not change significantly.

Mill Creek*. *(Figure 3-13b). During the 1990s, groundwater levels along Mill Creek increased, particularly along the north reach of Mill Creek where groundwater levels increased by about 10 feet, most likely due to reduced agricultural pumping in the area. Since 2000, groundwater levels along the north reach of Mill Creek have declined by up to 15 feet. The decline in groundwater levels was most likely due to the onset and progressive increase in Chino Basin Desalter pumping at CDA wells I-5, I-6, I-7, I-8, I-9, I-10, I-11, I-13, I-14, I-20, I-21, and II-11 to the north of Mill Creek (see inset map on Figure 3-13b). Since 2017, total pumping at these Chino Desalter wells has progressively increased, reaching a historically high volume in 2021 and slightly declining after, contributing to the overall increase in the total pumping in this region.

From 2015 to 2024, the measured groundwater levels at the PBHSP monitoring wells along Mill Creek show an overall decreasing trend in the northern and central portion of Mill Creek (PB-2 and HCMP-5/1, and PB-1/2) with groundwater levels decreasing from 2015 to 2022 and then increasing from 2022 to 2024. These decreases and increases in groundwater levels follow the same trends as groundwater pumping observed in this area. From 2015 to 2024, the measured groundwater elevations in the southern reach of Mill Creek show a slight increasing trend of about 1 foot (HCMP-6/1) and a stable trend (PB-5/1).

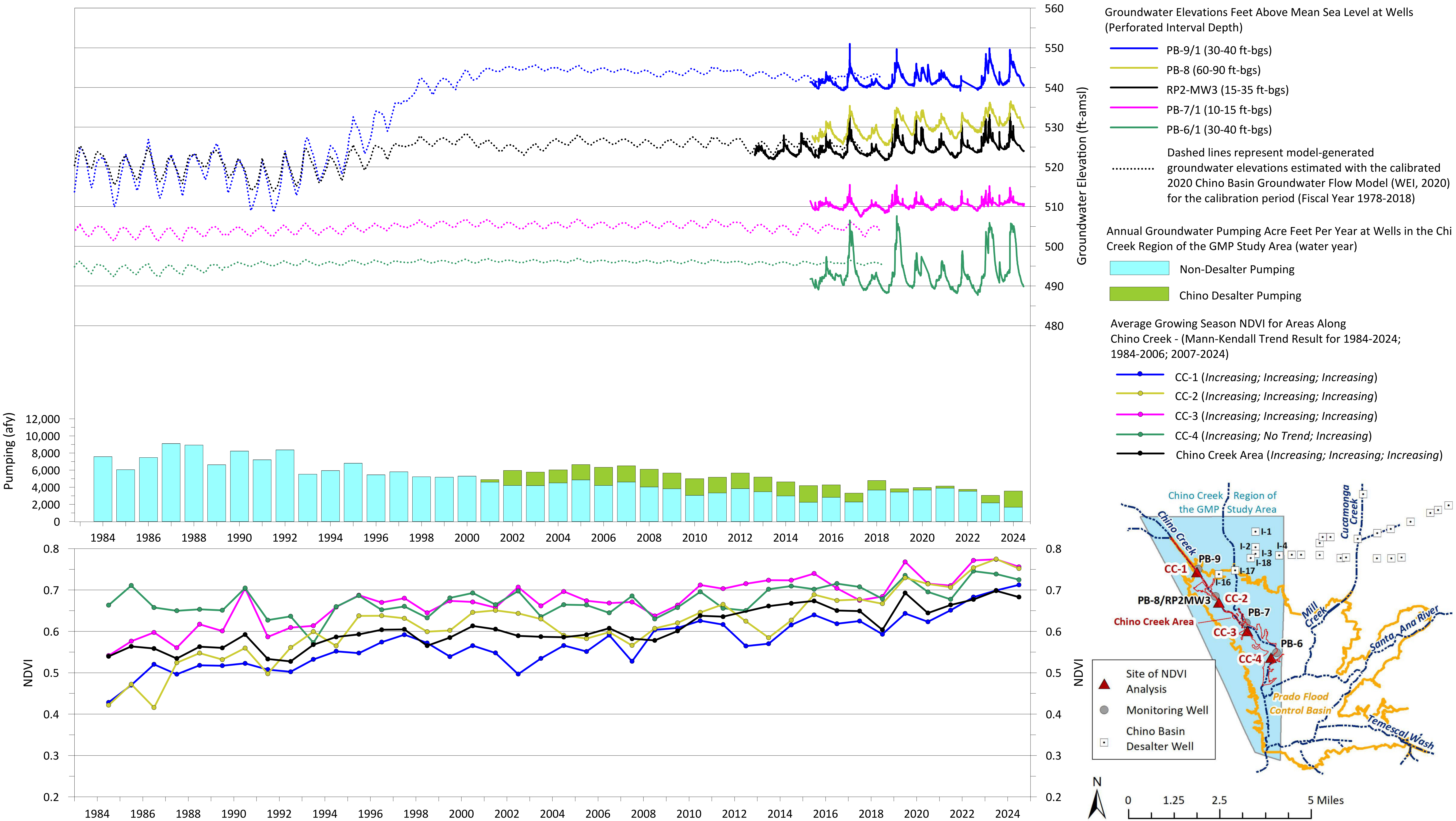
Groundwater levels fluctuate seasonally, in some cases up to 10 feet, under the seasonal stresses of pumping and recharge. During the winter months in WY 2017, WY 2019, WY 2023, and WY 2024, groundwater levels at most of the PBHSP monitoring wells increased to their highest recorded levels, likely in response to the recharge of stormwater discharge in unlined creeks. Over this past year from September 2023 to September 2024, groundwater levels increased about a foot in the northern portion of Mill Creek (PB-2 and HCMP-5/1), remained stable in the central portion (PB-1/2) and decreased about a foot at the southern portion (HCMP-6/1 and PB-5/1).

The Average Growing-Season NDVI analyses along Mill Creek show that changes in the vegetation were relatively minor during 2023 to 2024 (discussed in Section 3.1), with NDVI decreasing at all the areas, except for MC-3 in the central-southern reach of Mill Creek. The greatest decreases in NDVI were in the northern (MC-5) and central (MC-2) reaches of Mill Creek, and the air photos for these areas show notable browning and reductions in the riparian vegetation. Hence, the main observations and conclusions for the period of 2023 to 2024 for the Mill Creek reach are that groundwater level trends fluctuated up to +/- one foot or remained stable, and there are notable changes in riparian vegetation in some areas.

Santa Ana River (***Figure 3-13c***). During the 1990s, the groundwater levels along SAR increased in response to a decline in pumping from 1990 to 2000. These responses were greatest along the eastern portion of SAR where they increased up to five feet. Since 2000, groundwater levels have declined by a similar magnitude along the eastern portion of the SAR due to the onset and progressive increase in Chino Basin Desalter pumping at CDA wells I-13, I-14, I-15, and II-1 through II-11 to the north of the SAR (see inset map on Figure 3-13c), while groundwater levels slightly increased along the western portion of the SAR near the Archibald well. Since 2018, total pumping at these Chino Desalter wells progressively increased to a historically high volume in 2021, declining only slightly since, contributing to the increase in the total pumping observed in this area.

From 2015 to 2024, the measured groundwater levels at the PBHSP monitoring wells show a slight decreasing trend along the northeastern portion near PB-4/1, a stable trend along the northern portion near PB-3/1 following a decreasing trend between 2019 and 2022, and an increasing trend along the southwestern portion near the Archibald 1. The decreases in groundwater levels in the northeastern portion of the SAR area (near PB-4/1) are likely due to the increase in pumping observed in this area. Groundwater levels fluctuate seasonally, in some cases by up to seven feet under the seasonal stresses of pumping and recharge. Over the last year, from September 2023 to September 2024, groundwater levels at the monitoring wells along the SAR remained stable along the northeastern and northern portions (PB-4/1 and PB-3/1) and decreased by about 2 feet along the western portion (Archibald 1).

The Average Growing-Season NDVI and air photo analyses along the SAR show that changes in the vegetation were relatively minor from 2023 to 2024 (discussed in Section 3.1) and the NDVI increased slightly at SAR-1 and LP and decreased slightly at SAR-2 and SAR-3. Hence, the main observations and conclusions for the period of 2023 to 2024 for the SAR reach are that groundwater levels remained stable or decreased, and the riparian vegetation did not change significantly.



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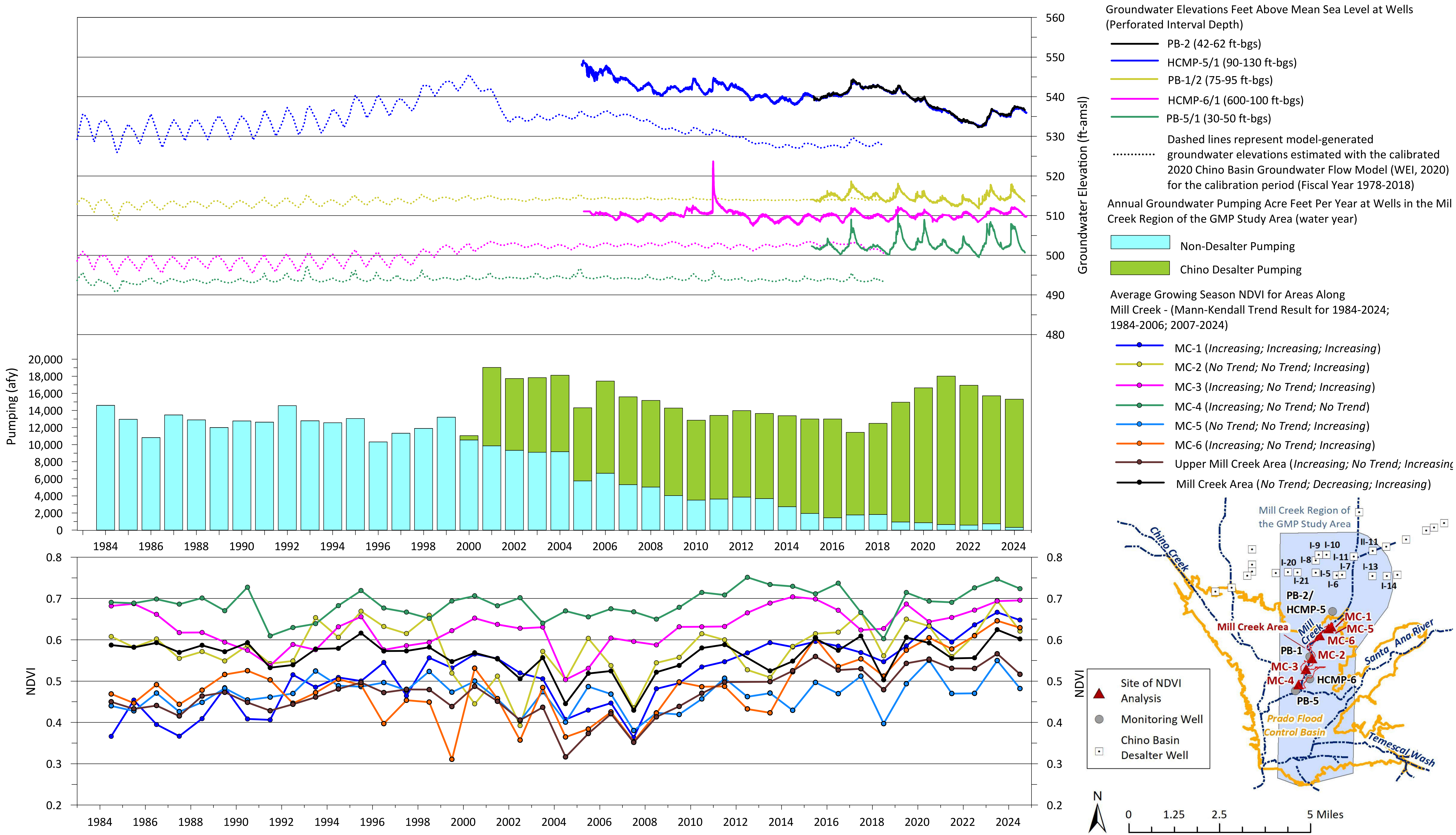
Groundwater Levels and Production versus NDVI
Chino Creek Area for 1984-2024

Figure 3-13a



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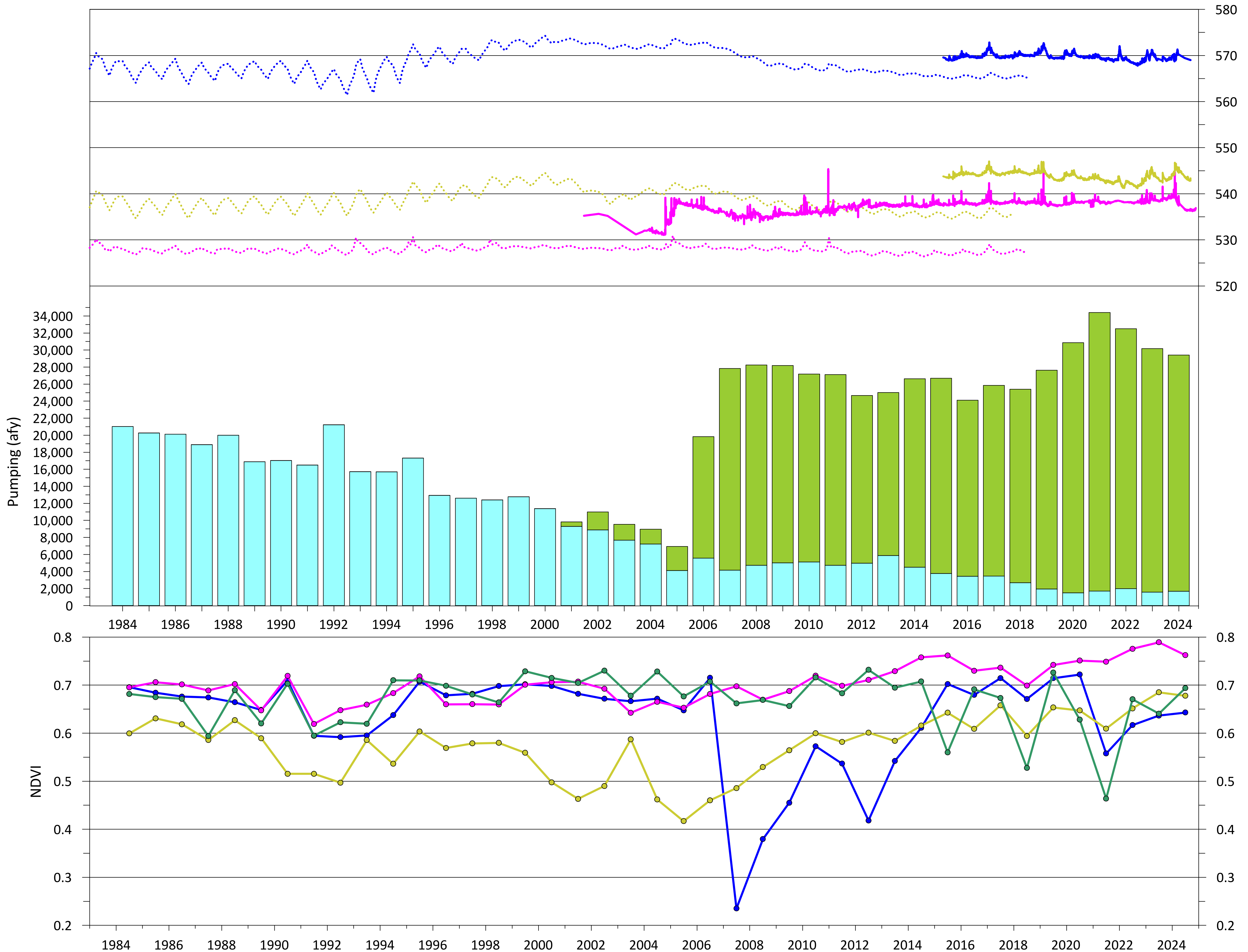
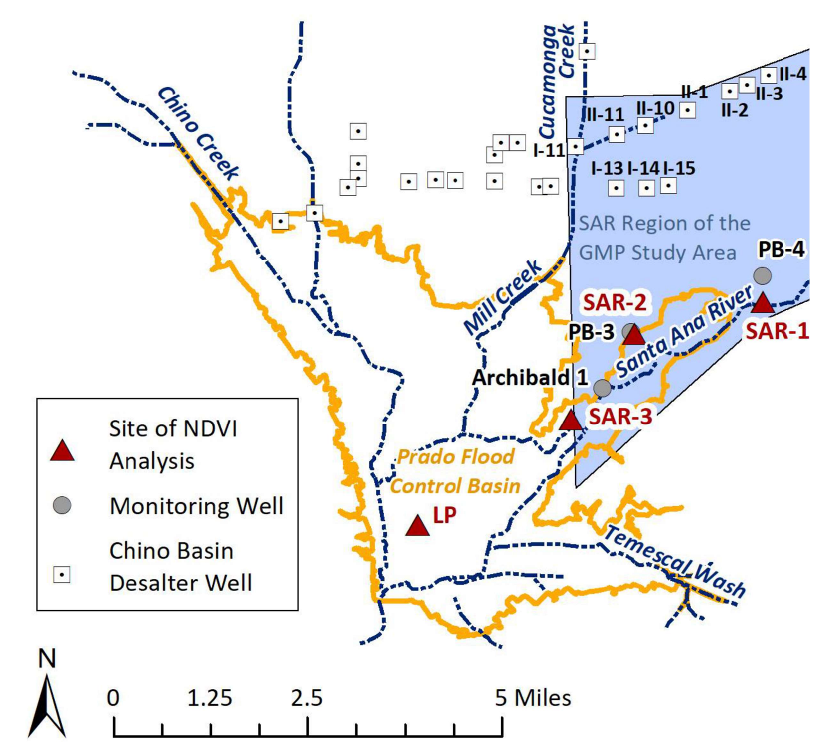
Groundwater Levels and Production versus NDVI
Mill Creek Area for 1984-2024

Figure 3-13b





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Groundwater Levels and Production versus NDVI
Santa Ana River Area for 1984-2024

Figure 3-13c

3.2.4 Summary

The following observations and interpretations were derived from the analysis of groundwater pumping, groundwater levels, and NDVI:

- From 1961 to 1990, groundwater pumping from private domestic and agricultural wells in the study area averaged about 45,900 afy. From 1991 to 1999, groundwater pumping steadily declined to about 23,600 afy primarily due to conversions from agricultural to urban land uses. In 2000, CDA pumping commenced to replace the declining agricultural production and by 2018, groundwater pumping in the study area was about 37,000 afy. Since WY 2019, total groundwater pumping in the study area increased almost 10,000 afy due to increased CDA pumping to reach its intended pumping rate of 40,000 afy. In WY 2024, there was 40,598 af total groundwater pumping in the GMP study area; 37,002 af of this was CDA pumping.
- Since groundwater-level measurements commenced at the PBHSP monitoring wells in 2015, there have been some increasing and decreasing trends in groundwater levels observed in the riparian vegetation area along the reaches of Chino Creek, Mill Creek, and SAR. From September 2016 to September 2024, groundwater levels have changed less than +/-5 feet throughout most of the extent. Historically, groundwater levels have declined the most along the northern portion of Mill Creek, just south of the PB-2 monitoring well, where levels decreased by eight feet from 2015 to 2022 likely due to increased pumping at the Chino Desalter wells to the north. Since 2022 groundwater levels have increased in this area over four feet likely due to above average precipitation and streamflow in 2023 and 2024, and reduced pumping in this area. From 2015 to 2024, groundwater levels increased the most in the northern reach of Chino Creek where groundwater levels have increased about 10 feet due to decreased pumping.
- Over the past year from 2023 to 2024 groundwater levels generally remained stable with groundwater levels changing up to +/- one foot at most of the PBHSP wells near the riparian vegetation along the reaches of Chino Creek, Mill Creek, and SAR. In Section 3.1, the analysis of air photos and NDVI for the riparian habitat indicates that the riparian vegetation did not change significantly in any of the areas, and there was a slight decrease in NDVI at most of the sites as groundwater levels remained stable or slightly changed.

3.3 Analysis of Groundwater/Surface-Water Interactions

One of the objectives of the PBHSP is to identify factors that contribute to the long-term sustainability of Prado Basin riparian habitat. The depth to groundwater analysis shown in Figure 3-12 indicates that the riparian vegetation exists in areas of shallow groundwater, where groundwater levels are typically 15 ft-bgs or less, and that the riparian vegetation is likely dependent, at least in part, upon the shallow groundwater. There have been multiple studies for the PBHSP on the groundwater/surface-water interactions in the Prado Basin to determine the source of shallow groundwater that is available for consumptive use by the riparian vegetation, and that may be important to the long-term sustainability of the riparian habitat.

3.3.1 Past Monitoring of Groundwater/Surface-Water Interactions:

Historical monitoring of groundwater/surface-water interactions for the PBHSP include:

- From FY 2015 to FY 2018 quarterly groundwater samples were collected from the 18 PBHSP monitoring wells and analyzed at a minimum for general minerals. The general mineral chemistry data collected was analyzed along with groundwater-level data, model-generated groundwater-flow directions, and surface-water quality and flow data to help characterize groundwater/surface-water interactions in the Prado Basin and determine the source of the shallow groundwater.
- The Annual Reports for WY 2017 and WY 2018 (Section 3.3) included a comprehensive analysis to understand the sources of the shallow groundwater in the Prado Basin (WEI, 2018; 2019). The analysis included using surface-water discharge and quality, groundwater quality, groundwater levels, and groundwater modeling as multiple lines of evidence to analyze the groundwater/surface-water interactions at the nine PBHSP well locations—along the fringes of the riparian habitat and adjacent to Chino Creek, Mill Creek, and the SAR. In general, the analysis concluded that the SAR and northern portion of Mill Creek are losing reaches, characterized by streambed recharge. Most other areas along Chino and Mill Creeks are gaining reaches, characterized by groundwater discharge. That said, at most locations in the Prado Basin, there appear to be multiple and transient sources that feed the shallow groundwater, and the groundwater/surface-water interactions are complex. Additional monitoring was recommended to better characterize the sources of shallow groundwater and groundwater/surface-water interactions.
- From FY 2018 to FY 2023 a pilot monitoring program was conducted to determine if the high-frequency data enhances and better reveals the interpretation of groundwater/surface-water interactions previously studied for the PBHSP. The pilot monitoring program included the installation of transducers that record EC, temperature, and water levels at 15-minute intervals at two locations in Chino Creek and the same high-frequency monitoring at four nearby monitoring wells (PB-7 and PB-8 clusters). Additionally, during the first two years of the pilot monitoring program, surface-water and groundwater-quality samples were collected to support the high-frequency data.
- The Annual Report for WY 2022 included an analysis of the pilot monitoring program data (West Yost, 2023). The analysis concluded that that the high-frequency monitoring of EC and temperature at shallow monitoring wells can reveal the source waters that recharge shallow groundwater. Additionally, the high-frequency monitoring of groundwater-level elevations, surface-water stage, and thalweg elevations can also reveal the source waters that recharge shallow groundwater. We also learned from the pilot monitoring program that it is difficult to collect high-frequency data in the surface water because the transducers are oftentimes lost during large storm events and the transducers become clogged with mud which compromises the accuracy of the data. The WY 2022 report included recommendations to discontinue the pilot monitoring program and, in its place, use the high-frequency monitoring of EC, temperature, and water level for each pair of PBHSP monitoring wells, most of which was already being collected, and collect quarterly field measurements for EC and temperature of the surface water flowing in the streams adjacent to the monitoring wells.

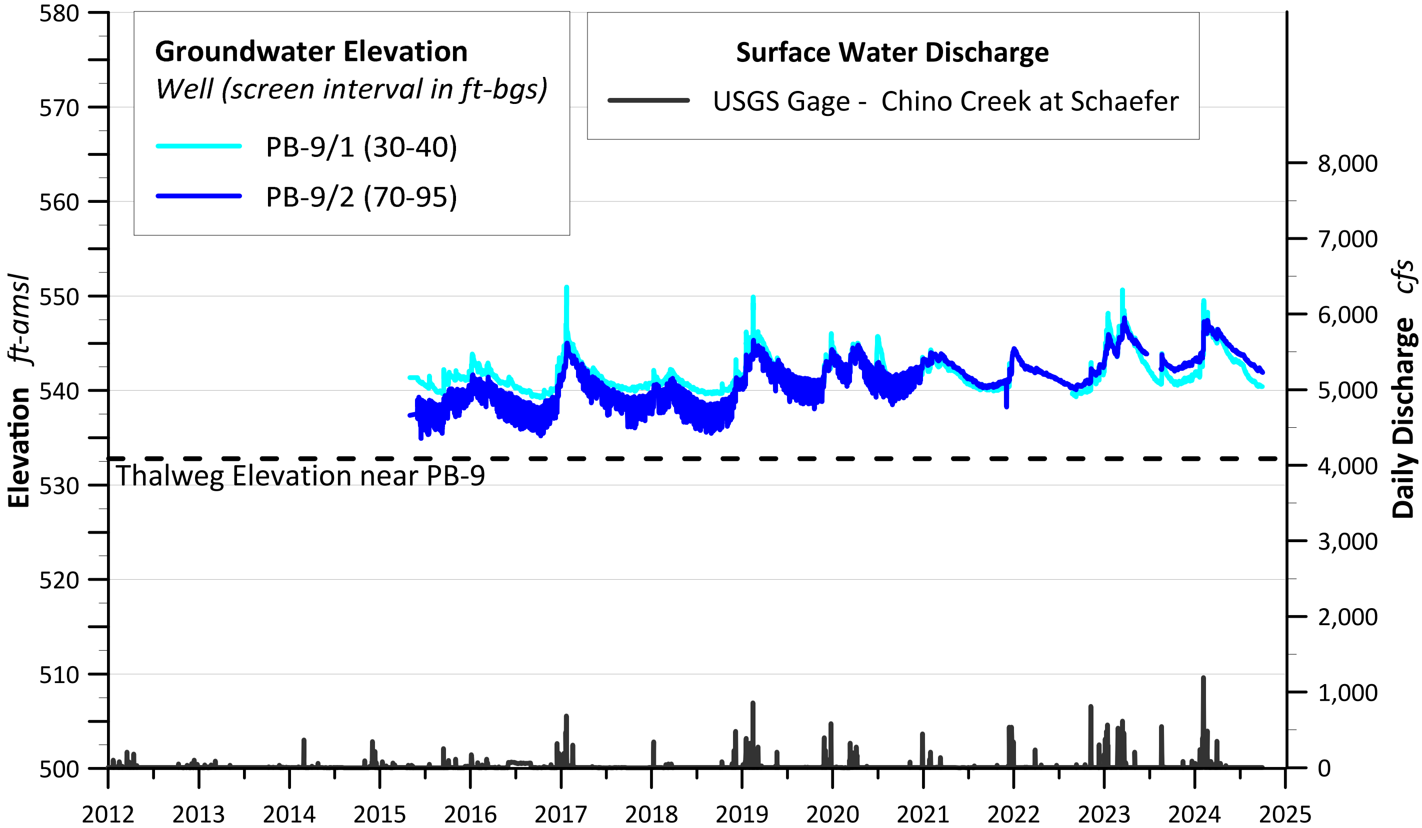
3.3.2 Current Monitoring for Groundwater/Surface-Water Interactions

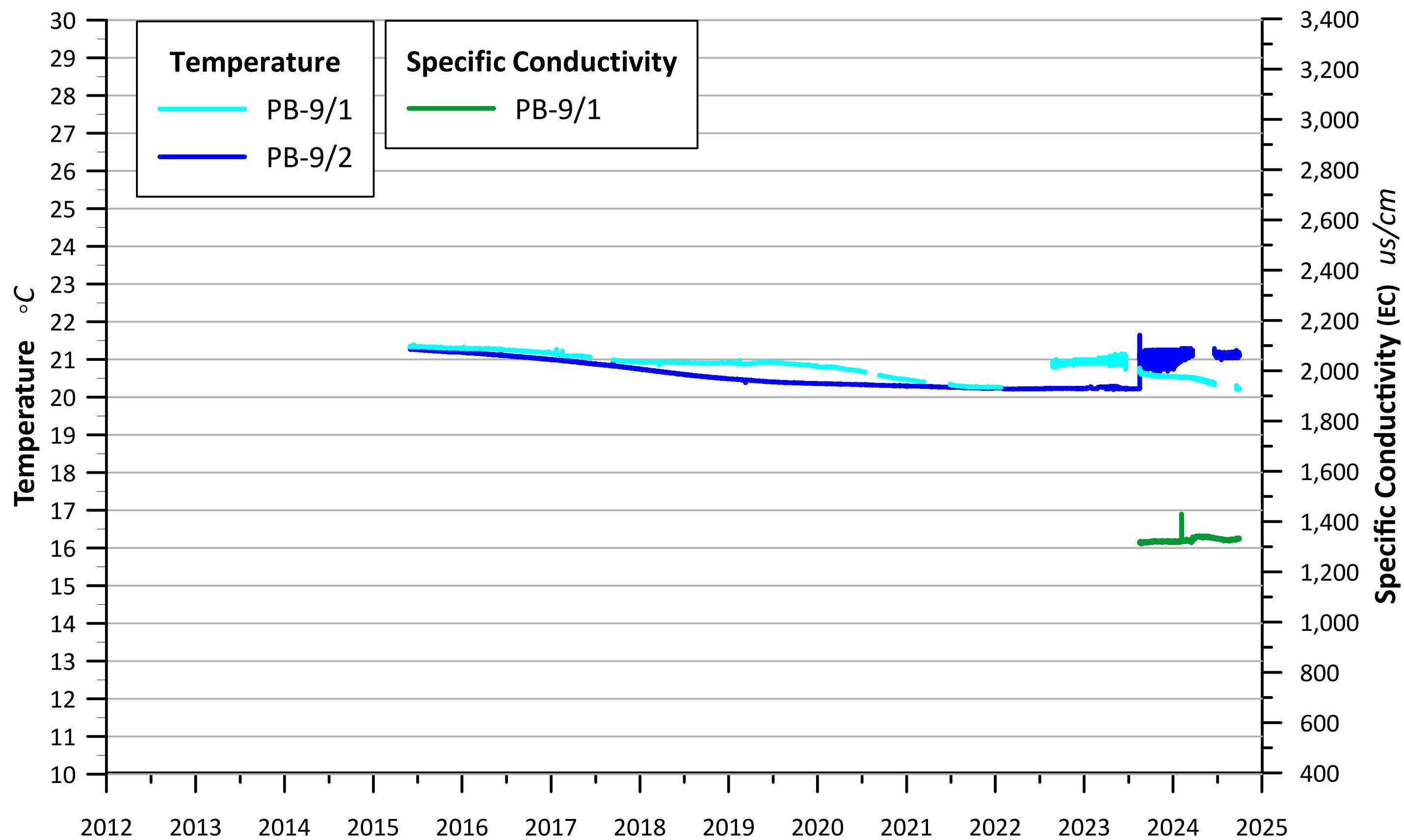
In 2023, monitoring of groundwater/surface-water interactions was initiated based on recommendations in the WY 2022 Annual Report following the analysis of the pilot monitoring program. This monitoring included: (i) compiling, processing, and uploading to the database the high-frequency temperature data which was already being collected at all the PBSHP monitoring wells since 2015; (ii) establishing the locations of surface-water sites near the PBHSP monitoring wells to collect field measurements of EC and temperature, and initiating quarterly measurements; and (iii) replacing transducers at the PBHSP monitoring wells as needed with transducers that measure EC in addition to temperature and level readings (now ten wells have transducer that measure EC). As described in Section 3.2, this monitoring continued in 2024.

In June 2024, professional elevation surveys were conducted of the thalweg elevations of the adjacent water bodies to all PBHSP monitoring wells. The thalweg elevation can be compared to the groundwater elevations in PBHSP monitoring wells to help characterize groundwater/surface-water interactions within the GMP study area and determine if the shallow groundwater supporting the riparian vegetation is supported by the groundwater and/or the surface water. The thalweg elevations were surveyed using the same datum as the PBHSP monitoring wells. Figures 3-14a through 3-14i are time series charts that display the high-frequency monitoring data at each PBHSP monitoring well location located along the fringes of the riparian habitat, adjacent to Chino Creek, Mill Creek, and the SAR. These figures will use this data to help further discern groundwater/surface water interactions. Each figure contains the following:

- The upper chart is a time series of the high-frequency groundwater elevations at the PBHSP monitoring wells at each location and the surface water discharge in the adjacent stream to the monitoring wells. The groundwater elevation time-series for the shallow and deep PBHSP monitoring wells are charted with the thalweg elevation of the adjacent creek or river. The thalweg elevations are from surveys performed in June 2024 by Guida Geospatial Solutions Inc. Thalweg elevations are compared to the groundwater elevations to determine the potential for groundwater discharge or streambed recharge along the specific stream reaches, and daily surface-water discharge data are charted and compared with groundwater elevations to characterize the relationship between surface-water discharge and groundwater levels.
- The lower chart is a time series of high-frequency temperature and EC at the PBHSP monitoring wells at each location with the surface-water field measurements of EC and temperature.

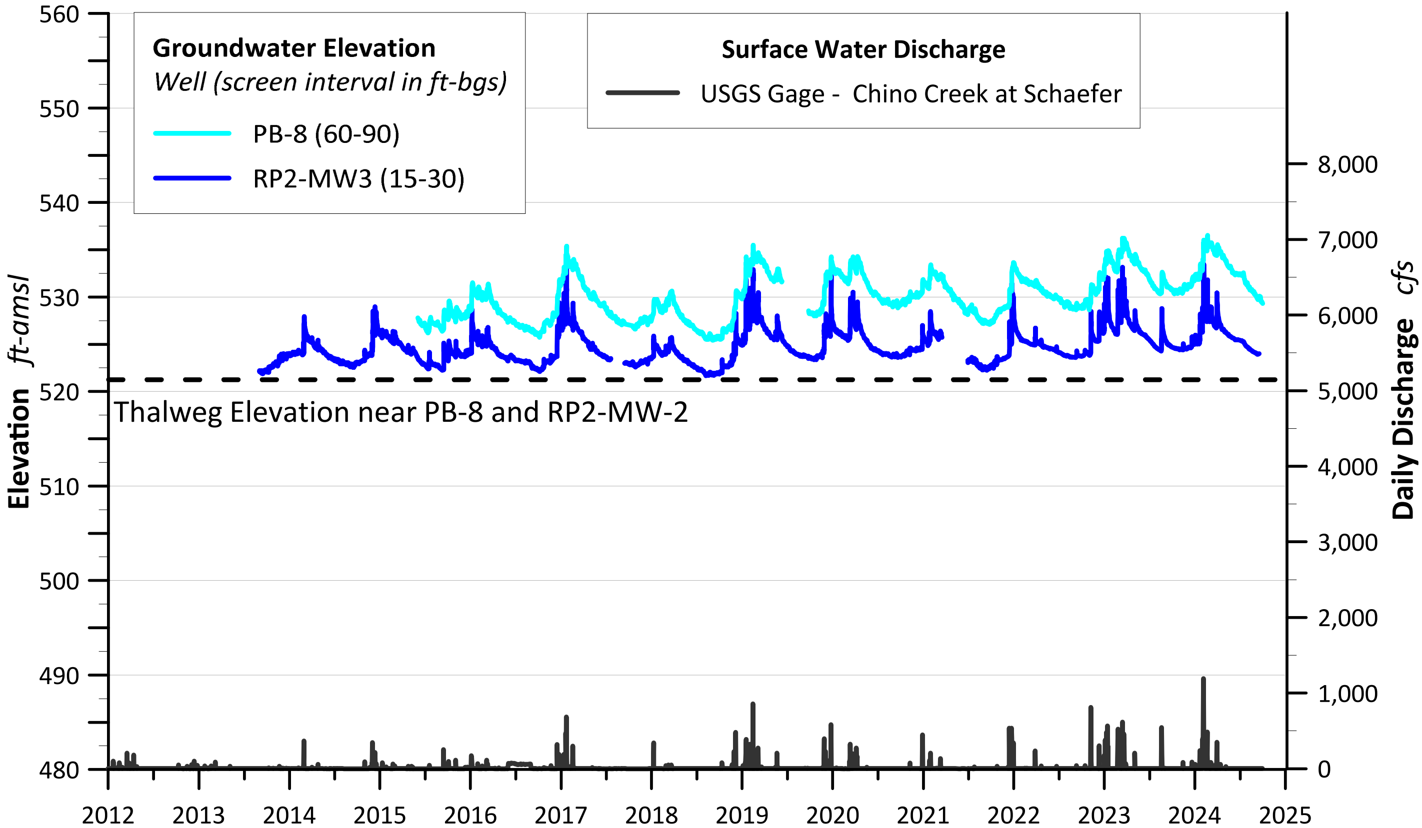
The high-frequency monitoring data and the surveyed thalweg elevations in Figures 3-14a through 3-14i was intended to better reveal the interpretation of groundwater/surface-water interactions previously studied for the PBHSP that used the general mineral chemistry data collected at the PBHSP wells. Table 3-5 summarizes the analysis of groundwater/surface-water interactions based on the data presented in Figures 3-14a through 3-14i. Table 3-5 also includes the interpretation from the original groundwater/surface-water interactions analysis presented in the Annual Reports for WY 2017 and WY 2018 (Section 3.3) that used multiple lines of evidence, including the general mineral chemistry data to analyze the groundwater/surface-water interactions at the nine PBHSP well locations (WEI, 2018; 2019). In general, the analysis concludes similar analysis from the 2017 to 2018 Annual Reports that the SAR from PB-4 to PB-3 and Mill Creek near PB-2 are losing reaches, characterized by streambed recharge. Most other areas along Chino Creek and Mill Creek are gaining reaches, characterized by groundwater discharge.



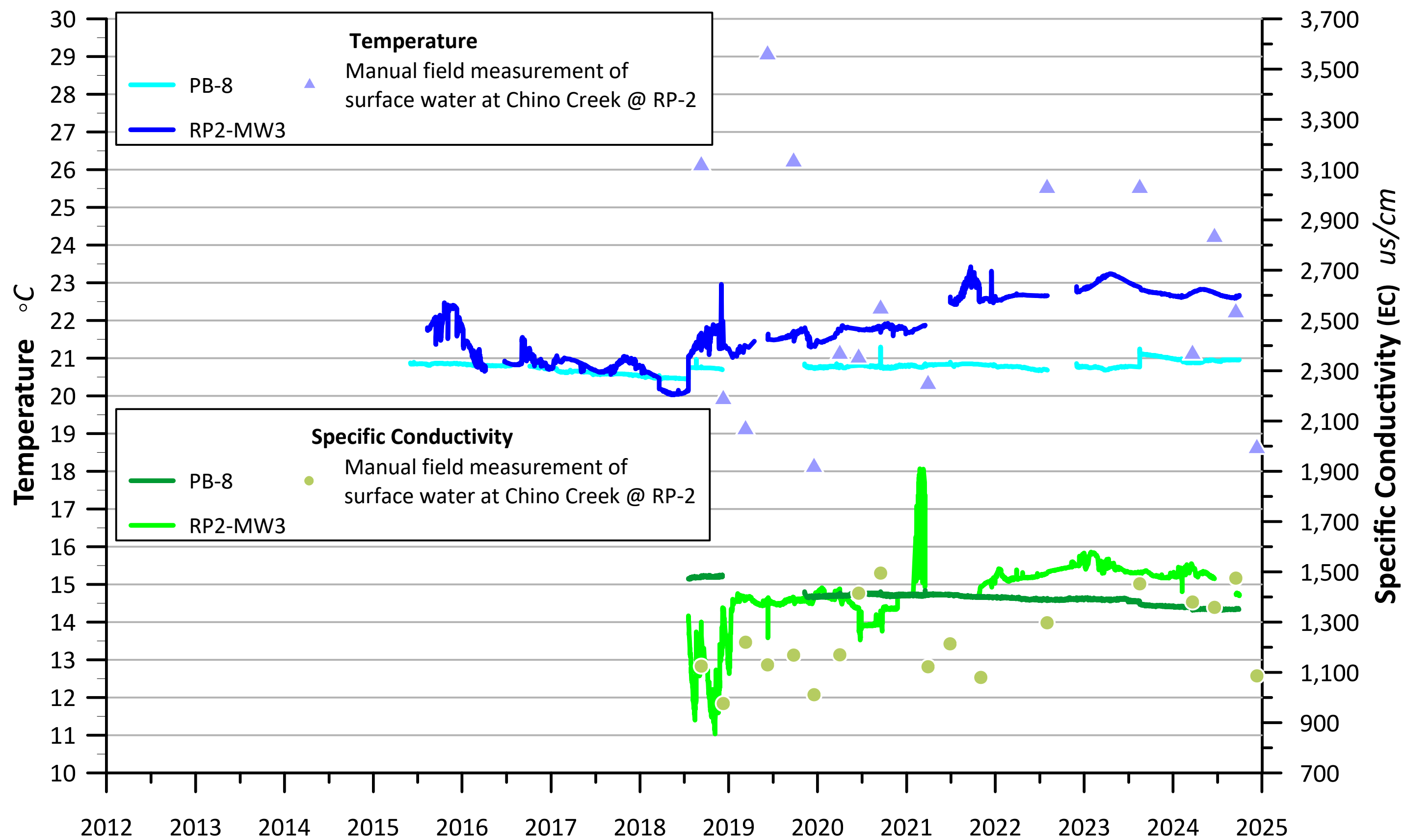


Monitoring to Characterize Groundwater and Surface-Water Interactions
PB-9 Near Chino Creek

Figure 3-14a



Groundwater Elevation
Well (screen interval in ft-bgs)
PB-8 (60-90)
RP2-MW3 (15-30)
Surface Water Discharge
USGS Gage - Chino Creek at Schaefer
Thalweg Elevation near PB-8 and RP2-MW-2
Elevation ft-amsl
Daily Discharge cfs
560
550
540
530
520
510
500
490
480
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025



Temperature
PB-8
RP2-MW3
Manual field measurement of surface water at Chino Creek @ RP-2
Specific Conductivity
PB-8
RP2-MW3
Manual field measurement of surface water at Chino Creek @ RP-2
Temperature °C
Specific Conductivity (EC) us/cm
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
3,700
3,500
3,300
3,100
2,900
2,700
2,500
2,300
2,100
1,900
1,700
1,500
1,300
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700
2012
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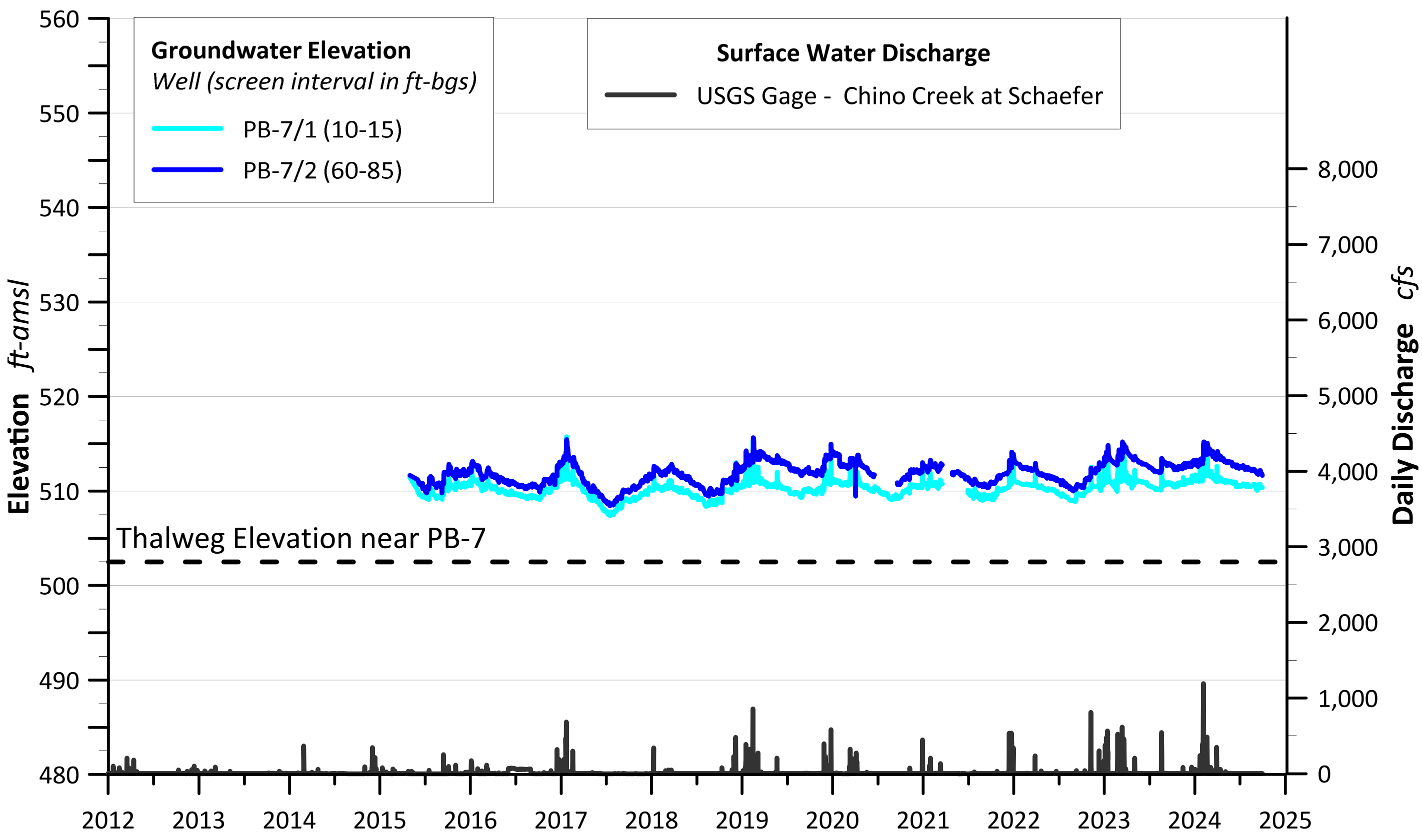
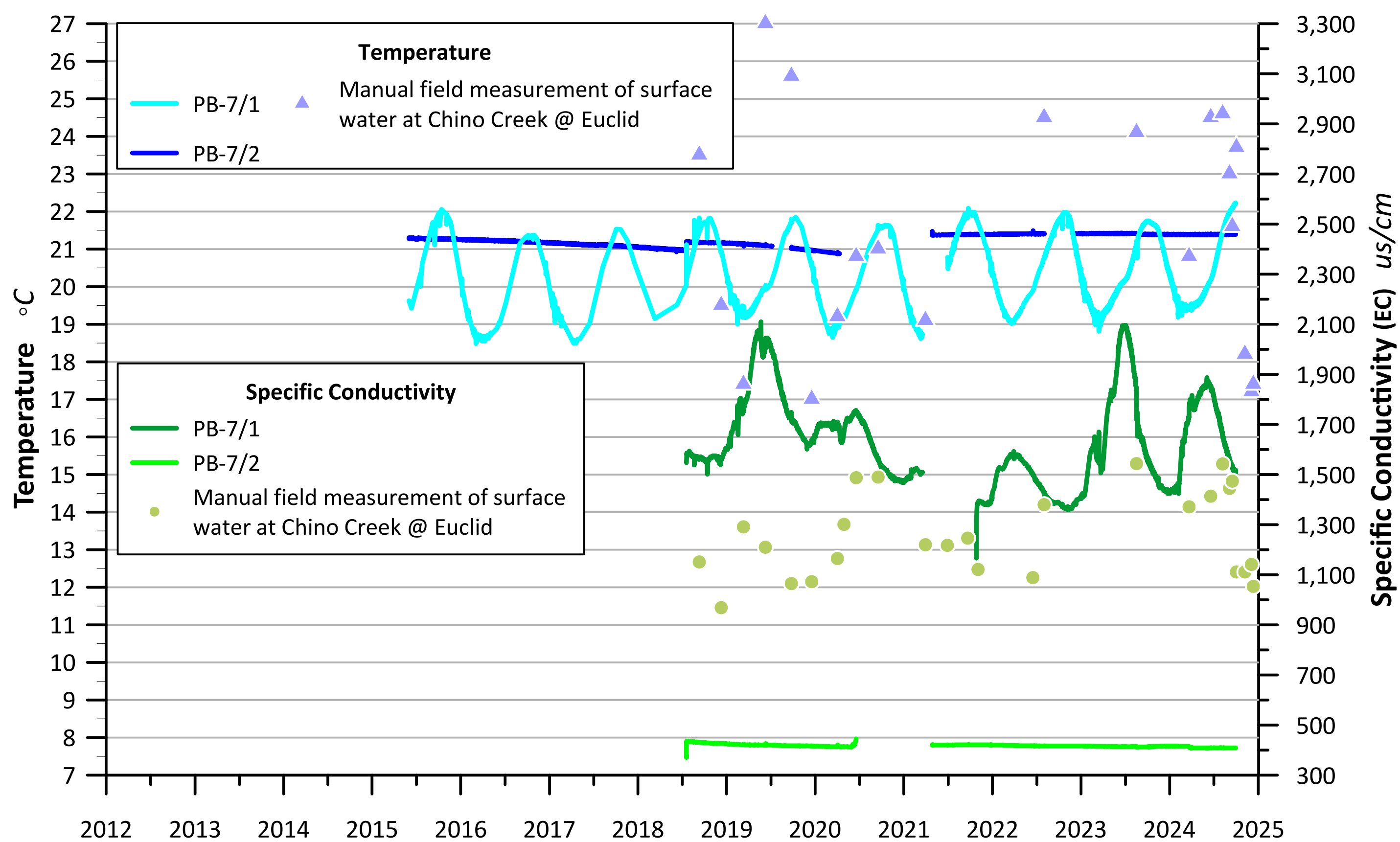
2022
2023
2024
2025

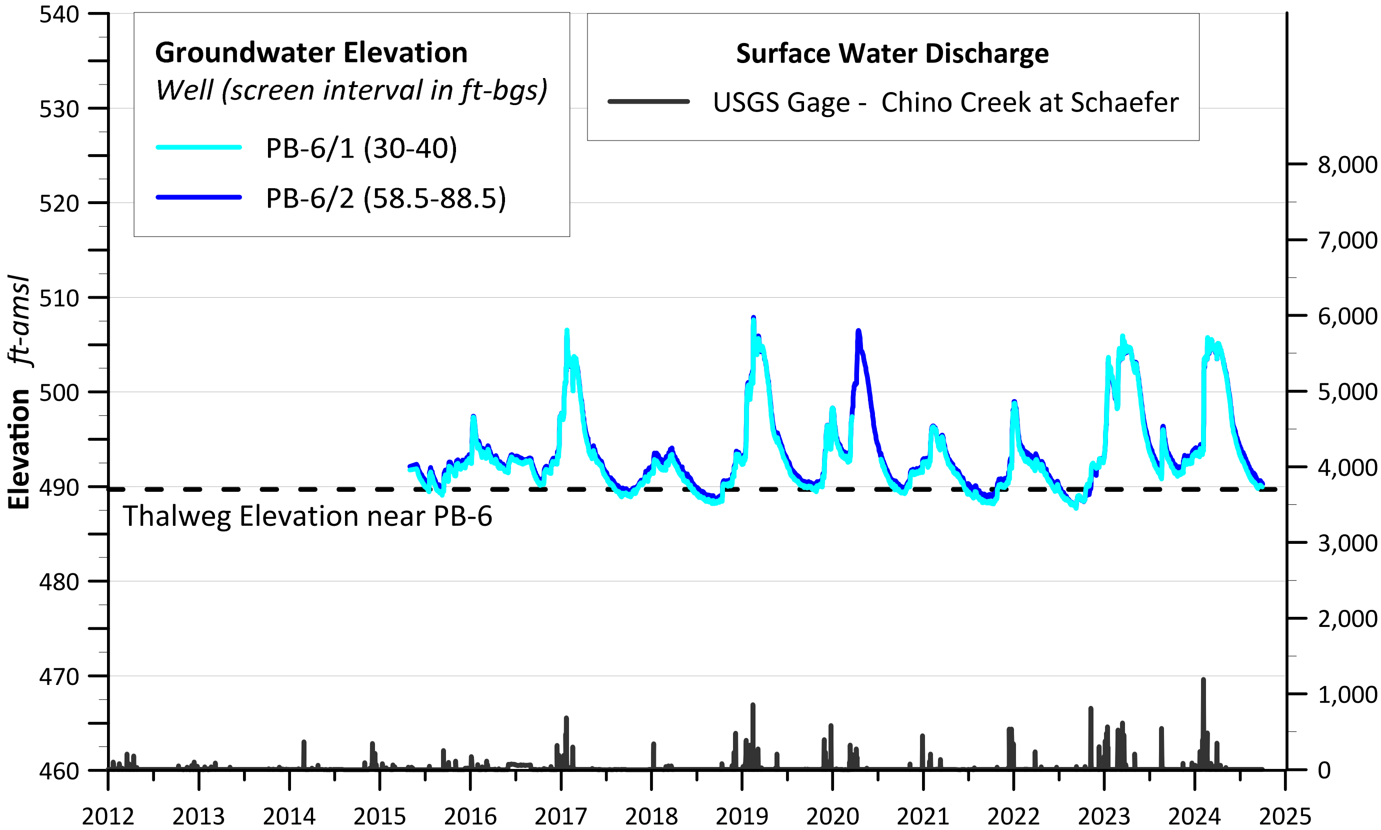


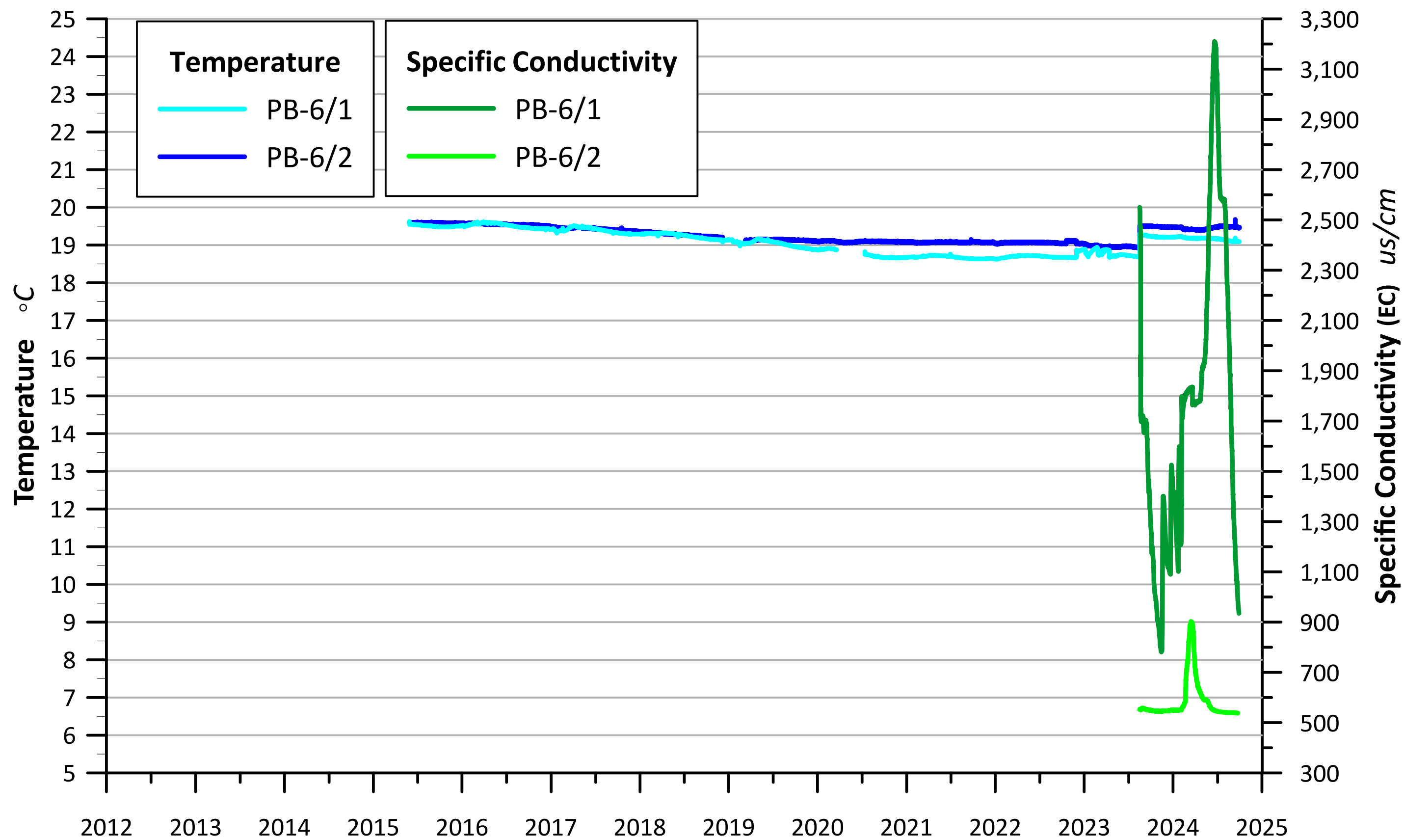


Monitoring to Characterize Groundwater and Surface-Water Interactions

PB-7 Near Chino Creek

Figure 3-14c

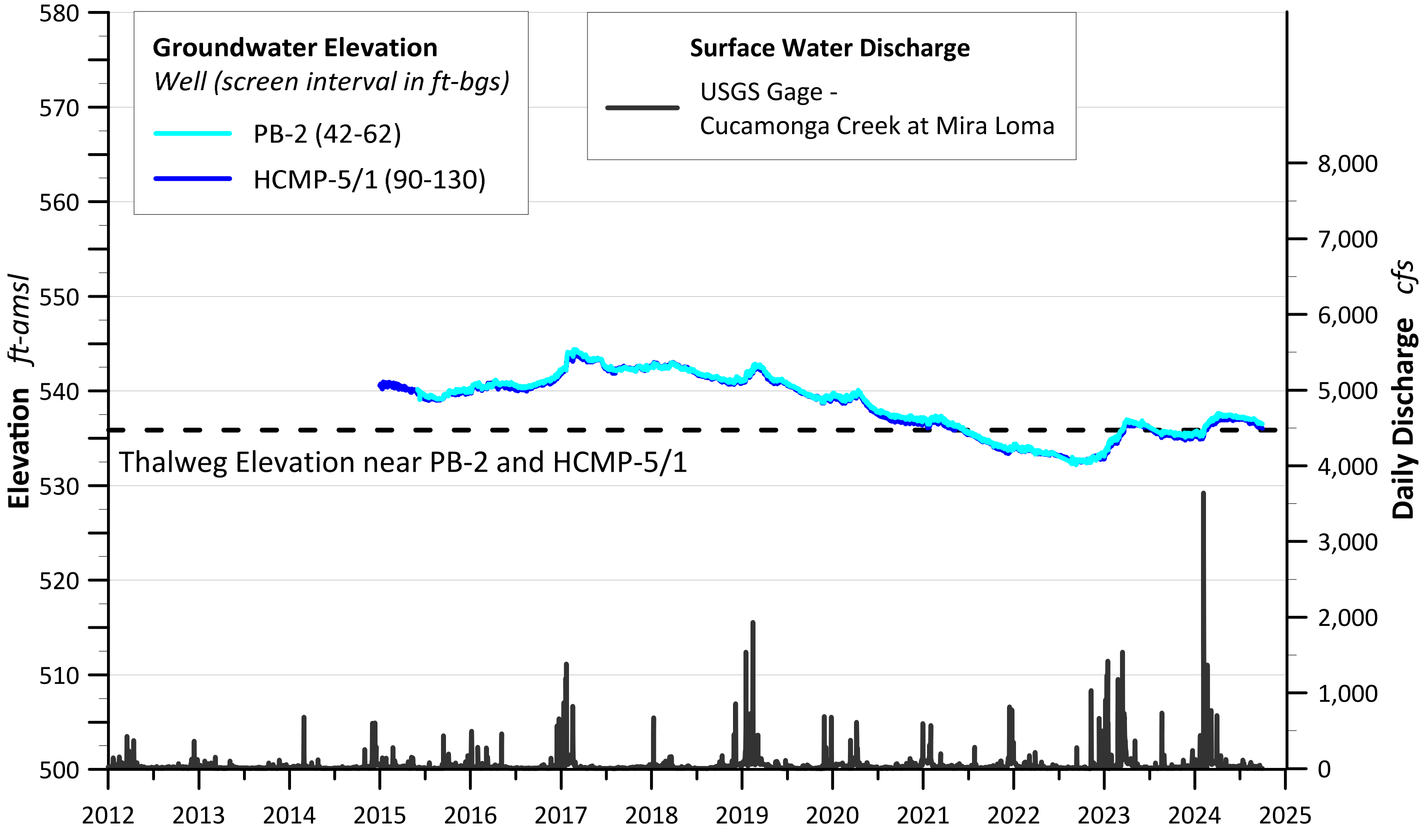


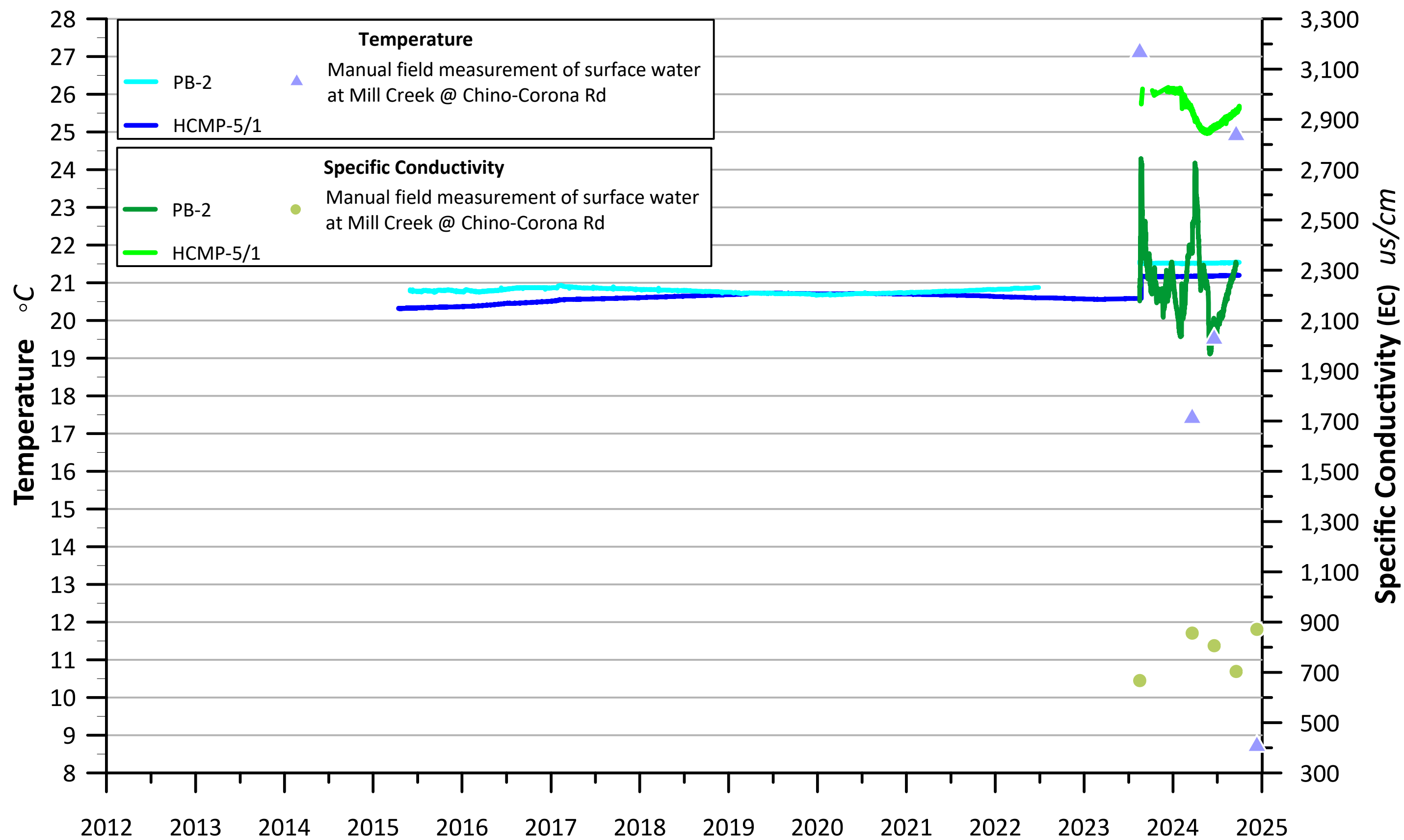


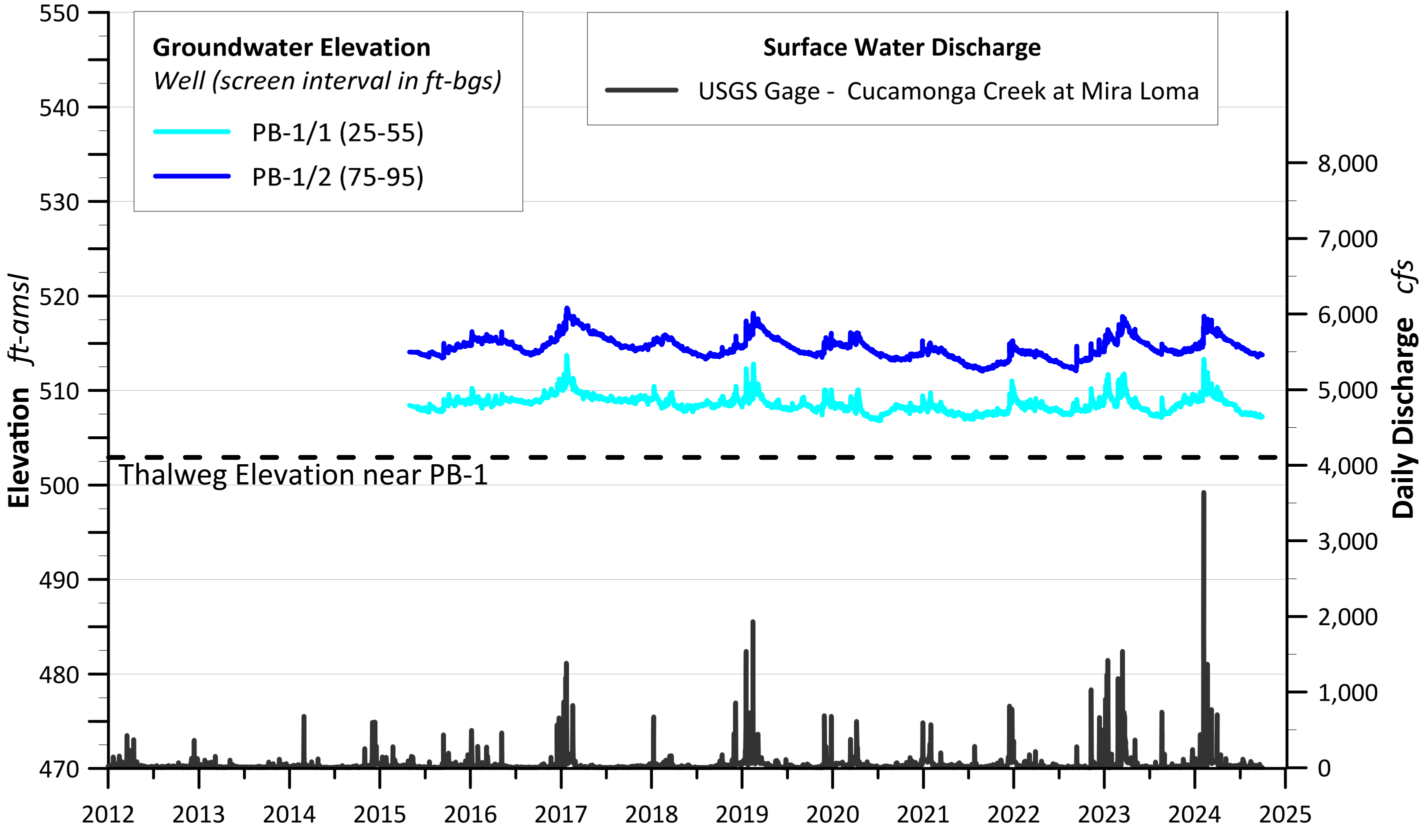
Monitoring to Characterize Groundwater and Surface-Water Interactions

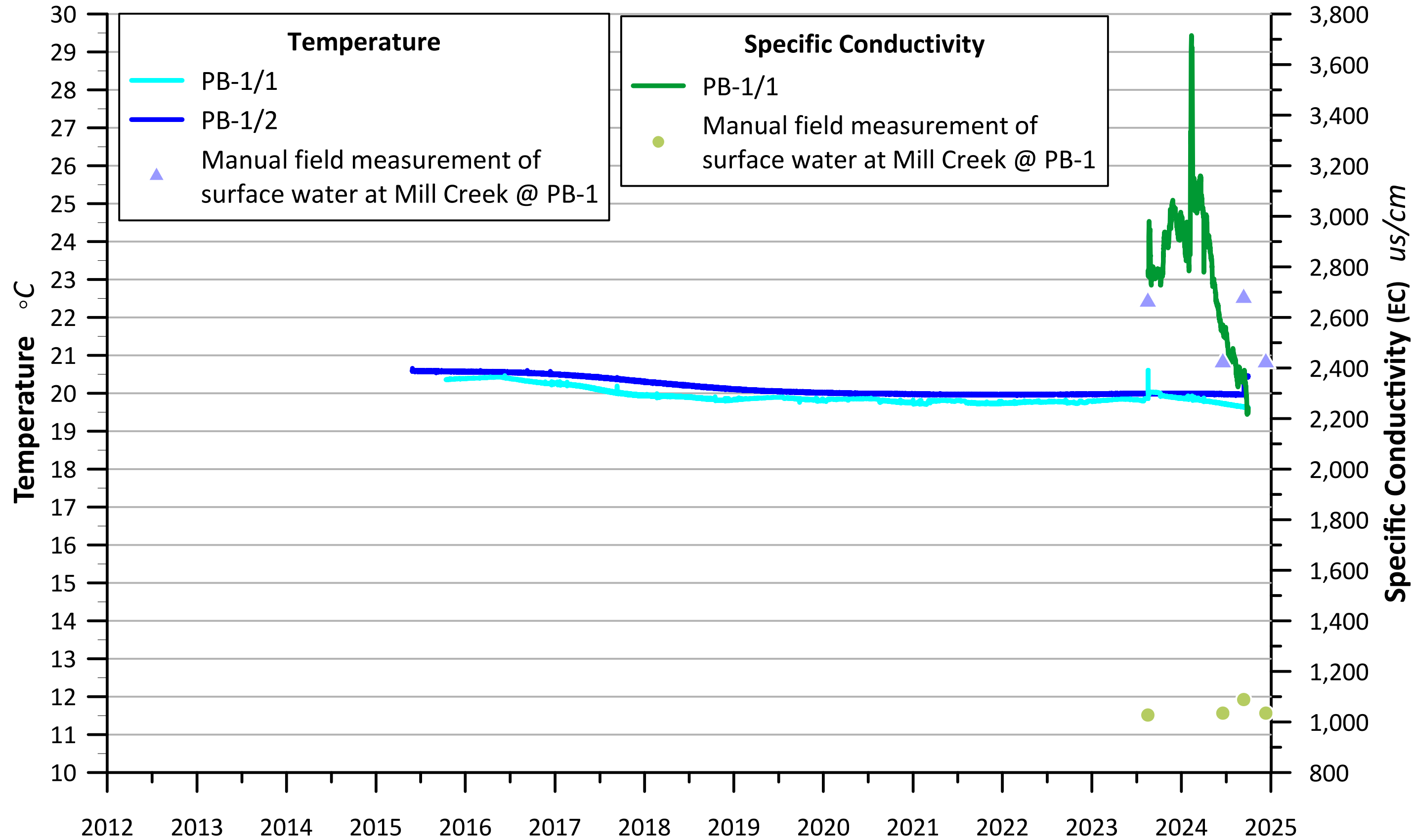
PB-6 Near Chino Creek

Figure 3-14d


Groundwater Elevation
Well (screen interval in ft-bgs)
PB-2 (42-62)
HCMP-5/1 (90-130)
Surface Water Discharge
USGS Gage -
Cucamonga Creek at Mira Loma
Thalweg Elevation near PB-2 and HCMP-5/1
Elevation ft-amsl
Daily Discharge cfs
580
570
560
550
540
530
520
510
500
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

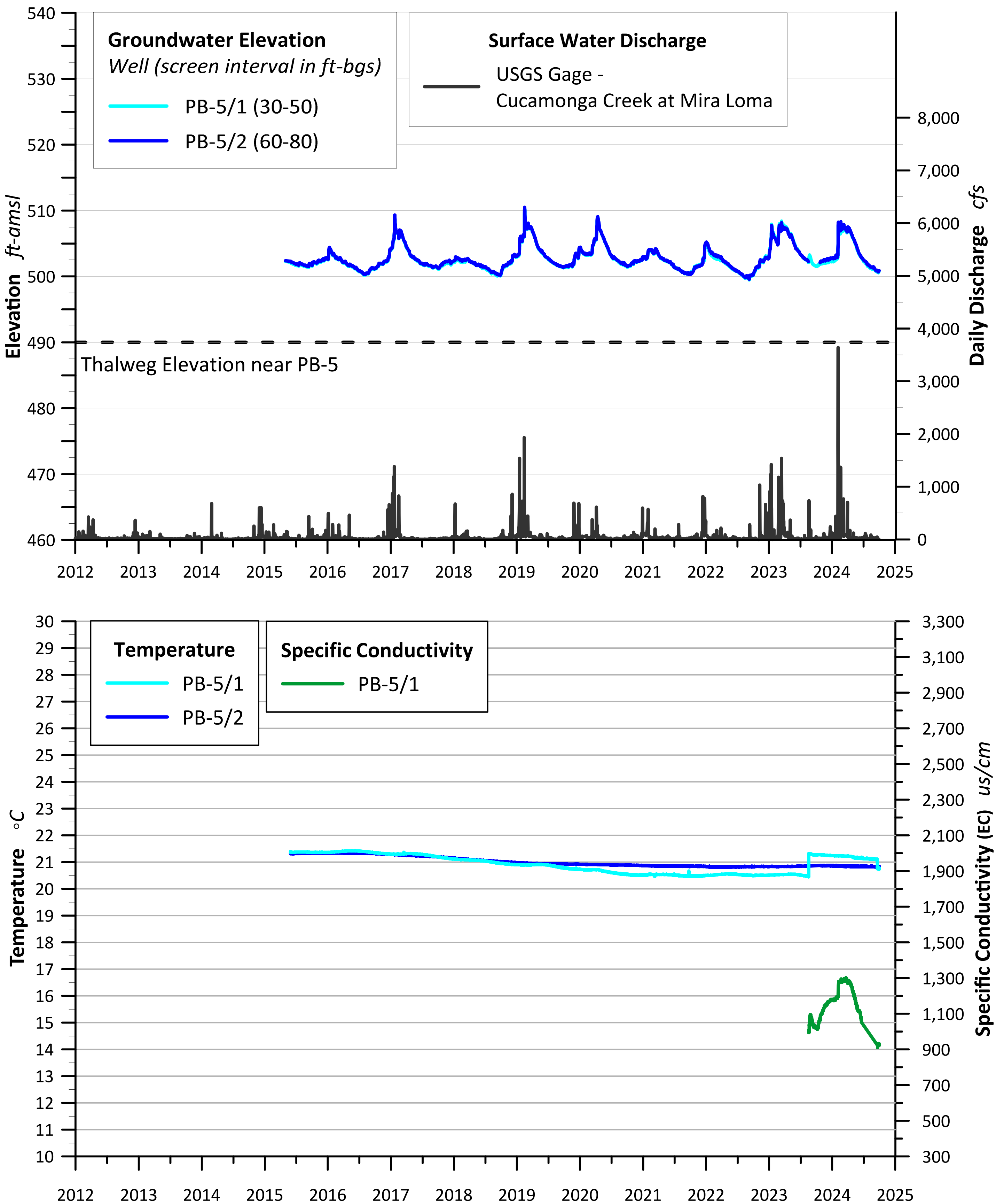

Temperature
PB-2
HCMP-5/1
Manual field measurement of surface water at Mill Creek @ Chino-Corona Rd
Specific Conductivity
PB-2
HCMP-5/1
Manual field measurement of surface water at Mill Creek @ Chino-Corona Rd
Temperature °C
Specific Conductivity (EC) us/cm
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
3,300
3,100
2,900
2,700
2,500
2,300
2,100
1,900
1,700
1,500
1,300
1,100
900
700
500
300
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025





Monitoring to Characterize Groundwater and Surface-Water Interactions
PB-1 Near Mill Creek

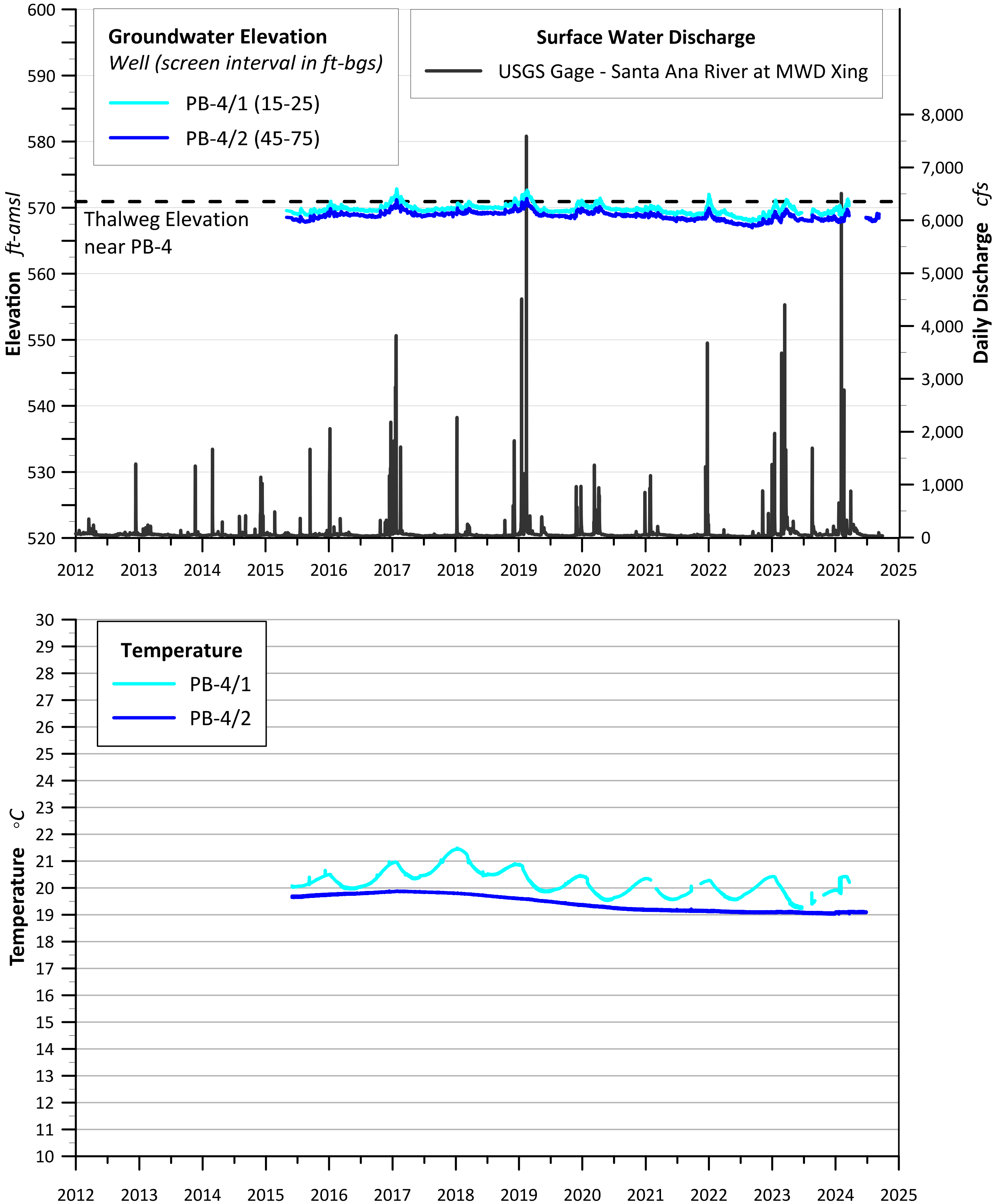
Figure 3-14f



Monitoring to Characterize Groundwater and Surface-Water Interactions

PB-5 Near Mill Creek

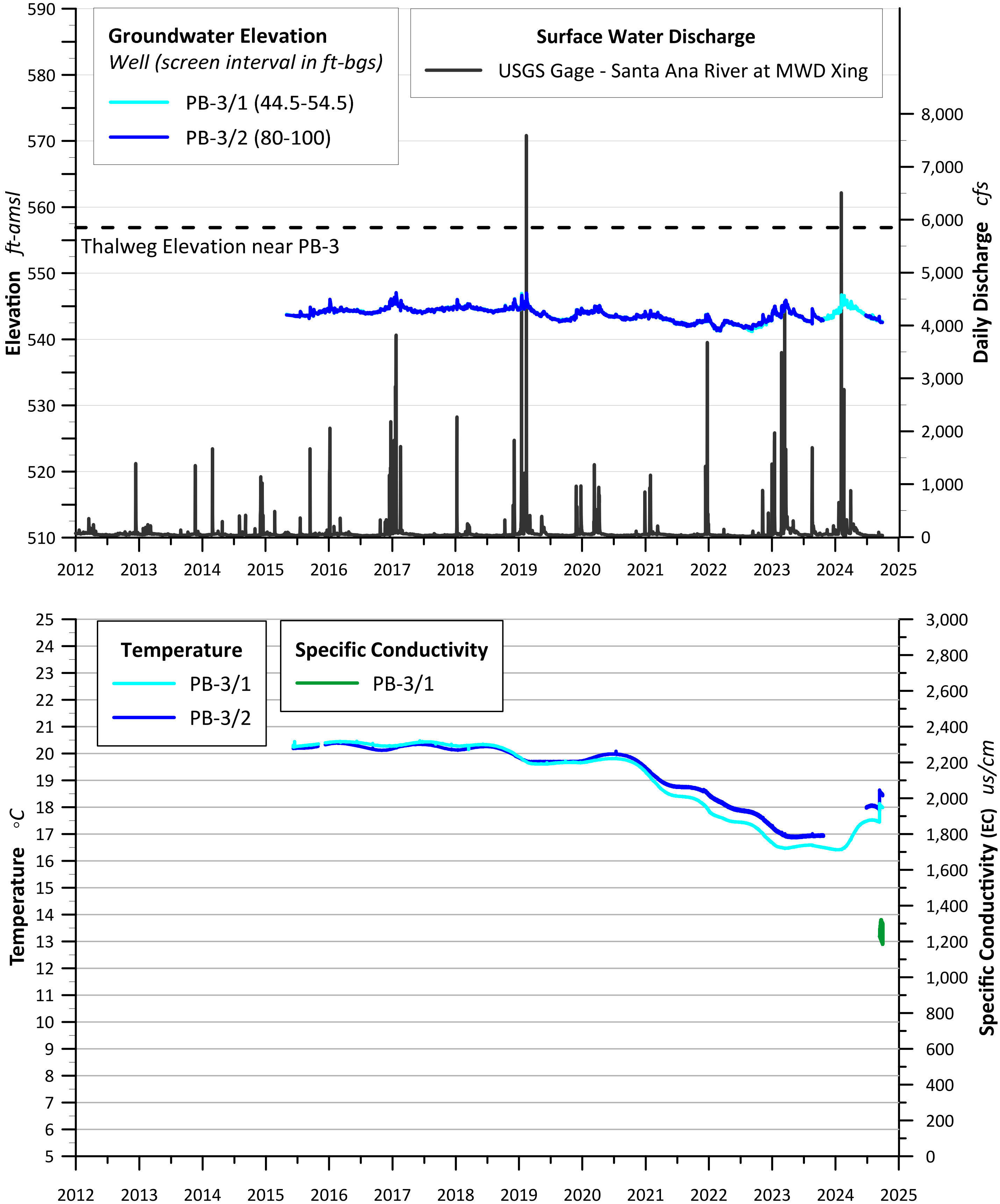
Figure 3-14g



Monitoring to Characterize Groundwater and Surface-Water Interactions

PB-4 Near Santa Ana River

Figure 3-14h



Monitoring to Characterize Groundwater and Surface-Water Interactions
PB-3 Near Santa Ana River

Figure 3-14i

Table 3-5. Analysis of Groundwater/Surface-Water Interactions in the Prado Basin

Location Figure No.	Overall Interpretation	Interpretation from the 2017 and 2018 Annual Reports	Lines of Evidence in Figures 3-14a through 3-14i			
			Groundwater Levels vs. Thalweg Elevations	Groundwater Levels vs. Surface Water Discharge	High-Frequency Temperature Data	High-Frequency EC Data
PB-9 @Chino Creek Figure 3-14a	**Rising Groundwater (Gaining Reach)**	Chino Creek at PB-9 appears to be an area of groundwater discharge with instances of streambed recharge when groundwater levels decline below the thalweg. The likely primary sources of shallow groundwater in this area are a perched aquifer, the shallow regional aquifer system, and local return flows from precipitation and applied water. There are some indications that streambed recharge contributes to shallow groundwater, especially during stormwater discharge events and when groundwater levels in the shallow regional aquifer system decline below the thalweg.	From 2015-2021 groundwater elevations at the deeper screened well PB-9/2 are higher than then the groundwater elevation of the shallow screened well (PB-9/1), indicating an upward hydraulic gradient. This reverses after 2021 when nearby pumping that impacts the PB-9/2 appears to stop. The groundwater elevations at both wells always remain above thalweg elevation, both of which indicate that this is an area of rising groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Chino Creek, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	Both monitoring wells exhibit a relatively constant time series of temperature data, indicating that the groundwater is likely being recharged by the regional groundwater	EC data is has been collected in the shallow well (PB-9/1) since mid-2023. The EC data will be evaluated at another time
PB-8 @ Chino Creek Figure 3-14b	**Rising Groundwater (Gaining Reach)**	Chino Creek at PB-8 appears to be an area of groundwater discharge. The likely primary sources of the shallow groundwater in this area are the shallow regional aquifer system and local return flows from precipitation and applied water. There are some indications that streambed recharge contributes to the shallow groundwater, especially during stormwater discharge events.	Groundwater elevations at the deeper screened well PB-8 are higher than then the groundwater elevation of the shallow screened well (RP2-MW3), indicating an upward hydraulic gradient, and the groundwater elevations at both wells always remain above thalweg elevation, both of which indicate that this is an area of rising groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Chino Creek, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	The shallow monitoring well (RP2-MW3) exhibits temperature data with gradual upward trend over time, indicating that the groundwater is likely being recharged by the regional groundwater. The deeper well (PB-8) exhibits a relatively constant time series of temperature data, also indicating that the groundwater is likely being recharged by the regional groundwater, but from a slightly different source.	The shallow monitoring well (RP2-MW3) exhibits EC data with gradual upward trend over time, indicating that the groundwater is likely being recharged by the regional groundwater. The deeper well (PB-8) exhibits a relatively constant EC of temperature data, also indicating that the groundwater is likely being recharged by the regional groundwater, but from a slightly different source.
PB-7 @ Chino Creek Figure 3-14c	**Rising Groundwater (Gaining Reach)**	Chino Creek at PB-7 appears to be an area of groundwater discharge. The likely primary source of the shallow groundwater in this area is the shallow regional aquifer system. However, the groundwater/surface-water interactions in this area appear to be complex with multiple and transient sources of water that are tributary to the PB-7 wells.	Groundwater elevations at the deeper screened well (PB-7/2) are slightly higher than then the groundwater elevation of the shallow screened well (PB-7/1), indicating an upward hydraulic gradient, and the groundwater elevations at both wells always remain above thalweg elevation—both of which indicate that this is an area of rising groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Chino Creek and the formation of a reservoir behind Prado Dam, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	The temperature data for the shallow well (PB-7/1) shows a seasonal sinusoidal pattern between 18 and 22 degrees C, which indicates that the shallow well is under the influence of surface water recharge. The temperature at the deeper well (PB-7/2) remains relatively constant, which indicates that it is not under the influence of surface water recharge.	The EC at the shallow well (PB-7/1) shows a seasonal sinusoidal pattern, like the temperature data, which indicates the shallow well is under the influence of surface water recharge.
PB-6 @ Chino Creek Figure 3-14d	**Rising Groundwater (Gaining Reach)**	Chino Creek at PB-6 appears to be an area of both groundwater discharge and streambed recharge. The likely sources of the shallow groundwater in this area are the shallow regional aquifer system and streambed recharge. However, the groundwater/surface-water interactions in this area appear to be complex with multiple and transient sources of water that are tributary to the PB-6 wells.	Groundwater elevations at the both PB-6 wells are the same. The groundwater elevations are typically above the thalweg elevation, indicating this is an area of rising groundwater. However, there some years there are brief periods during the late summer/early fall where they fall below the thalweg. This indicates that there are short periods where the surface water is likely recharging the shallow groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Chino Creek and the formation of a reservoir behind Prado Dam, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	Both monitoring wells exhibit a relatively constant time series of temperature data with a slow declining trend, indicating that the groundwater is likely being recharged by the regional groundwater	EC data is has been collected in the both wells since mid-2023. The EC data will be evaluated at another time
PB-2 @ Mill Creek Figure 3-14e	**Streambed Infiltration (Losing Reach)**	Mill Creek to the south of PB-2 appears to be an area of streambed recharge. However, the primary source of the shallow groundwater near PB-2 appears to be return flows from precipitation and applied water.	Groundwater elevations at the shallow screened well (PB-2) and deeper screened well (HCMP-5/1) are the same. From 2015 to 2021 the groundwater elevations at the wells are above the thalweg elevation, indicating this is an area of rising groundwater. After 2021, as groundwater levels declined the groundwater elevations are typically below the thalweg, indicating an area where the surface water is likely recharging the shallow groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Mill Creek, suggesting that stormwater discharge in Mill Creek is a source of recharge to shallow groundwater.	Both monitoring wells exhibit a relatively constant time series of temperature data, with slight decreasing trends, indicating that the groundwater is likely being recharged by the regional groundwater.	EC data is has been collected in the both wells since mid-2023. The EC data will be evaluated at another time
PB-1 @ Mill Creek Figure 3-14f	**Rising Groundwater (Gaining Reach)**	Mill Creek at PB-1 appears to be an area of groundwater discharge. The primary source of the shallow groundwater at PB-1 appears to be a complex mixture of the shallow regional aquifer system that is fed, in part, by streambed recharge in upstream areas of Mill Creek. The groundwater/surface-water interactions in this area appear to be complex with multiple sources of water that are tributary to the PB-1 wells.	Groundwater elevations at the deeper screened well (PB-1/2) are slightly higher than then the groundwater elevation of the shallow screened well (PB-1/1), indicating an upward hydraulic gradient, and the groundwater elevations at both wells always remain above thalweg elevation—both of which indicate that this is an area of rising groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Mill Creek, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	Both monitoring wells exhibit a relatively constant time series of temperature data with a slow declining trend, indicating that the groundwater is likely being recharged by the regional groundwater.	EC data is has been collected in the shallow well (PB-1/1) since mid-2023. The EC data will be evaluated at another time
PB-5 @ Mill Creek Figure 3-14g	**Rising Groundwater (Gaining Reach)**	Mill Creek at PB-5 appears to be an area of groundwater discharge. The likely source of shallow groundwater at PB-5 is a complex mixture of: (i) streambed recharge of effluent discharge in upstream areas of Mill Creek, the SAR, and the diversion channel that conveys WRCRWA effluent to the OCWD Wetlands, and (ii) rising groundwater discharge.	Groundwater elevations at the shallow screened well (PB-5/1) and deeper screened well (PB-5/2) are the same. The groundwater elevations at the wells are typically above the thalweg elevation, indicating this is an area of rising groundwater.	Water levels in both monitoring wells increase during and immediately after periods of stormwater discharge in Mill Creek, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	Both monitoring wells exhibit a relatively constant time series of temperature data with a slow declining trend, indicating that the groundwater is likely being recharged by the regional groundwater.	EC data is has been collected in the shallow well (PB-1/1) since mid-2023. The EC data will be evaluated at another time
PB-4 @ SAR Figure 3-14h	**Streambed Infiltration (Losing Reach)**	The SAR at PB-4 is primarily an area of streambed recharge. The primary source of shallow groundwater at PB-4 is streambed recharge of the SAR, and at times, there appears to be some influence of the shallow regional aquifer system and/or local return flows of precipitation and applied water.	Groundwater elevations at both PB-4 wells are below the thalweg elevation, which indicates that this is an area of streambed recharge during the period of record.	Water levels in both monitoring wells increase slightly during and immediately after periods of stormwater discharge in the SAR, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	The temperature data for the shallow well (PB-4/1) shows a seasonal sinusoidal pattern between 19 and 22 degrees C, which indicates that the shallow well is under the influence of surface water recharge. The temperature at the deeper well (PB-4/2) remains relatively constant with a slow declining trend, which indicates that it is not under the influence of surface water recharge, and groundwater is likely being recharged by the regional groundwater.	No EC data is being collected at both wells
PB-3 @ SAR Figure 3-14i	**Streambed Infiltration (Losing Reach)**	The SAR at PB-3 is an area of streambed recharge. The primary source of shallow groundwater at PB-3 is SAR streambed recharge.	Groundwater elevations at both PB-3 wells are below the thalweg elevation, indicating that this is an area of streambed recharge during the period of record.	Water levels in both monitoring wells increase slightly during and immediately after periods of stormwater discharge in the SAR, suggesting that stormwater discharge is a source of recharge to shallow groundwater.	The temperature data for both wells shows a seasonal sinusoidal pattern with a long term declining trend from 2021 to 2024, which indicates that the shallow well is under the influence of surface water recharge and some other changing condition after 2021.	EC data is has been collected in the shallow well (PB-3/1) since mid-2024. The EC data will be evaluated at another time

3.4 Climate and Its Relationship to the Riparian Habitat

Precipitation and temperature are climatic factors that can affect the extent and quality of riparian habitat. Precipitation can provide a source of water for consumptive use by the riparian vegetation via the direct infiltration of precipitation and runoff, which increases soil moisture that can be directly used by the vegetation, or by maintaining groundwater levels underlying the vegetation for its subsequent use. Temperatures affect the rate of plant growth and productivity. Both factors are unrelated to the implementation of the Peace II Agreement. This section characterizes the time series of precipitation and temperature in the Prado Basin area and compares that time series to trends in the quality of the riparian habitat, as indicated by NDVI, to help determine if these factors have influenced the riparian habitat in the Prado Basin.

3.4.1 Precipitation

Figure 3-15 is a time-series chart that shows annual precipitation estimates within the Chino Basin for WY 1896 to 2024. These estimates were computed as a spatial average across the Chino Basin using rasterized data from the PRISM Climatic Group (an 800-meter by 800-meter grid). The long-term average annual precipitation in the Chino Basin is 16.3 inches per year (in/yr). The chart includes a cumulative departure from mean (CDFM) precipitation curve, which characterizes the occurrence and magnitude of wet and dry periods: positive sloping segments (trending upward to the right) indicate wet periods, and negative sloping segments (trending downward to the right) indicate dry periods.

Review of the CDFM precipitation curve indicates that the Chino Basin experienced several prolonged wet and dry periods from WY 1896 to 2024. Typically, dry periods are longer in duration than wet periods. The longest dry period occurred between 1946 through 1977 (32 years). The current dry period is a 26-year period, starting in WY 1999, and includes the Peace/Peace II Agreement period (2001 through 2024). Over the 129-year record, about 40 percent of the years had precipitation greater than the average, and 60 percent had below average precipitation. In the 24-year period since the Peace Agreement was implemented, about 33 percent of the years had precipitation greater than the average, and 67 percent had below average precipitation. Precipitation in WY 2024 was 20.72 inches, which is:

- 4.39 inches above the long-term average
- about 26 percent less than the previous WY 2022 (28.12 inches)
- the fourth highest annual precipitation over the last 20 years
- In the 22nd percentile for wettest years over the 128-year record.

3.4.2 Temperature

Maximum and minimum temperatures during the growing season are the temperature metrics used in this analysis because plant growth and development are dependent upon the temperatures surrounding the plant (Hatfield and Prueger, 2015). Maximum temperatures during the growing season directly influence photosynthesis, evapotranspiration, and breaking of the dormancy of vegetation (Pettorelli, 2015). Minimum temperatures affect nighttime plant respiration rates and can potentially have an effect on plant growth that occurs during the day (Hatfiled et al., 2011). Hence, both temperature metrics can influence NDVI. All species of plants have a range of maximum and minimum temperatures necessary for growth (Hatfield and Prueger, 2015). Climate change is more likely to increase minimum temperatures while maximum temperatures are affected more by local conditions (Knowles et al., 2006; Alfaro et al., 2006).

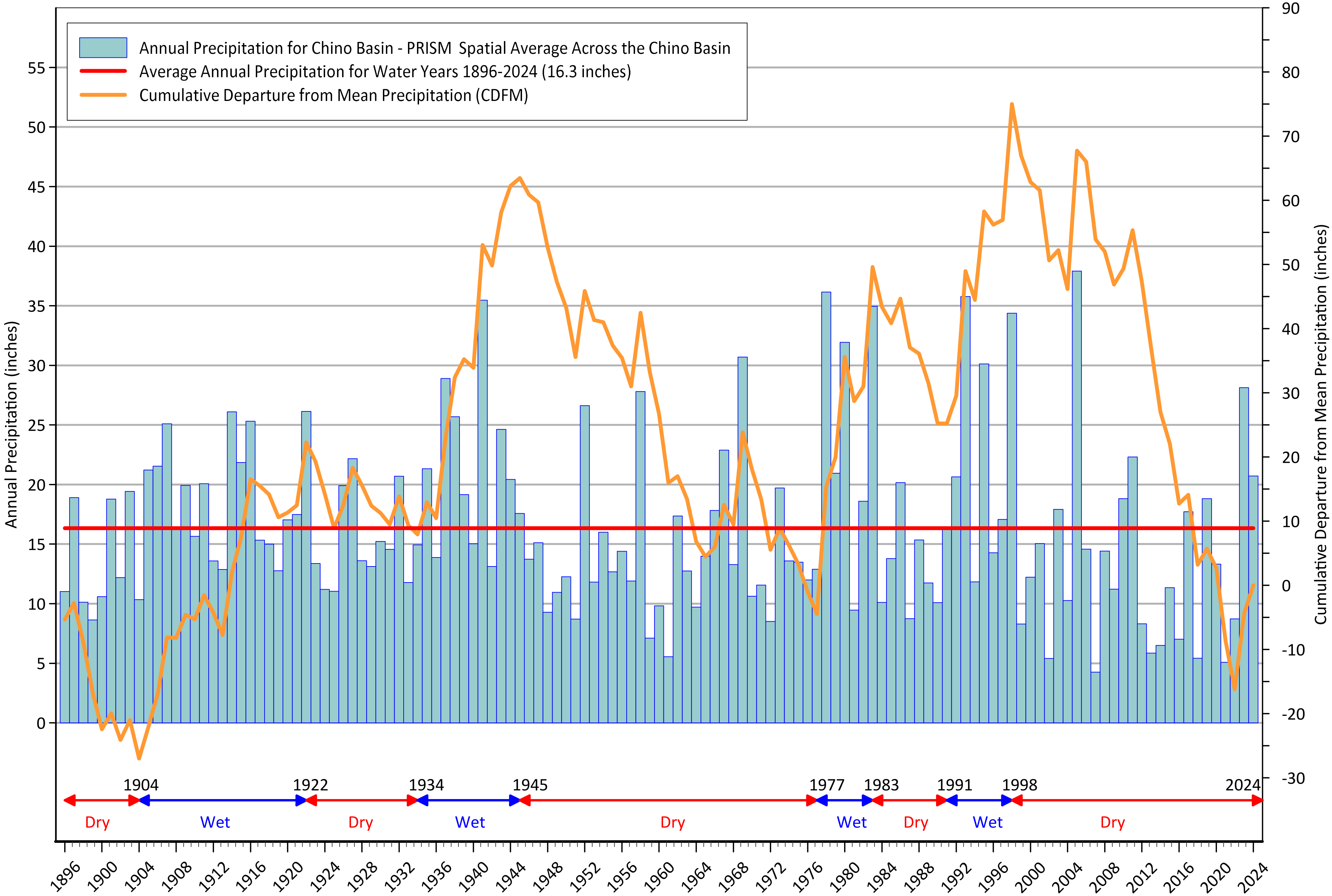
Figure 3-16 is a time-series chart that shows the average maximum and minimum Prado Basin temperatures for the growing-season months of March through October from 1896 to 2024 (growing-season maximum and minimum temperatures). These temperature estimates were computed as a spatial average across the Prado Basin using rasterized data from the PRISM Climatic Group (an 800-meter by 800-meter grid) of monthly maximum and minimum temperature estimates. This chart also shows the five-year moving average of the growing-season maximum and minimum temperatures for the Prado Basin. The five-year moving average is a smoothing technique used to reveal trends over time.

This chart also shows a complete record of atmospheric carbon dioxide (CO_2) concentrations assembled from multiple sources:

- Values prior to 1959 were estimated from an analysis of the Law Dome DE08 and DE08-2 ice cores in Antarctica. (Acquired from the Carbon Dioxide Information Analysis Center, http://cdiac.ornl.gov/trends/co2/lawdome.html. Accessed on June 6, 2017).
- Values after 1959 are from measured CO2 concentration data at the Mauna Loa Observatory in Hawaii. (Acquired from the National Oceanic and Atmospheric Association's Earth Systems Research Laboratory, https://www.esrl.noaa.gov/gmd/ ccgg/trends/full.html. Accessed on April 2, 2025.

The time history of atmospheric CO_2 concentrations shows a slight increasing trend from about 290 parts per million (ppm) in the late 1890s to about 310 ppm in 1950. After 1950, the CO_2 concentration shows an amplified consistent increasing trend and exceeds 400 ppm by 2015.

From 1896 to 2024, the growing-season maximum temperature fluctuates between 80 degrees Fahrenheit (°F) to 87°F and has a slight increasing trend. From 1896 to 2024, the growing-season minimum temperature fluctuates between 49°F to 59°F and has a prominent increasing trend starting in 1950 of about 5°F through 2024. This increasing trend in the growing-season minimum temperature beginning 1950 appears to correlate with the increase in atmospheric CO_2 concentrations. The five-year moving averages of both the growing-season minimum and maximum temperatures display a decreasing trend over the last six-year period since 2018 when it had the highest values over the entire period of record. In 2024, the growing-season minimum and maximum temperatures and the five-year moving averages all increased from the previous period. The average growing-season minimum temperature was 56°F and the average growing-season maximum temperature was 84°F.



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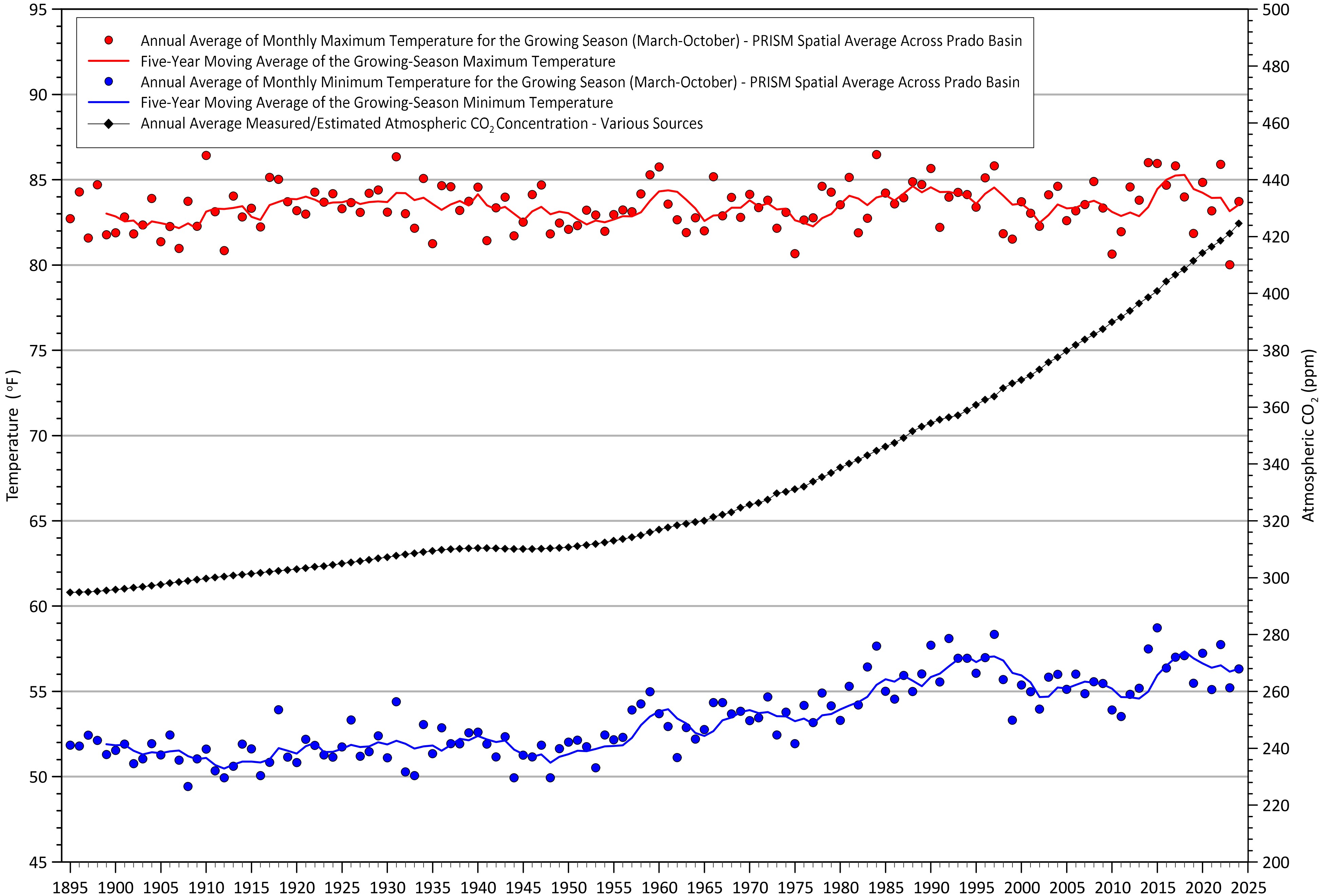
2024 Annual Report

Annual Precipitation in the Chino Basin
Water Year 1986 - 2024

Figure 3-15



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Maximum and Minimum Temperature in Prado Basin

1895-2024

Figure 3-16

3.4.3 Climate Compared to NDVI

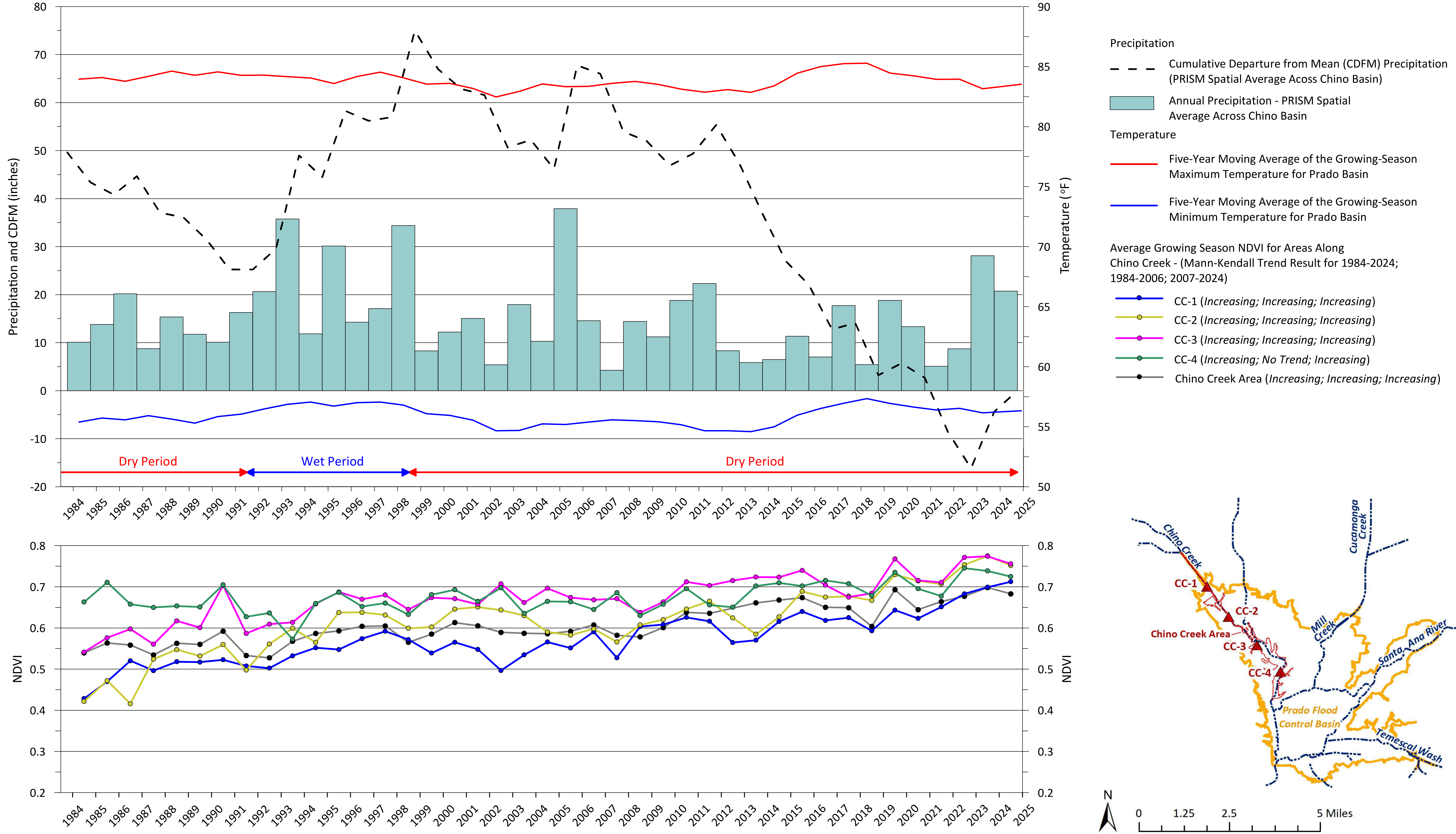
Figures 3-17a through 3-17c are time-series charts that compare long-term trends in precipitation and temperature to trends in the quality of the riparian vegetation, as indicated by NDVI, for three reaches in the Prado Basin: Chino Creek, Mill Creek, and the SAR. The period of analysis is 1984-2024—the period of NDVI availability. The upper chart on the figures displays the time series of annual precipitation in Chino Basin, the CDFM precipitation curve, and the five-year moving average for the growing-season maximum and minimum temperatures in the Prado Basin. The lower chart displays the time series of the Average Growing-Season NDVI for the defined areas discussed in Section 3.1 along Chino Creek, Mill Creek, and the SAR. For reference, the Mann-Kendall test results for trends in the Average Growing-Season NDVI for 1984-2024, 1984-2006, and 2007-2024 are shown in the legend.

The observations and interpretations below are focused on recent changes in Average Growing-Season NDVI during 2024 described in Section 3.1 and whether observed trends in temperature and precipitation may be contributing to recent increases in NDVI.

Chino Creek (Figure 3-17a). From 2023 to 2024, the Average Growing-Season NDVI for the whole Chino Creek area decreased slightly. Average Growing-Season NDVI increased for the northern-most area along Chino Creek (CC-1) and decreased for the other areas (CC-2, CC-3, and CC-4). For all these areas, the one-year change in NDVI was relatively minor and within the historical range of one-year NDVI variability (see Table 3-2). These recent changes in NDVI and vegetation occurred during a year in which precipitation was above average but less than the prior year. The slightly drier conditions compared to the record wet conditions in 2023 could be a contributing cause of the slight decreases in the NDVI along Chino Creek. Hence, the main observations and conclusions for the 2023 to 2024 period indicate above average wet conditions, with no significant changes in the riparian vegetation along Chino Creek.

Mill Creek (Figure 3-17b). From 2023 to 2024, the Average Growing-Season NDVI decreased across the entire Mill Creek area and Upper Mill Creek area. NDVI also decreased in five of the six small areas, with the exception of MC-3 where it remained unchanged. At all the areas, the one-year NDVI changes are within their historical ranges of the one-year NDVI variability (see Table 3-2), however the changes at MC-5 and MC-2 are greater than the average one-year change in NDVI observed over the historical period, and air photos confirm reduced vegetation. These recent changes in NDVI and vegetation occurred during a year in which precipitation was above average but less than the prior year. Hence, the main observations and conclusions for the 2023 to 2024 period indicate above-average wet conditions, with some notable changes in the riparian vegetation along Mill Creek.

Santa Ana River (Figure 3-17c). From 2023 to 2024, the Average Growing-Season NDVI decreased at two of the sites along the SAR (SAR-1 and SAR-2) and increased at two sites (SAR-3 and LP). For all these areas, the one-year NDVI changes were relatively minor and within the historical ranges of one-year NDVI variability (see Table 3-2). These recent changes in NDVI and vegetation occurred during a year in which precipitation was above average but less than the prior year. The slight increase in NDVI for the LP area is likely because the area was flooded during the early part of the growing season in 2023 and not in 2024. Hence, the main observations and conclusions for the 2023 to 2024 period indicate above average wet conditions, with no significant changes in the riparian vegetation along the SAR.



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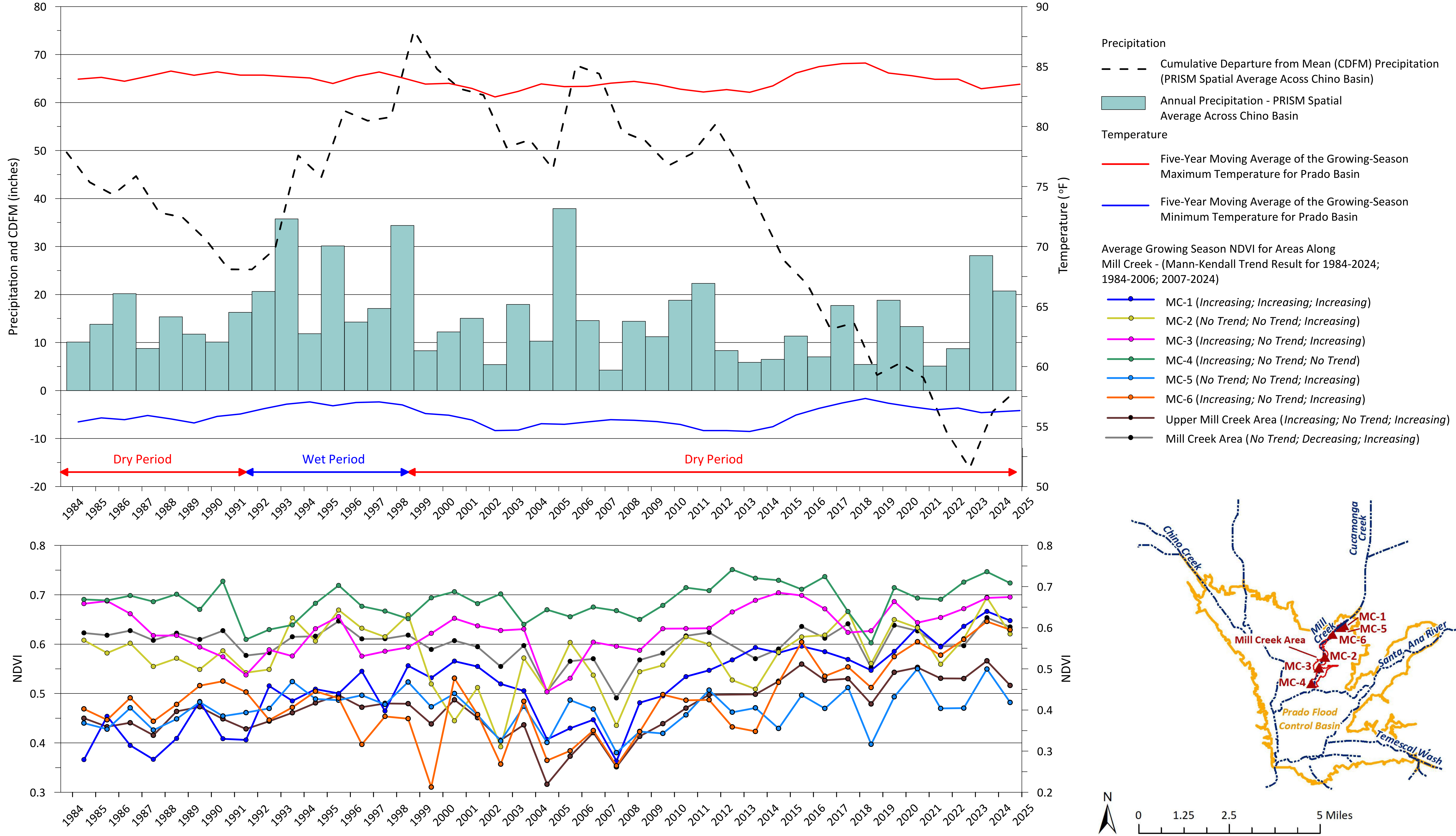
Climate verus NDVI
Chino Creek Area for 1984-2024

Figure 3-17a



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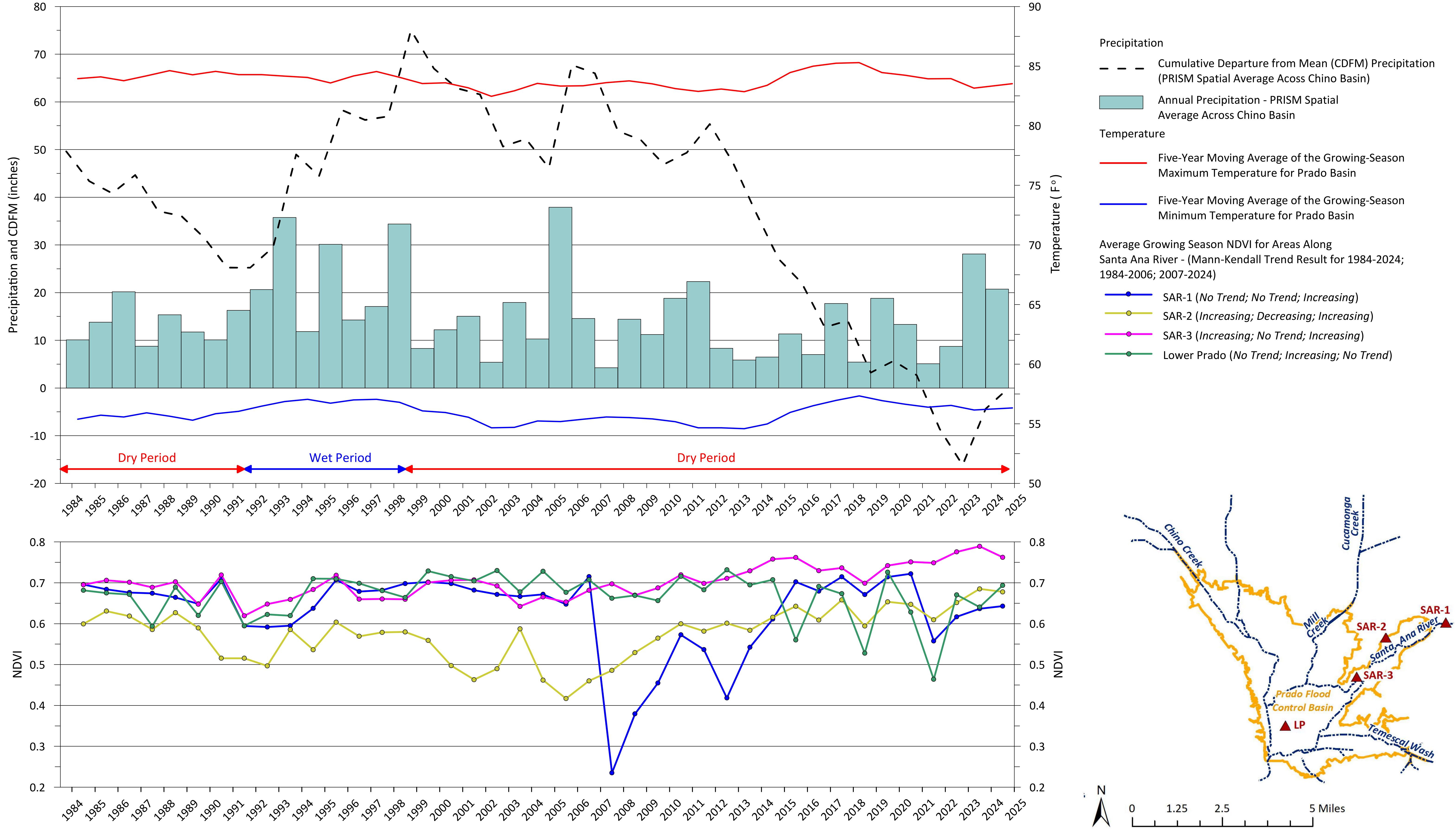
Climate verus NDVI
Mill Creek Area for 1984-2024

Figure 3-17b



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Climate verus NDVI
Santa Ana River and Lower Prado Area for 1984-2024

Figure 3-17c

3.5 Stream Discharge and Its Relationship to the Riparian Habitat

Stream discharge in the SAR and its tributaries that flow through the Prado Basin is a factor that can affect the extent and quality of Prado Basin riparian habitat. Stream discharge can recharge the groundwater system along losing stream reaches and supply water through the groundwater system to riparian vegetation. Stream discharge is also important to fauna living within the stream system. Flooding events and flood-control/water-conservation operations at Prado Dam can scour and inundate areas of the riparian habitat and potentially cause adverse impacts.

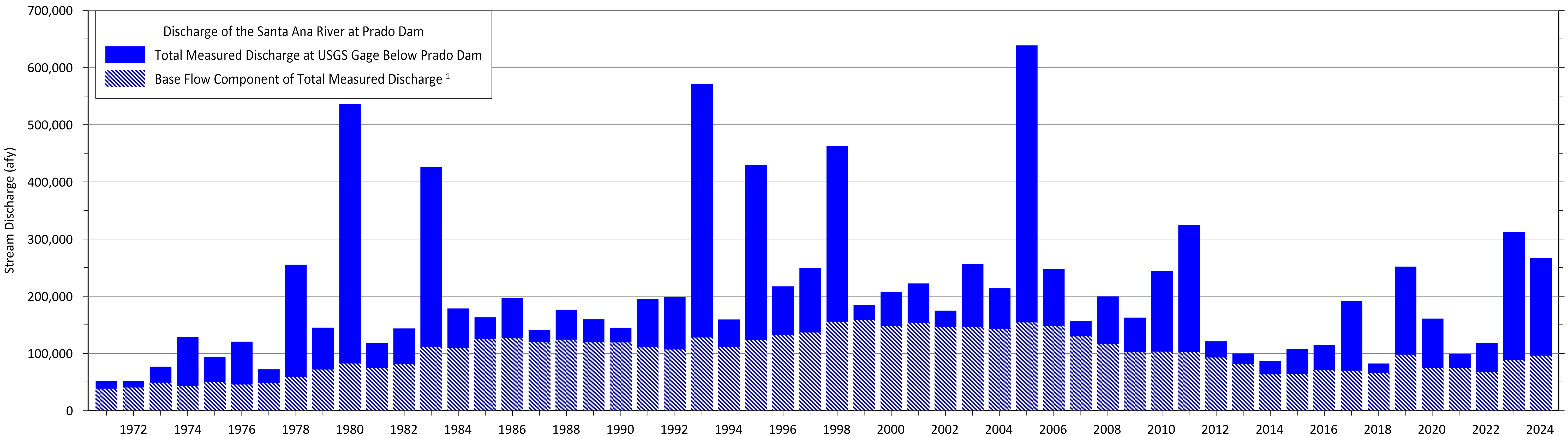
This section characterizes the time series of stream discharge within the Prado Basin and compares that time series to trends in the extent and quality of the riparian habitat, as indicated by NDVI, to help determine whether changes in stream discharge have influenced the riparian habitat in the Prado Basin.

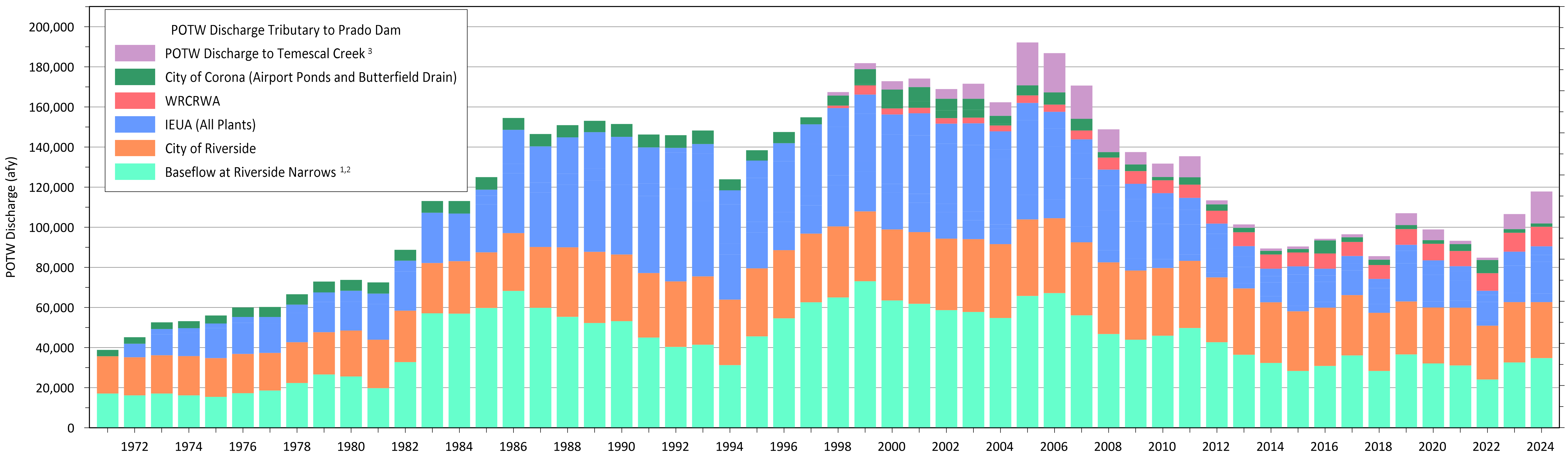
3.5.1 Stream Discharge

There are three primary components of stream discharge in the SAR and its tributaries: storm discharge, non-tributary discharge, and base-flow discharge. Storm discharge is rainfall runoff. Non-tributary discharge typically originates from outside the watershed, such as imported water discharged from the OC-59 turnout on San Antonio Creek. Base-flow discharge, as used herein and by the Santa Ana River Watermaster (SARWM), includes tertiary-treated wastewater discharge from POTWs, rising groundwater, and dry-weather runoff. Figure 3-18 includes time-series charts that summarize important annual discharges within the upper SAR watershed that are tributary to Prado Dam from water years 1971 to 2024 (SARWM, 2025). The upper chart on Figure 3-18 characterizes the annual outflow from the Prado Basin as total measured SAR discharge at USGS gage *SAR at below Prado Dam* and shows the base-flow component of the total measured discharge as estimated by the SARWM. This chart shows that base-flow discharge declined from about 154,000 afy in 2005 to an average of about 80,300 afy over the recent five-year period 2020-2024. The decline in base-flow discharge is primarily related to declines in POTW effluent discharges that are tributary to Prado Basin. In WY 2024, the total discharge at below Prado Dam decreased from the previous year while the total baseflow discharge increased:

- **Total Discharge at below Prado Dam in WY 2024**. Total discharge in WY 2024 was about 267,150 af, which is about 114,560 afy more than the average over the previous ten years (2014 to 2023), and a 45,120 afy decrease from WY 2023. It is the ninth highest total discharge over the entire time period of record from 1971 to 2024.
- **Base-Flow Discharge at below Prado Dam in WY 2024**. Base-flow discharge was about 96,000 afy, which is about 22,300 afy more than the average over the previous ten years (2014 to 2023), and about 6,900 afy more than WY 2023.

The lower chart on Figure 3-18 shows the combined POTW discharges that are tributary, at least in part, to Prado Dam. The POTW discharges are the primary component of the baseflow discharge. The POTW discharges declined from a high of about 192,200 afy in 2005 to an average of about 100,270 afy for the last five years (2020-2024). The reduction in POTW effluent discharge since 2005 can be attributed to several factors: the increased use of recycled-water, a decline in water use due to the economic recession that began in 2008, and the implementation of emergency water-conservation measures during the 2012 drought and thereafter. In WY 2024, POTW discharge was about 117,800 afy, which is about 23,140 afy more than the average POTW discharge over the previous ten years (2014-2023), and about 11,240 afy more than POTW discharge in WY 2023.





[1] Data are interpretations of the Santa Ana River Watermaster as published in thier Annual Reports.

[2] Baseflow at Riverside Narrows primarily includes POTW discharge from RIX and Rialto Plants; and can also include rising groundwater, dry weather flow

[3] Includes discharge from EVMWD, EMWD, and LLWD plants

Discharge Tributary to Prado Dam
Water Year 1960-2024

Figure 3-18

3.5.2 Stream Discharge Compared to NDVI

Figures 3-19a through 3-19c are time-series charts that compare long-term trends in stream discharge to trends in the quality of the riparian vegetation, as indicated by NDVI, for three reaches in Prado Basin: Chino Creek, Mill Creek, and the SAR. The period of analysis for these charts is 1984 to 2024, the period of NDVI availability. The upper chart on the figures displays the annual volumes of measured discharge to each stream during the growing season (March to October), including measurements at USGS gaging stations located upstream of the Prado Basin, and POTW discharges.[21] The lower chart displays the time series of the Average Growing-Season NDVI for defined areas, as discussed in Section 3.1, along Chino Creek, Mill Creek, and the SAR. For reference, the Mann-Kendall test results for trends in the Average Growing-Season NDVI for 1984 to 2024, 1984 to 2006, and 2007 to 2024 are shown in the legend.

The observations and interpretations below are focused on the recent (2024) changes in Average Growing-Season NDVI, as described in Section 3.1, and whether observed trends in surface-water discharge may be contributing to recent changes in NDVI.

Chino Creek (Figure 3-19a). Chino Creek is a concrete-lined, flood-control channel that transitions into an unlined stream channel at the Prado Basin boundary and flows south into the SAR behind Prado Dam (see Figure 2-3). The upper chart on Figure 3-19a shows discharge in Chino Creek during the growing season, including: measured discharge at USGS gage *Chino Creek at Schaefer* and the POTW discharges downstream of the USGS gage, including discharges from the IEUA Carbon Canyon, RP-2, RP-5, and RP-1 plants. Measured discharge at *Chino Creek at Schaefer*[22] includes storm-water and dry-weather runoff in the concrete-lined channel upstream of the IEUA discharge locations. Discharges not characterized in this figure are storm-water runoff, dry-weather runoff, and rising-groundwater discharge downstream of the *Chino Creek at Schaefer* gage. From 1984 to 2024, discharge in Chino Creek during the growing season progressively increased through 1999 and then decreased. The decreasing trend in growing-season discharge since about 1999 was caused by dry climatic conditions, water conservation in response to drought, and decreases in effluent discharge from the IEUA plants. During the previous ten-year period from 2014 to 2023, growing-season discharge in Chino Creek averaged about 8,200 afy. In 2024, growing-season discharge was about 8,900 afy, which is about 700 af more than the average growing-season discharge for the previous ten years (2014-2023) and about 4,300 af less than growing-season discharge in 2023, which was a notably wetter year.

From 2023 to 2024, the Average Growing-Season NDVI for the whole Chino Creek area decreased. Average Growing-Season NDVI increased for the northern-most area along Chino Creek (CC-1) and decreased slightly for the rest of the areas (CC-2, CC-3, and CC-4). For all these areas, the one-year changes in NDVI were relatively minor and within the historical ranges of one-year NDVI variability (see Table 3-2). These recent changes in NDVI occurred during a year of above average discharge. The main observations and conclusions for the 2024 period are that there were higher discharge conditions in Chino Creek and the riparian vegetation did not change significantly along Chino Creek.

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[21] These charts do not describe other hydrologic processes that affect surface-water discharge within the Prado Basin, including evaporation, evapotranspiration, the infiltration of water along unlined stream segments, and rising groundwater discharge.

[22] Historically until 2016 this also included imported water discharge from the OC-59 turnout.

Mill Creek (Figure 3-19b). Cucamonga Creek is a concrete-lined flood-control channel that transitions into an unlined stream channel at the Prado Basin boundary, where its name changes to Mill Creek (see Figure 2-3). The upper chart on Figure 3-19b shows discharge in Mill Creek during the growing season, including: POTW effluent discharge from the IEUA RP-1 plant to Cucamonga Creek, and measured discharge downstream at the USGS gage *Cucamonga Creek near Mira Loma* (less the RP-1 discharge). The measured discharge at *Cucamonga Creek near Mira Loma* (less the RP-1 discharge) is representative of storm-water and dry-weather runoff in Cucamonga Creek upstream of this gaging station. Discharges not characterized on this figure are storm-water runoff, dry-weather runoff, and rising-groundwater discharge downstream of the *Cucamonga Creek near Mira Loma* gage.

Also shown on the upper chart is the volume of flow during the growing season that is estimated to be in the upper portion of Mill Creek excluding the surface water diverted to the Mill Creek Wetlands. The Mill Creek Wetlands began diverting water from Mill Creek just north of where Mill Creek begins in 2016 (see inset map for location of Mill Creek Wetlands). Water from the Mill Creek Wetlands re-enters Mill Creek just downstream of the MC-6 area; hence the volume of water in the upper portion of Mill Creek near the MC-1, MC-5, and MC-6 areas is less than the total flow represented in the bar chart. Since 2016, water diverted to the Mill Creek Wetlands during the growing-season has ranged from 13 percent to 42 percent of the total flow. Therefore, the growing-season discharge in the northernmost region of Mill Creek near the MC-1, MC-5, and MC-6 areas is on average about 27 percent less than the discharge in Mill Creek south of the Mill Creek Wetlands.

From 1984 to 2024, growing-season discharge in Mill Creek progressively increased through 2004 and then decreased. The decreasing trend in growing-season discharge since about 2004 was caused by dry climatic conditions, water conservation in response to drought conditions after 2012, and the decrease in effluent discharge from the IEUA RP-1 plant. In 2024, growing-season discharge was about 19,050 afy, which is about 7,620 af more than the average growing-season discharge for the previous ten years (2014-2023) and about 12,720 af less than growing-season discharge in 2023, which was a notably wetter year. The above-average growing-season discharge is attributed to increased stormwater flow from above-average precipitation in WY 2024. In 2024 the growing-season discharge in the Upper portion of Mill Creek between the diversion and the outlet for the Mill Creek Wetlands was about 16,000 afy[23].

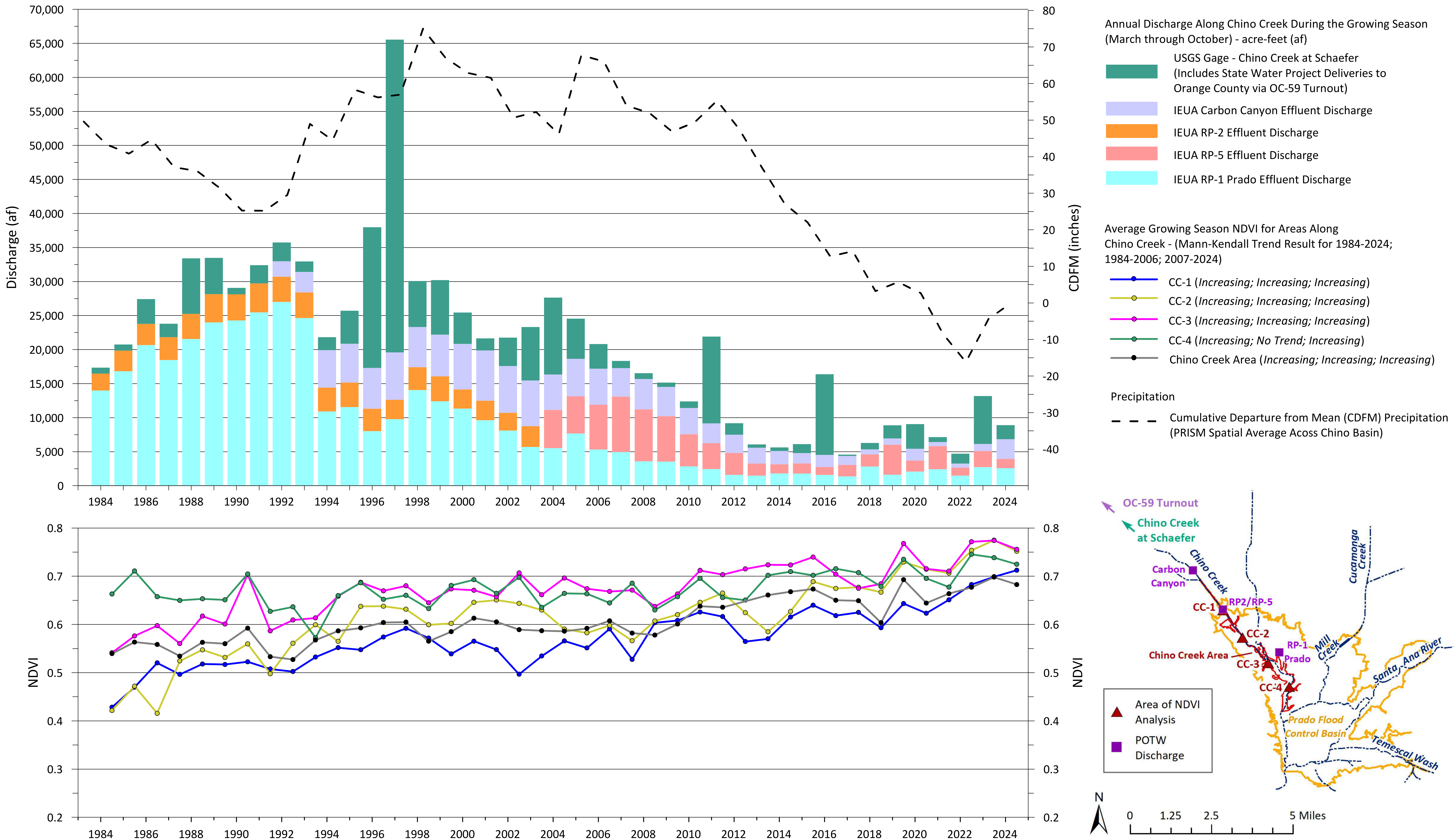
From 2023 to 2024, the Average Growing-Season NDVI decreased across the entire Mill Creek area and Upper Mill Creek area. NDVI also decreased in five of the six small areas, with the exception of MC-3 where it remained unchanged. At all the areas, the one-year NDVI changes are within their historical ranges of the one-year NDVI variability (see Table 3-2), however the changes at MC-5 and MC-2 are greater than the average one-year change in NDVI observed over the historical period, and air photos confirm reduced vegetation. These recent changes in NDVI occurred during a year of above-average discharge in Mill Creek. Hence, the main observations and conclusions for the 2024 period are that there were higher discharge conditions in Mill Creek and there were some notable changes in the riparian vegetation along Mill Creek.

[23] The City of Ontario measures the water diverted to the Mill Creek Wetlands every month using flow meters located at the two culverts where water is diverted. Due to equipment malfunction no monthly flow data was available from July 2023 to August 2024. During these months, flow was estimated as 28% (average historical percentage diverted during the growing season from 2016 to 2022) of the total monthly discharge measured at the USGS gage *Cucamonga Creek near Mira Loma*.

Santa Ana River (Figure 3-19c). The SAR is an unlined stream channel from the Riverside Narrows to Prado Dam—its entire reach across the Chino Basin (see Figure 2-3). The upper chart on Figure 3-19c shows the annual growing-season discharge at the USGS gage *SAR at MWD Crossing* (Riverside Narrows) and the annual growing-season discharges to the SAR downstream of the Riverside Narrows, including POTW effluent from the City of Riverside's Regional Water Quality Control Plant and the Western Riverside County Regional Wastewater Authority (WRCRWA) plant that is conveyed in an unlined channel (along with a portion of SAR discharge) to the OCWD Wetlands. The measured discharge at the *SAR at MWD Crossing* gage represents storm-water runoff and base-flow discharge in the SAR upstream of the gaging station at the Riverside Narrows. The base-flow discharge includes POTW discharge from the RIX and Rialto treatment plants, dry-weather runoff, and rising groundwater. Discharges not characterized on this figure are storm-water runoff, dry-weather runoff, and rising-groundwater discharge downstream of the *SAR at MWD Crossing* gage.

From 1984 to 2005, growing-season discharge in the SAR averaged about 81,940 afy with episodic increases in storm-water discharge during wet years. Since 2012, growing-season discharge in the SAR gradually declined and averaged about 46,500 afy from 2013 to 2022. The decreasing trend in growing-season discharge was caused by dry climatic conditions, water conservation in response to drought, and decreasing base flow at the Riverside Narrows. In 2023, an exceptionally wet year resulted in the growing-season discharge in the SAR being more than twice the average from 2013 to 2022. In 2024, the growing-season discharge in the SAR was about 59,180 af, which is about 7,820 af more than the average growing-season discharge for the previous ten years (2014-2023) and about 38,160 af less than the growing season discharge in 2023, which was a notably wetter year.

From 2023 to 2024, the Average Growing-Season NDVI decreased at two of the sites (SAR-2 and SAR-3) and increased at two of the sites (SAR-1 and LP). For all these areas, the one-year NDVI changes were relatively minor and within the historical ranges of one-year NDVI variability (see Table 3-2). These recent changes occurred during a year of above-average discharge conditions in the SAR. Hence, the main observations and conclusions for the 2024 period are that there were higher discharge conditions in the SAR and the riparian vegetation did not change significantly along the SAR.



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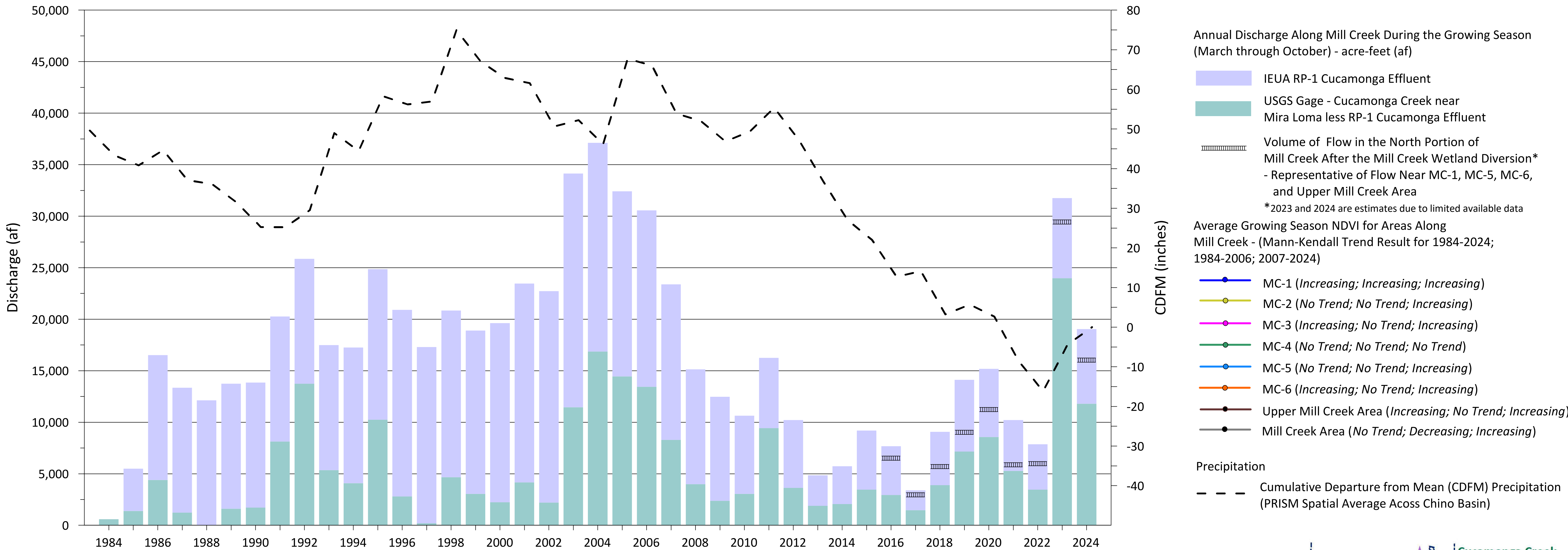
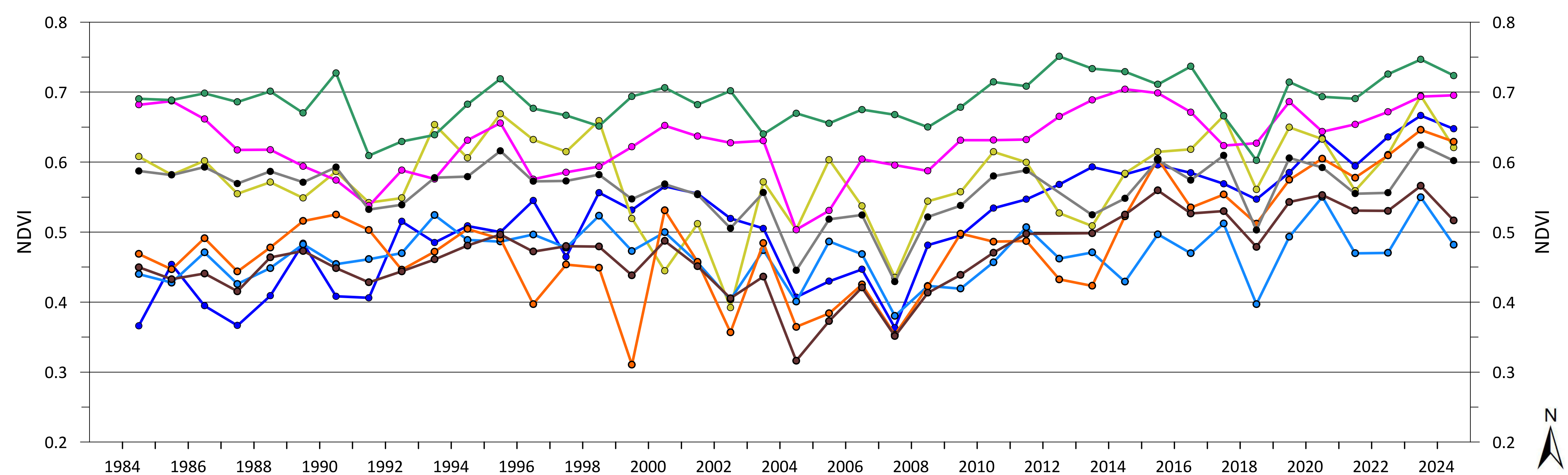
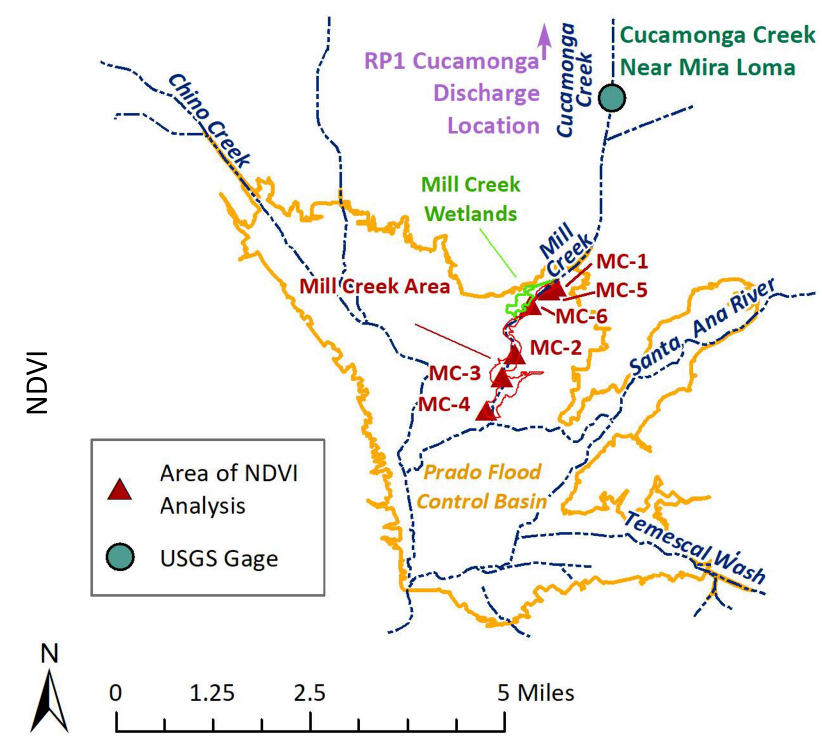
Surface-Water Discharge versus NDVI
Chino Creek Area for 1984-2024

Figure 3-19a







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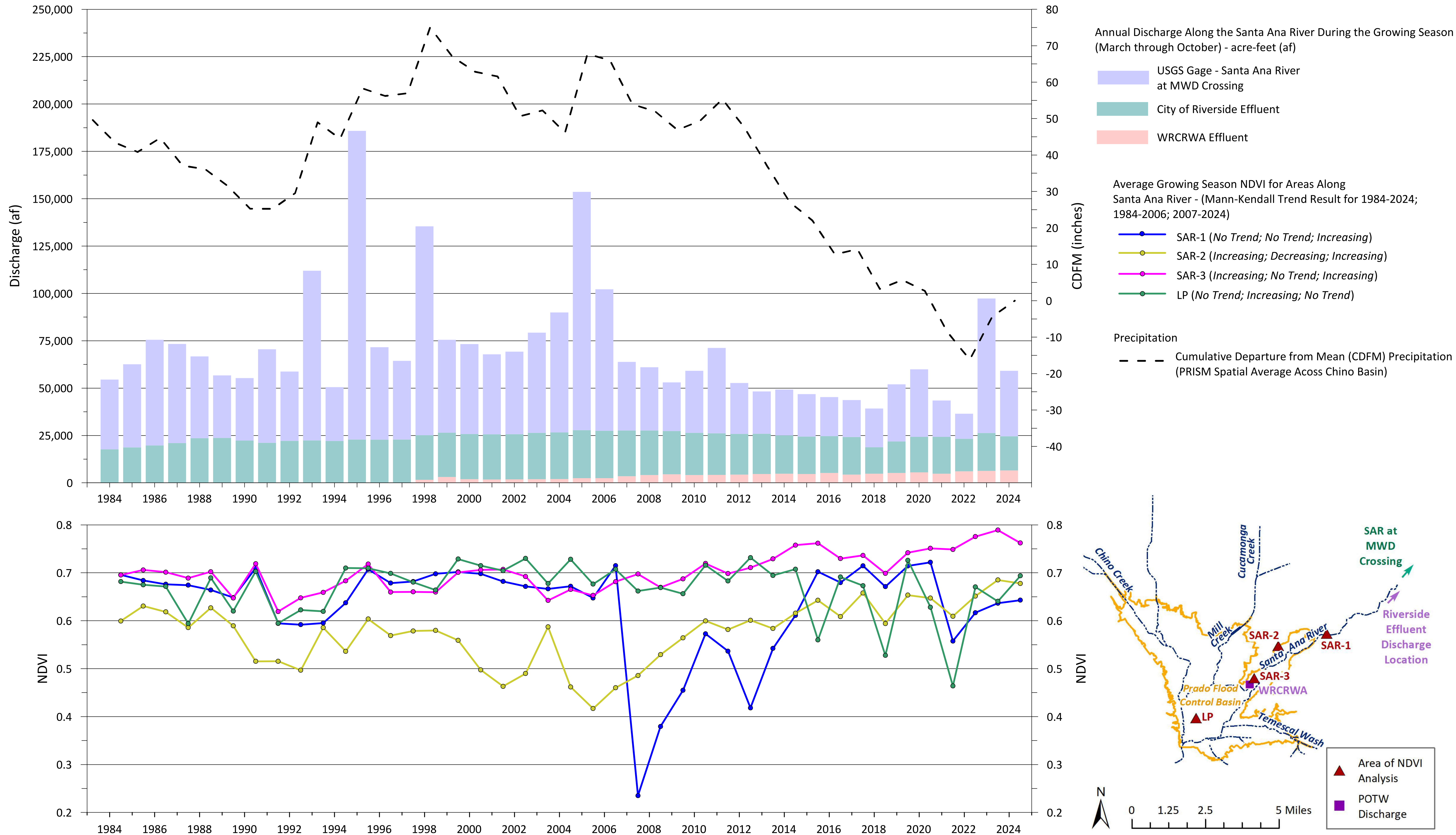
Surface-Water Discharge versus NDVI
Mill Creek Area for 1984-2024

Figure 3-19b



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Surface-Water Discharge versus NDVI
Santa Ana River and LP Area for 1984-2024

Figure 3-19c

3.6 Other Factors and Their Relationships to Riparian Habitat

Other factors that can affect the extent and quality of riparian habitat in the Prado Basin analyzed in this Annual Report include wildfire, Arundo management, pests, and development/construction. These factors are unrelated to Peace II Agreement implementation.

This section characterizes what is known about these factors and compares them to trends in the extent and quality of the riparian habitat to determine their impacts, as characterized by the NDVI.

3.6.1 Wildfire

Available wildfire perimeter data from the FRAP database[24] were compiled within the Prado Basin extent for the period of 1950-2023.[25] The FRAP database shows that wildfires occurred in the Prado Basin in 1985, 1989, 2007, 2015, 2018, and 2020. Figure 3-20a shows the spatial extent of these wildfires, mapped over the 2024 air photo. The most recent wildfire was in December 2020 along the southern portion of the Prado Basin.

Figure 3-20b shows the spatial extent of the most recent wildfires in 2015, 2018, and 2020, overlying a side-by-side of the change map of NDVI from 2023 to 2024 and the 2024 air photo for the majority of Prado Basin area. The locations of the wildfires in 2015 and 2020 align with several of the notable patches of NDVI decreases shown on the NDVI change map, and areas of less vegetated land cover along the Santa Ana River in the air photo. The NDVI decreases are likely not caused from these historic fires since there has been observed vegetation regrowth since these fires as documented in previous Annual Reports (WEI, 2020; West Yost, 2022).

Figures 3-21a through 3-21c are time-series charts that explore the relationship between other factors that can impact riparian vegetation and NDVI for three reaches in the Prado Basin: Chino Creek, Mill Creek, and the SAR. The figures show the Average Growing-Season NDVI for 16 defined areas of riparian habitat discussed in Section 3.1 and shown in Figures 3-6, 3-7a, 3-7b, and 3-8a through 3-8n. Wildfire occurrences, annotated by year, are shown on the charts if their extent intersects with the extent of the defined area of NDVI analysis. Previous Annual Reports have described that the NDVI time series for the entire riparian vegetation extent (Figure 3-5) and other impacted defined areas indicated NDVI declines after the 2015, 2018, and 2020 fires, followed by increases in some of these areas as the vegetation started to regrow (WEI, 2019; 2020; West Yost, 2021; 2022).

3.6.2 Arundo Removal

The OCWD and SAWA[26] are the main entities that implement habitat restoration programs, including the removal and management of Arundo in the SAR watershed for the promotion of native habitat for endangered or threatened species. The OCWD and SAWA sometimes work collaboratively with each other on these programs and with other stakeholders in the watershed, such as the Santa Ana Watershed Project

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[24] Link (Website for California Department of Forestry and Fire Protection's Fire and Resource Assessment Program).

[25] Data is updated in late April for the previous year; 2024 data were not available for this annual report.

[26] SAWA is a non-profit agency with a five-member board, consisting of one member from the OCWD and the remaining from four resource conservation districts (RCDs) in the watershed, including the Riverside-Corona RCD, Temecula-Elsinore-Anza RCD, San Jacinto RCD, and Inland Empire RCD.

Authority (SAWPA), the USFWS, California Department of Fish and Wildlife (CDFW), and the ACOE. There are many ongoing programs throughout the Prado Basin for the management and maintenance of riparian habitat that include the management of Arundo. SAWA publishes an annual report on the status of all habitat restoration projects they are involved with in the watershed (SAWA, 2020).

Figures 3-22a and 3-22b show the locations of known areas where habitat restoration activities have occurred recently in the Prado Basin. These locations and activities may not be inclusive of all current activities in the Prado Basin, but are the known locations identified and the information collected for the PBHSP:

- Various locations where SAWA has led the removal and management of Arundo growth along the SAR between 2016 and 2022 (areas outlined in cyan, purple, navy, coral, and yellow).
- 400 acres where the OCWD has been controlling the regrowth of Arundo within the perimeter of the 2015 wildfire (area outlined in dark red).
- 287-acres where the ACOE has historically removed and managed Arundo growth, including a 26.5-acre area where ACOE removed Arundo between May 2022 and June 2023 (area outlined in green).
- 255 acres where SAWA has been controlling the regrowth of Arundo from 2023 to 2024 (area outlined in light blue).

Figure 3-22b shows the locations of these known areas where habitat restoration activities have occurred, overlying a side-by-side of the change map of NDVI from 2023 to 2024, and the 2024 air photo. With a few exceptions, the locations of these habitat restoration activities generally do not align with areas of notable NDVI decreases or increases in the change map, or areas of brown land cover in the air photo. In the areas where SAWA and OCWD have been controlling the regrowth of Arundo since 2015, as well as in the 287-acre area managed by the ACOE, the decreases in NDVI may be in part related to these habitat restoration activities. And in the areas in the northern reach of the SAR, the increases in NDVI could be from re-growth of native vegetation.

3.6.3 Polyphagous Shot Hole Borer

PSHB, from the group known as ambrosia beetles, is a relatively new pest in Southern California. PSHB burrows into trees and introduces fungi that assists in establishing colonies. Infection caused by the fungi can cause a dark stain surrounding the entry holes, discolored bark, leaf discoloration and wilting, and die-off of entire branches or trees.

In spring 2016, OCWD biologists observed die-off of riparian trees in patches throughout the Prado Basin, especially arroyo and black willows, and confirmed that the cause was from PSHB (ACOE and OCWD, 2017; OCWD 2020). Although PSHB arrived prior to 2016, this was the first notable die off in the Prado Basin. Since 2016, OCWD biologists have noted that the presence of PSHB began widespread throughout the Prado Basin and reduced tree canopy cover, but tree mortality remained confined to small local patches (Zembal, R., personal communication, 2018). OCWD biologists observed that the affected trees that had not died were showing signs of severe infestation, exhibiting branch failure, significant staining, and crown sprouting after the upper branches had died back. (ACOE and OCWD, 2017). In infected trees, crown sprouting allows some of the trees to persist, but the PSHB have been observed to attack the recently emerged limbs once they grow to two to three inches in diameter, causing the sprouting to be temporary. The die back and crown sprouting has resulted in a reduction of canopy in many areas (OCWD, 2020). Canopy loss in heavily infested areas may allow faster-growing invasive non-native species to colonize and out-compete native trees and shrubs in the understory (OCWD, 2020).

In 2016 and 2017, OCWD biologists in the Prado Basin worked with the University of California, Riverside, the USFWS, and SAWA to actively monitor the occurrence and impact of PSHB within Prado Basin riparian habitat. These agencies conducted studies on how to potentially protect certain areas of the Prado Basin from PSHB using attractants and deterrents; however, there were too many trees to effectively protect the entire forest (Zembal, R., personal communication, 2018). Traps were placed throughout the lower portion of Prado Basin and along the SAR by the OCWD and SAWA. The total number of PSHB beetles trapped at each location between August 2016 and April 2017 ranged from seven to 2,092.

Figure 3-22a shows the locations where the presence of PSHB has been documented within the Prado Basin from 2016 to 2022 by: PSHB traps deployed by the OCWD and SAWA between August 2016 and April 2017; and the USBR vegetation surveys performed in 2016, 2019, and 2022.

Table 3-3 summarizes the presence of the PSHB during the 2016, 2019, and 2022 USBR vegetation surveys at all the sites surveyed. During the 2016 USBR vegetation surveys, the presence of the PSHB was identified at 30 of the 37 survey sites. At these sites, all the trees identified with the presence of PSHB were noted as "stressed," except one which was noted as "dead." The 2016 USBR surveys were the first site-specific surveys that documented the presence and abundance of PSHB for the PBHSP. During the 2019 USBR vegetation surveys, the presence of the PSHB was identified at only seven of the 30 sites that were originally identified with PSHB presence in 2016 and were only at sites along Chino and Mill Creeks. The reduced presence of the PSHB from 2016 to 2019 correlated to less stressed trees at each of the survey sites; however, the PSHB had an adverse impact from 2016 to 2019, as evidenced by the increased percentage of dead trees and some reductions in percent canopy cover at the survey sites (see Table 3-3).

During the 2022 USBR vegetation surveys, the presence of the PSHB was identified 11 of the 30 sites that were identified with PSHB presence in 2016 and/or 2019. The presence of the PSHB does not correlate to a trend in the increase of stressed or dead tress at the affected sites from 2019 to 2022.

Figures 3-21a through 3-21c are time-series charts that explore the relationship between PSHB occurrence and NDVI for three reaches in Prado Basin: Chino Creek, Mill Creek, and the SAR. These figures show the Average Growing-Season NDVI for the defined areas of riparian habitat discussed in Section 3.1 and shown in Figures 3-6, 3-7a, 3-7 b, and 3-8a through 3-8n. For each defined area, the percentage of infected trees within each survey site that is within the area are plotted on the charts. At all the sites within the small areas where the PSHB was first noted in 2016, the percentage of trees impacted decreased or stayed the same from 2016 to 2019 (many to zero percent). With few exceptions, at most of the sites within the small areas the percentage of trees impacted remained stable or decreased from 2019 to 2022 (many to zero percent). These exceptions are site X7 at CC-3 along Chino Creek where the percentage increased from 0 to 33 and site X10 at MC-1 along Mill Creek where the percentage increased from 0 to 18; however, the NDVI at both areas is showing an increasing trend from 2019 to 2022, indicating that the presence of the PSHB in 2022 is likely not causing a notable negative impact in these areas.

3.6.4 Miscellaneous Factors

Figure 3-3 highlights notable patches of NDVI increases and decreases from 2023 to 2024. These changes have not been correlated with the factors known to impact vegetation described in this Annual Report, including groundwater levels. The notable patches of NDVI changes are primarily along the SAR in the lower Prado Basin and behind the Prado Dam along Chino Creek. These are areas in the lower portion of Prado Basin where changes in the riparian vegetation are unlikely to be influenced by the implementation of the Peace II Agreement. These are vegetated areas in the Prado Basin that are dominated by perennial growth that respond to variations in precipitation over wet and dry years. As described in Section 3.4, although WY 2024 was an above-average wet year, it was not as wet as WY 2023. The lower precipitation in WY 2024 impacted the amount of perennial growth compared to WY 2023, which results in decreases in NDVI in these patches along the SAR and behind Prado Dam. Additionally, the 2023 and 2024 air photos in Figure 3-1a show changes in the green vegetation cover in these areas.

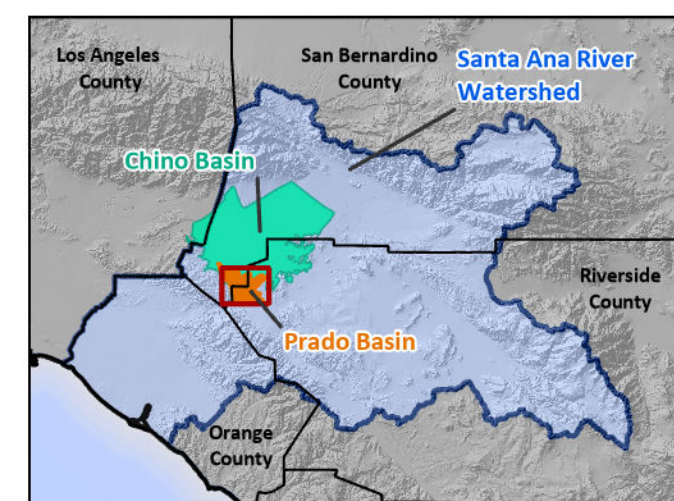
In addition to changes in the perennial plant growth affecting the NDVI of the riparian vegetation there are other factors related to the significant wet year in WY 2023 that also impacted the change in NDVI from 2023 to 2024:

- Some of the notable patches of NDVI decreases along the SAR and Chino Creek are due to scouring along edges of the creeks and river during the significant increases in surface water discharge in WY 2023. This impact was described in the 2023 Annual Report. Observation of the 2024 air photo shows these areas as bare light brown land.
- The notable NDVI increases behind Prado Dam and in the middle portion of Chino Creek are due to the extended period of seasonal inundation during water conservation efforts. The significant wet year in WY 2023 resulted in a prolonged conservation pool behind Prado Dam, disrupting the growth of perennial grasses and shrubs in these areas. Comparison of the 2023 and 2024 air photos reveals these areas as bare, gray/brown land in 2023, replaced by bright green land cover of perennial grasses and shrubs in 2024.

Extent of Wildfire Occurrences in Prado Basin (1985-2023)

1985	2015
1989	2018
2007	2020

Small Defined Area Analyzed for NDVI Time Series
1 NDVI pixel (30 x 30-meters)



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0 0.5 1 Miles

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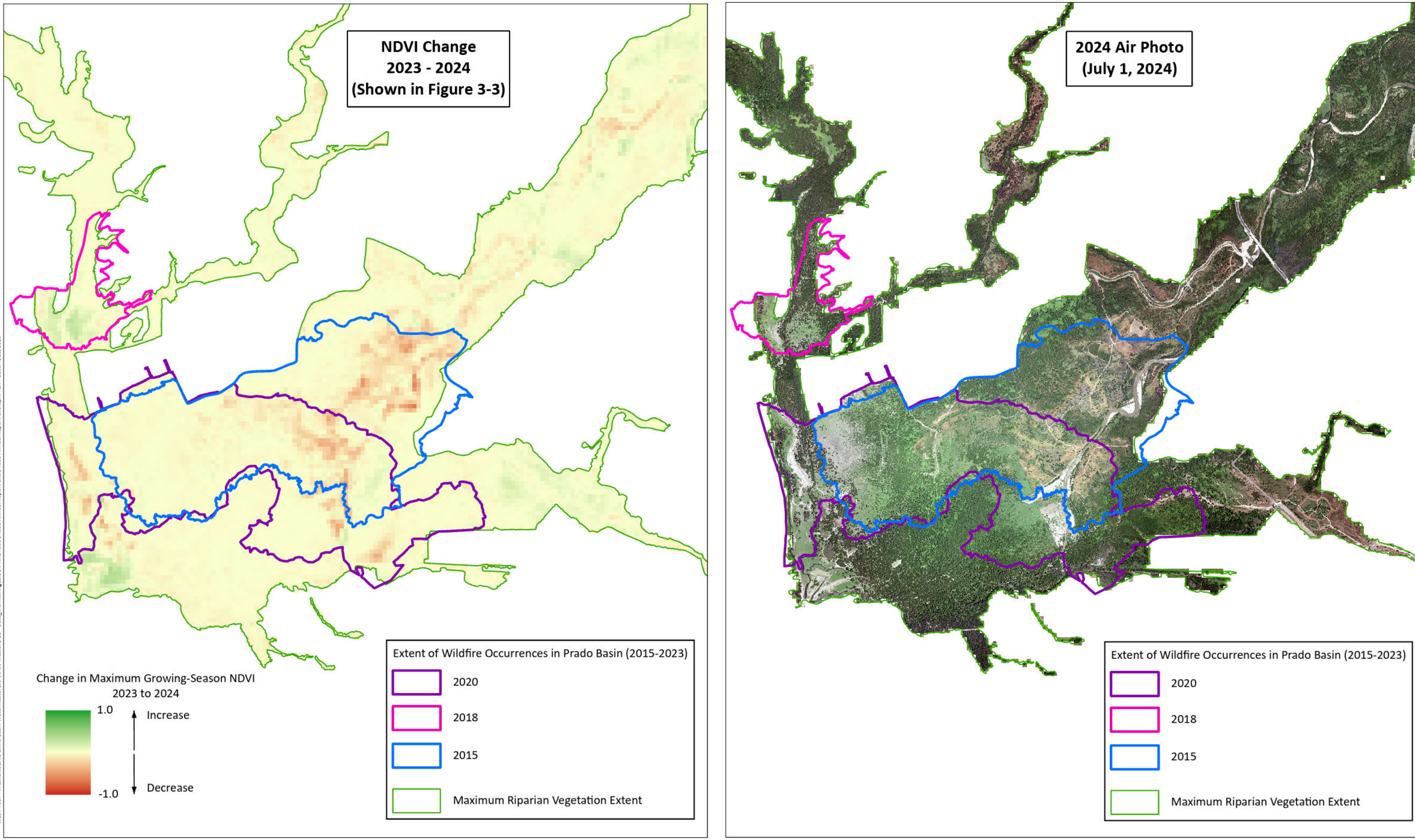
Location Map of Other Factors That Can Affect Riparian Habitat
Wildfire

Figure 3-20a



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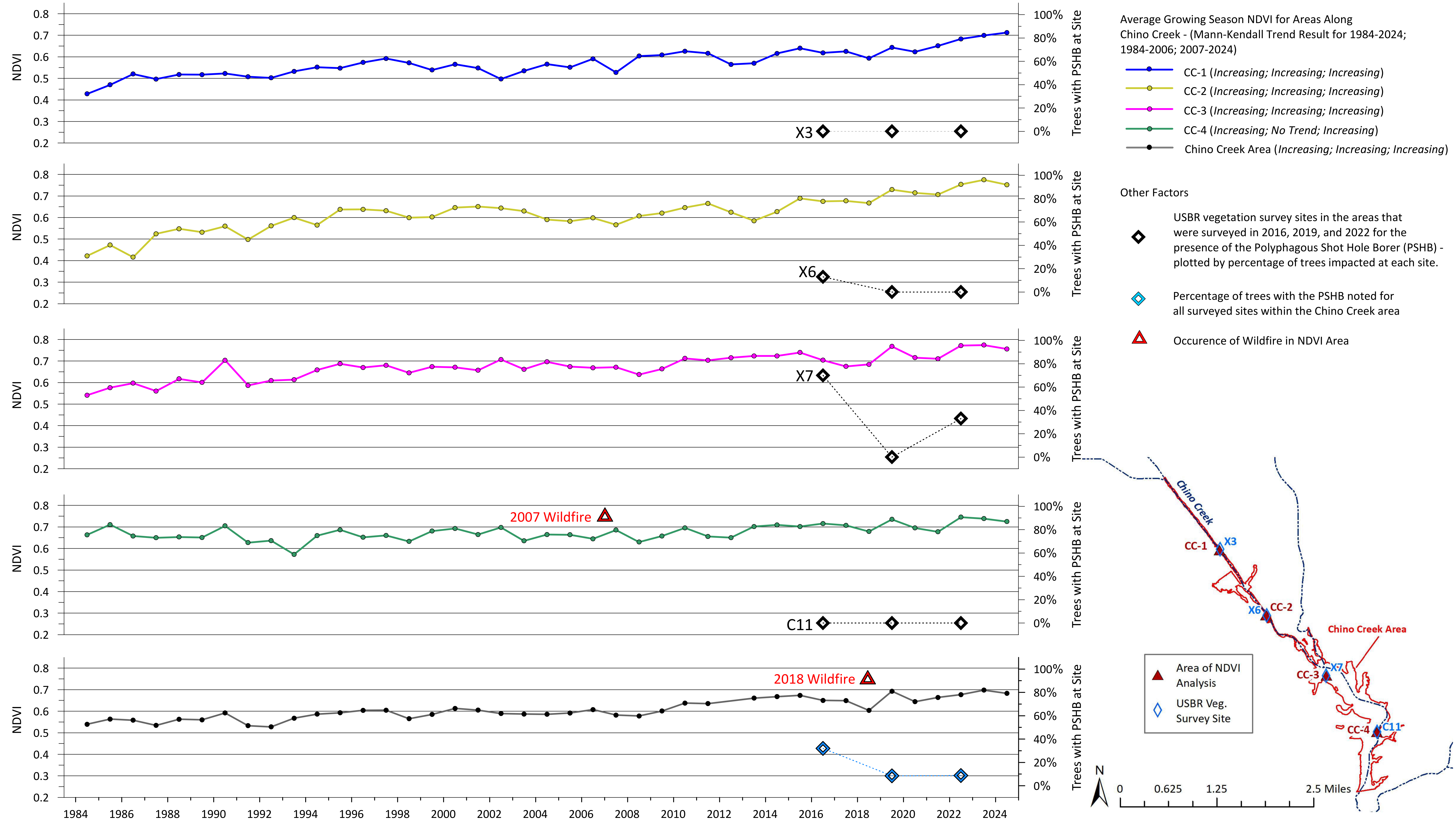
Spatial NDVI Change 2023-2024 and 2024 Air Photo with Prado Basin Wildfires in 2015, 2018, and 2020

Figure 3-20b



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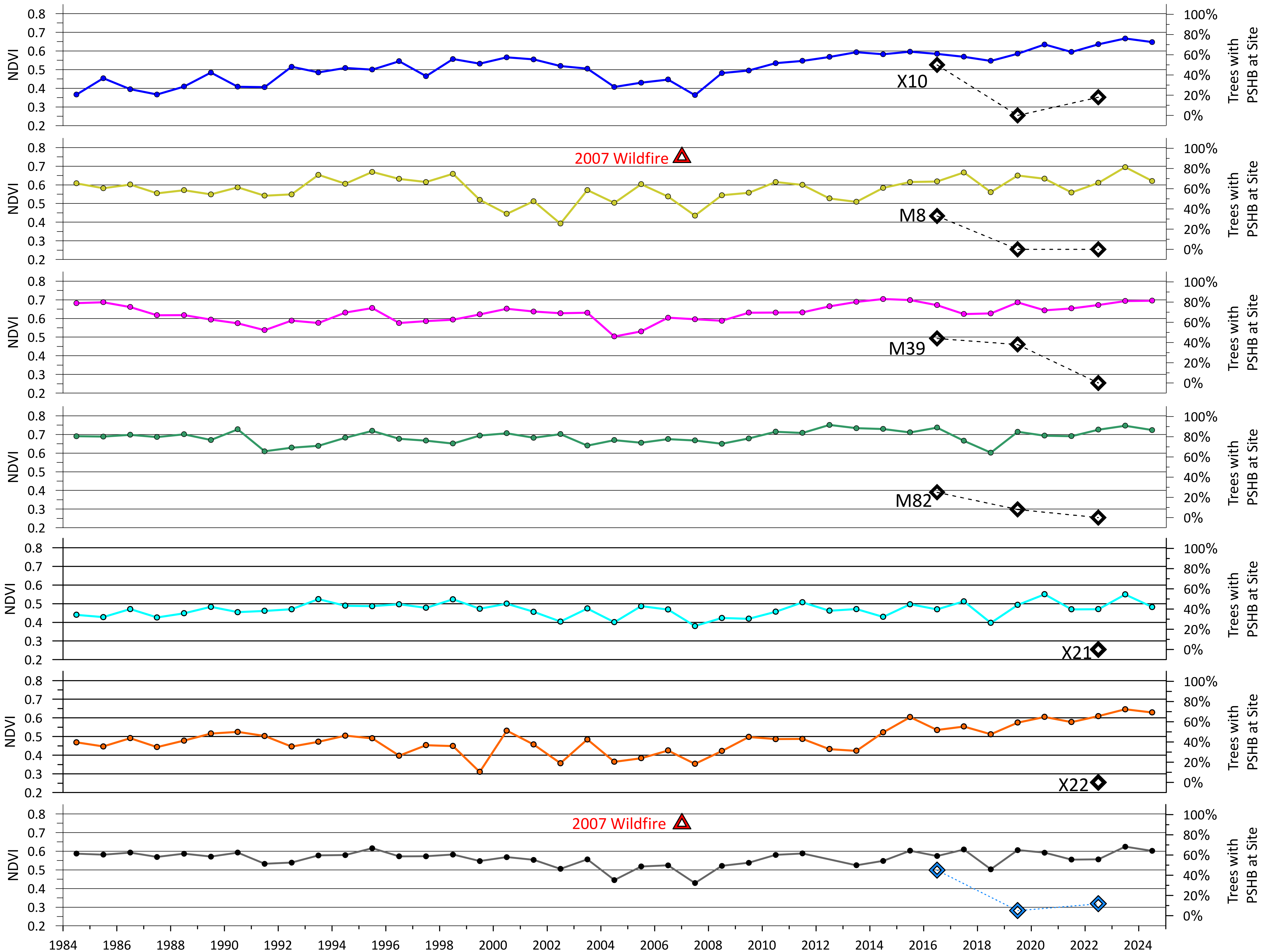
Other Factors that Affect Riparian Habitat verus NDVI
Chino Creek Area for 1984-2024

Figure 3-21a



Average Growing Season NDVI for Areas Along Mill Creek - (Mann-Kendall Trend Result for 1984-2024; 1984-2006; 2007-2024)

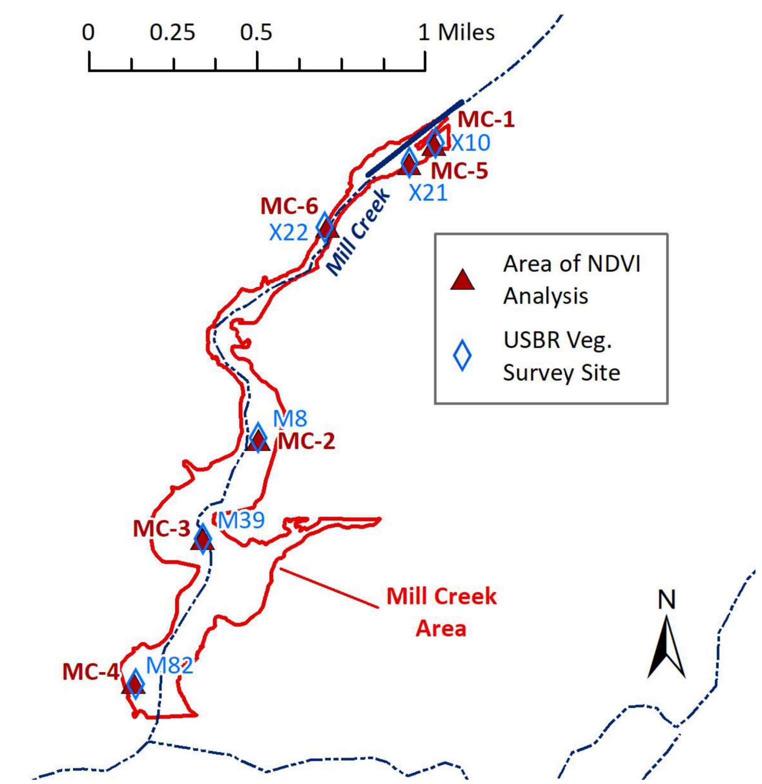
- MC-1 (*Increasing; Increasing; Increasing*)
- MC-2 (*No Trend; No Trend; Increasing*)
- MC-3 (*Increasing; No Trend; Increasing*)
- MC-4 (*Increasing; No Trend; No Trend*)
- MC-5 (*No Trend; No Trend; Increasing*)
- MC-6 (*Increasing; No Trend; Increasing*)
- Mill Creek Area (*No Trend; Decreasing; Increasing*)

Other Factors

USBR vegetation survey sites in the areas that were surveyed in 2016, 2019, and 2022 for the presence of the Polyphagous Shot Hole Borer (PSHB) - plotted by percentage of trees impacted at each site.

Percentage of trees with the PSHB noted for all surveyed sites within the Mill Creek area

Occurence of Wildfire in NDVI Area



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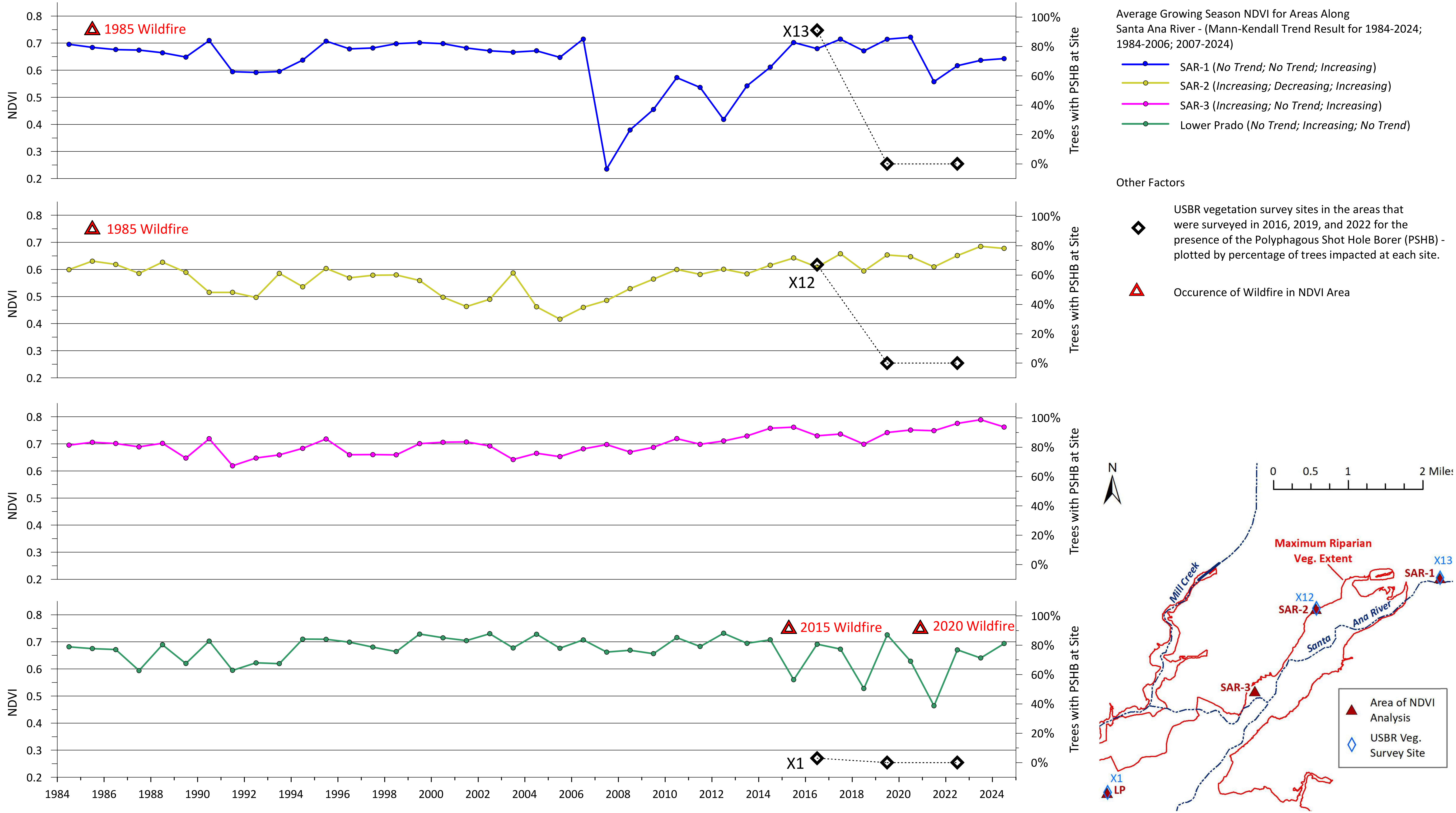
Other Factors that Affect Riparian Habitat verus NDVI
Mill Creek Area for 1984-2024

Figure 3-21b



Other Factors that Affect Riparian Habitat verus NDVI
Santa Ana River and Lower Prado Area for 1984-2024

Figure 3-21c

117°40'0"W

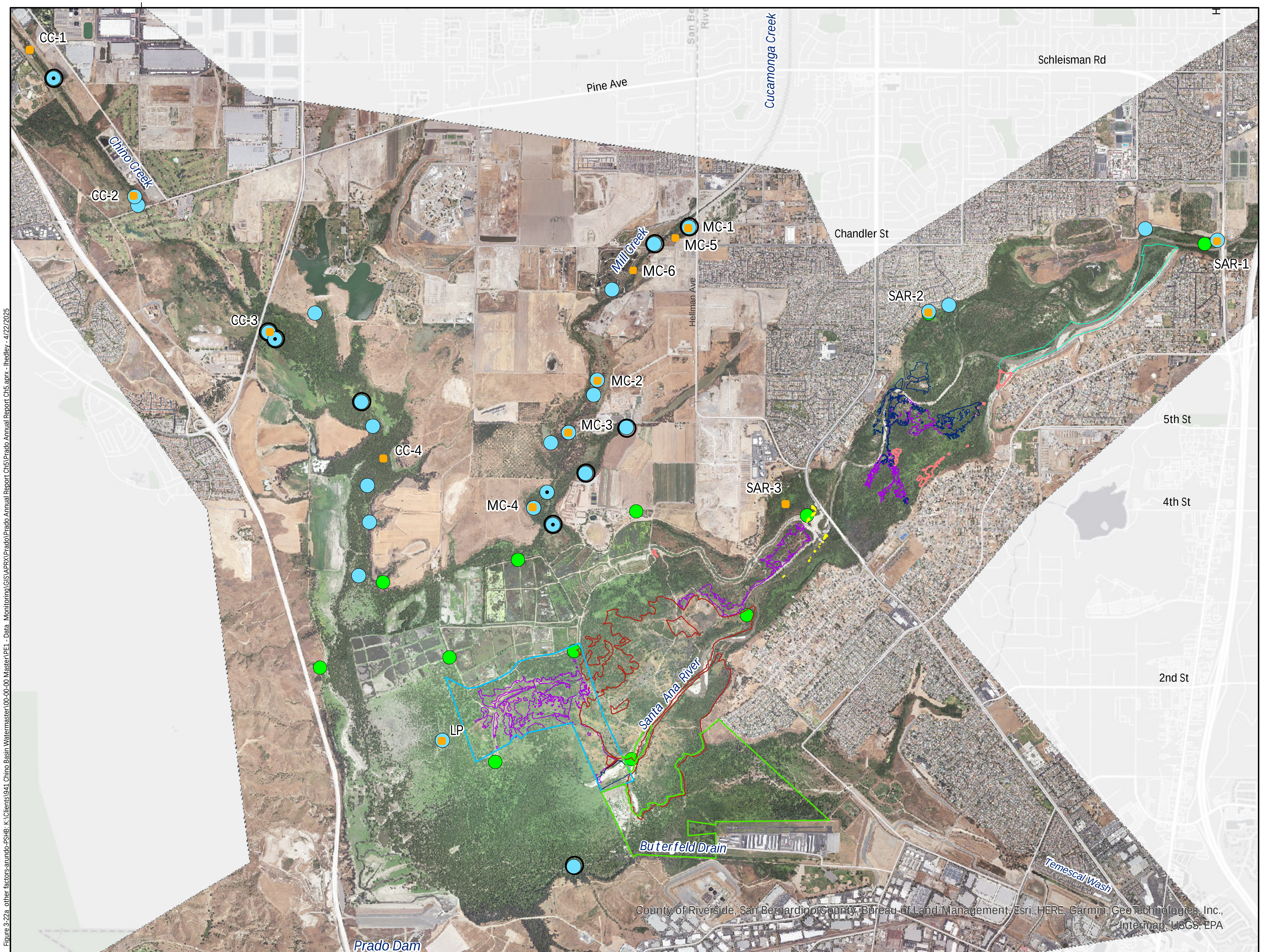


Figure 3-22a_other factors-arundo-PSHB; K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE1 - Data_Monitoring\GIS\APRX\Prado\Prado Annual Report Ch5\Prado Annual Report Ch5.aprx - lhedley - 4/22/2025

2023 - 2024 Area of SAWA Arundo Maintenance/ Treatment for Prior Arundo Removal*

Area of SAWA Arundo Removal

- 2022
- 2021
- 2020
- 2019
- 2016 - 2018

Area of Other Arundo Management

- Control of Arundo Regrowth by OCWD within the Perimeter of 2015 Wildfre
- ACOE Arundo Mitgaton Site - Parcel 2

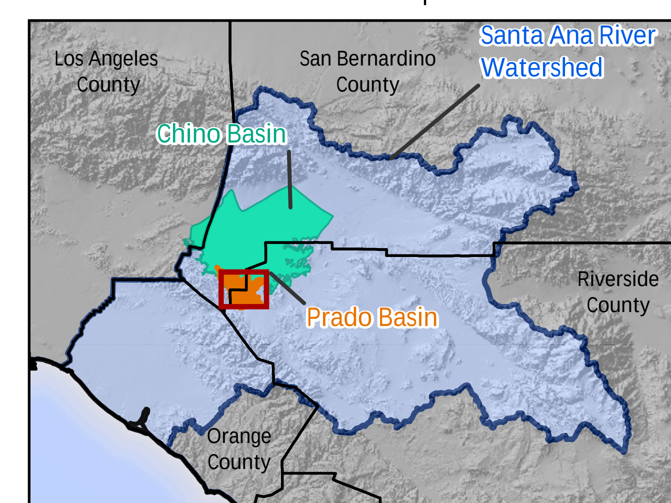
Documented Locatons of Polyphagous Shot-Hole Borer (PSHB)

- Identfed by USBR during the 2016 Site-Specifc Vegetaton Surveys
- Identfed by USBR during the 2019 Site-Specifc Vegetaton Surveys
- Identfed by USBR during the 2022 Site-Specifc Vegetaton Surveys

- Locaton of PSHB Traps Deployed by OCWD and SAWA from August 2016 to April 2017

- Small Defned Area Analyzed for NDVI Time Series - 1 NDVI pixel (30 x 30-meters)

*No new Arundo removal has been performed since 2022



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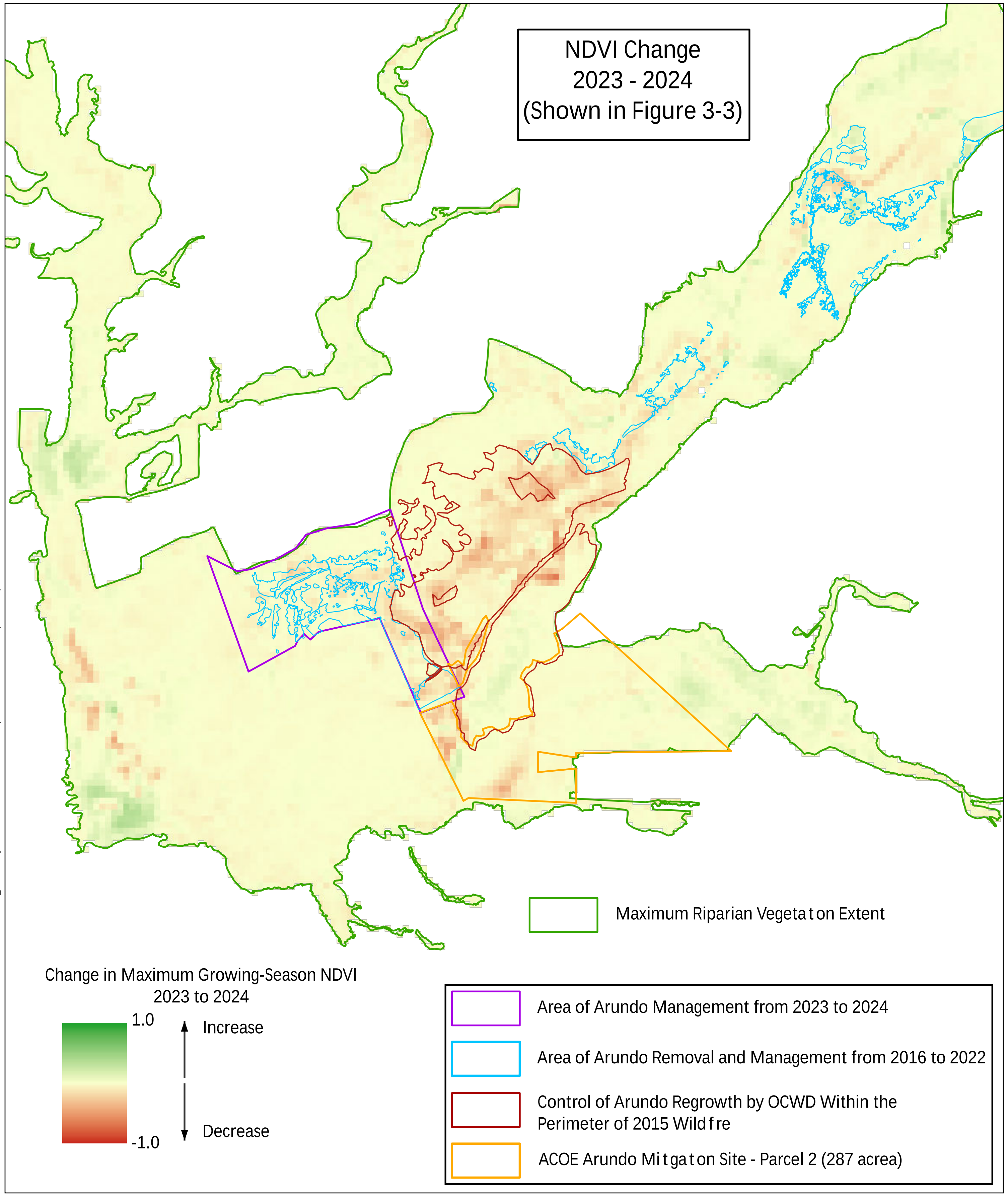
Prado Basin Sustainability Committee
2024 Annual Report

Locaton Map of Other Factors That Can Afect Riparian Habitat
Arundo and PSHB

Figure 3-22a



Prepared by:

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0 0.5 1 Miles

0 1 Km

Prepared for:

Prado Basin Sustainability Commi t ee
2024 Annual Report

Spa t al NDVI Change 2023-2024 and 2024 Air Photo
with Prado Basin Arundo Removal and Management
2016-2024

Figure 3-22b

3.7 Analysis of Prospective Loss of Riparian Habitat

The meaning of "prospective loss" of riparian habitat in this context is the "future potential loss" of riparian habitat. Watermaster's most recent (2020) predictive modeling results[27] were used to identify areas of prospective loss of riparian habitat that may be attributable to the Peace II Agreement by projecting future groundwater-level conditions in the Prado Basin area through 2030. To perform this evaluation, the predictive model results were mapped and charted to identify areas, if any, where groundwater levels are projected to decline to depths that may adversely impact the riparian habitat in the Prado Basin.

Figure 3-23 is a map that shows the 2020 model-predicted change in groundwater levels in the Prado Basin area over the period of 2018-2030 from the planning scenario used to recalculate the Safe Yield of the Chino Basin in 2020 using Watermaster's updated groundwater-flow model (WEI, 2020). The map shows that groundwater levels are predicted to remain steady across most of the Prado Basin area through 2030. The stability in groundwater levels is explained in part by projected declines in groundwater production from private wells in the area, the IEUA's delivery of treated recycled water to this area for direct uses (such as outdoor irrigation), and the fact that most of the Chino Basin Desalter production will occur to the north and northeast. Figure 3-24 shows that the most likely area where groundwater levels are projected to decline by 2030 is the northern portions of Mill Creek and the SAR.

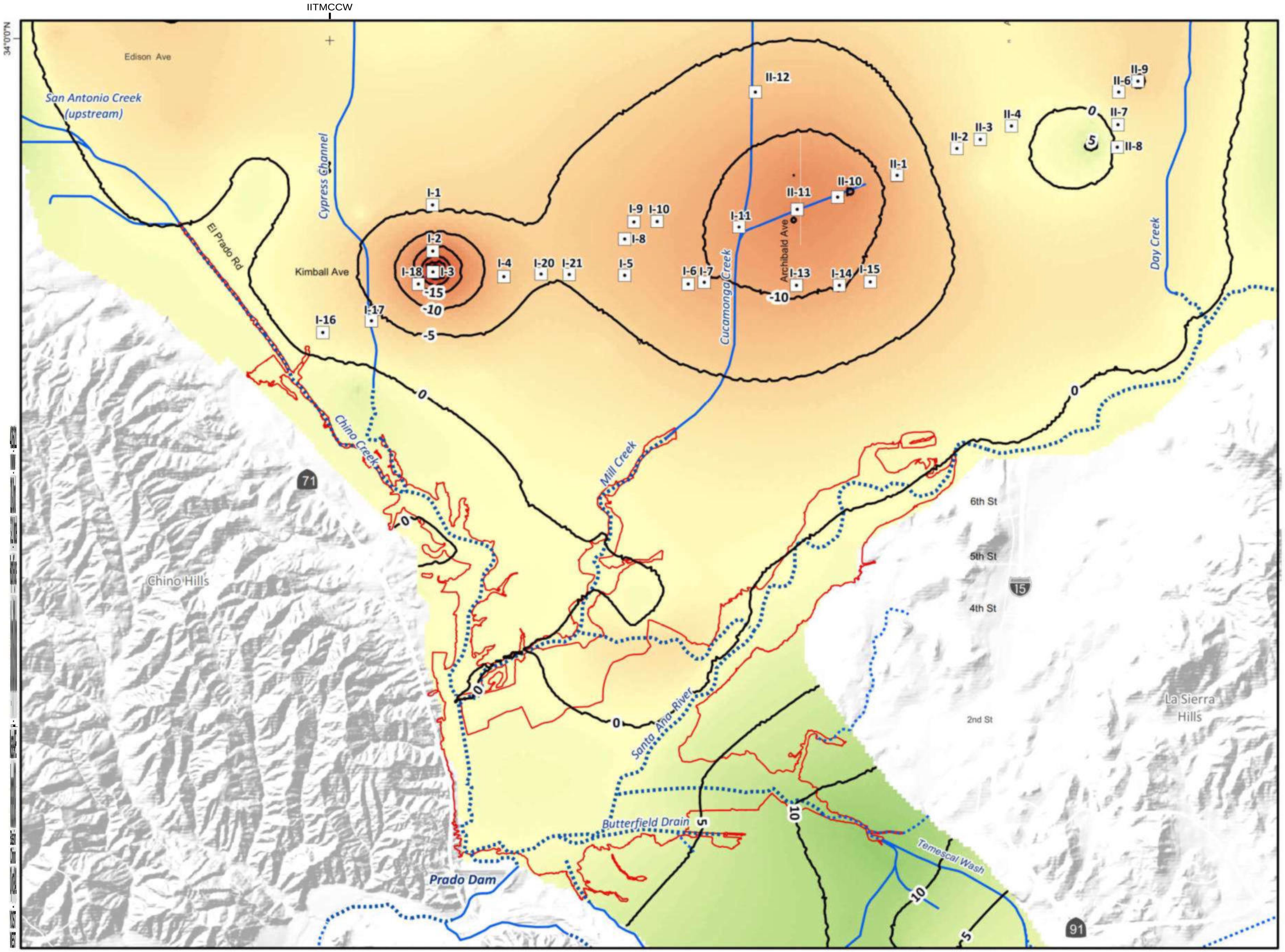
Figure 3-24 is a time-series chart of the 2020 model-predicted groundwater levels at the PBHSP monitoring wells for the period of 2018 to 2030. These wells are strategically located adjacent to the riparian habitat south of the Chino Desalter well field to understand the potential impacts of Peace II implementation on groundwater levels and the riparian habitat. The chart shows:

- Groundwater levels are projected to fluctuate seasonally at all PBHSP monitoring wells by about one to two feet.
- Groundwater-level trends are projected to remain stable at most of the PBHSP monitoring wells through the duration of the Peace II Agreement (through 2030).
- At two of the PBHSP monitoring wells, groundwater levels are projected to experience declines of about one to three feet from 2018 to 2030, which may represent a threat for prospective loss of riparian habitat:
  - **PB-2 above the northern reach of Mill Creek.** The 2020 model predicts a decline in groundwater levels at PB-2 of about three feet from 2018 to 2030. Figure 3-11 shows that groundwater levels declined at PB-2 by about 4.5 feet from 2018 to 2024, which is greater than the decline predicted by the model through 2030. Additionally, groundwater levels have declined by about 2.5 feet through 2024 in the riparian vegetation extent along Mill Creek just to the south. Figure 3-12 shows that the current (Fall 2024) depth-to-groundwater where the riparian vegetation is growing along the northernmost reaches of Mill Creek ranges from about 10-15 ft-bgs. Hence, if the groundwater levels

[27] The predicted groundwater level changes through 2030 were made with the 2020 Chino Valley Model (CVM) for Scenario 2020 SYR1 for Layer 1 of the aquifer. The results of this model scenario were used to recalculate the 2020 Safe Yield of the Chino Basin (WEI, 2020). Scenario SYR1 is based on the water demands and water supply plans provided by the Watermaster parties, Chino Basin parties' planning assumptions on pumping groundwater and conducting recharge operations, planning hydrology that incorporates climate change impacts on precipitation and ET0, and assumptions regarding cultural conditions and future replenishment.

continue to decline along Mill Creek, then it could result in adverse impacts to the riparian habitat in this area.

- **PB-3 along the northern portion of the SAR.** The 2020 model predicts a decline in groundwater levels at PB-3 of about one foot from 2018 to 2030. Figure 3-13c shows that groundwater levels declined at PB-3 by about 1.5 feet, from 2018 to 2024, which is slightly greater than the decline predicted by the model through 2030. Figure 3-12 shows that the current (Fall 2024) depth-to-groundwater where the riparian vegetation is growing along the northernmost reaches of the SAR ranges from 6-11 ft-bgs. If groundwater levels continue to decline at similar or higher rate through 2030, then it could result in a depth to groundwater greater than 15 ft-bgs and adverse impacts to the riparian habitat in this area. However, the groundwater-level declines in this northern reach of the SAR near PB-3 are not a concern for the riparian vegetation at this time because the depth to groundwater in this area is shallow (6 to 11 ft-bgs) and is supported by SAR recharge.



Contours of Model-Predicted Change in Groundwater Levels for Layer 1* *July 2018 to July 2030*, feet

Hydraulic Head Change (ft) *July 2018 to July 2030*

30 Increase
0
Decrease -30

Chino Desalter Well

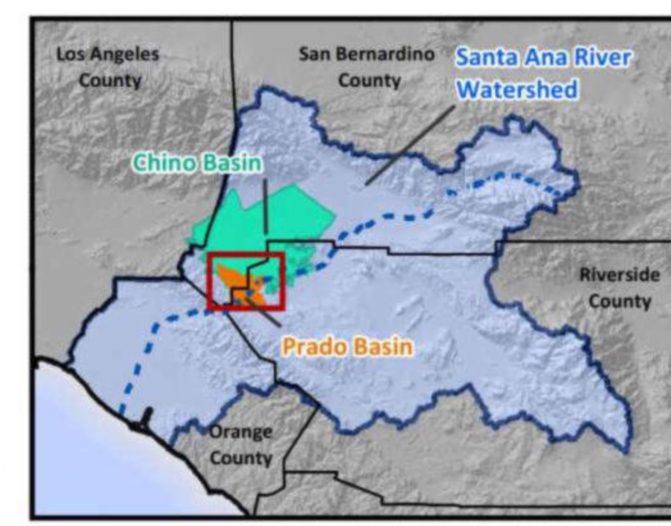
PBHSP Monitoring Well Site

Riparian Vegetation Extent in Prado Basin

Concrete-Lined Channels

Unlined Rivers and Streams

* Model Predicted Change in Groundwater Levels from the planning scenario 2020 SYR1 for the recalclation of Safe Yield using the updated Chino Valley Model (WEI, 2020)



Prepared by:

WEST# YOST
Water. Engineered.

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Chino Basin Watermaster and
Inland Empire Utilities Agency
2024 Annual Report of the
Prado Basin Habitat Sustainability Committee

Prepared for:

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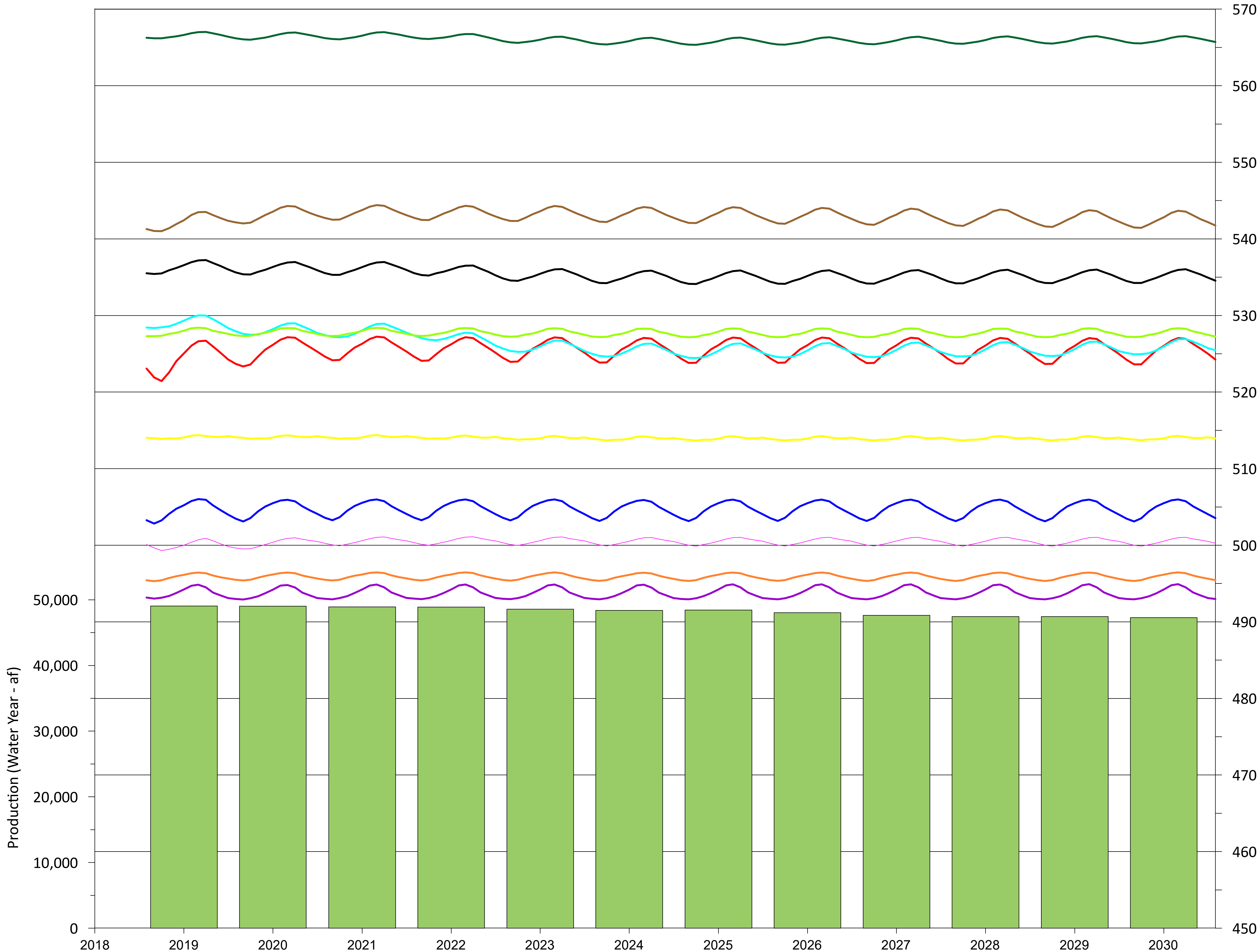
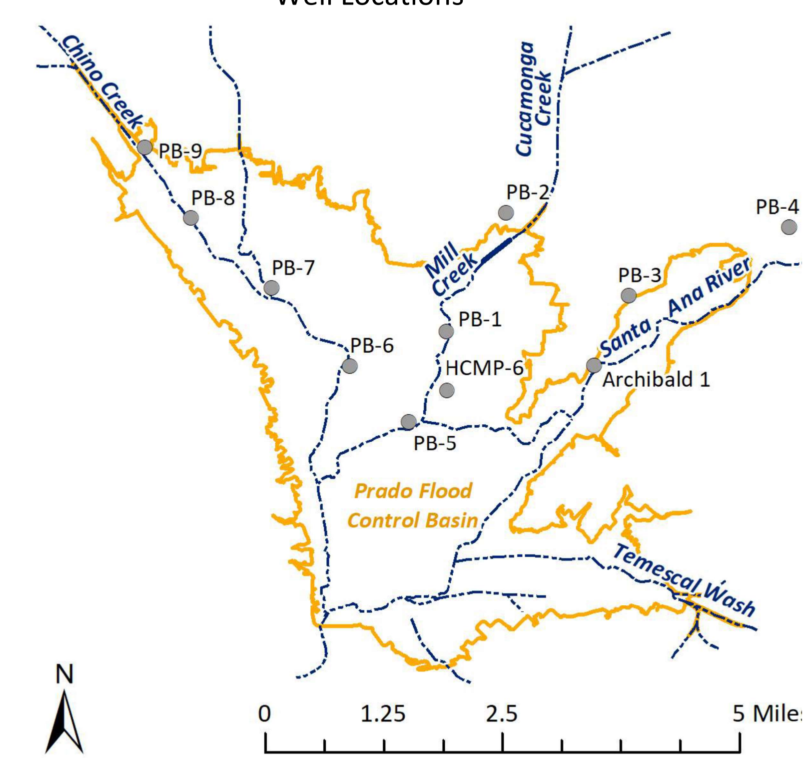
Predicted Change in Groundwater Level
2018 to 2030 - Scenario 2020 SYR1

Figure 3-23



*Model Simulated Groundwater Elevations and Pumping from the planning scenario 2020 SYR1 for the 2020 recalculation of Safe Yield using the updated Chino Basin groundwater-flow model (WEI, 2020)

Well Locations



Prepared by:

WEST YOST Water. Engineered.

Prepared for:

Prado Basin Habitat Sustainability Committee
2024 Annual Report

Predicted Change in Groundwater Levels
2018 to 2030 - Scenario 2020 SYR1

Figure 3-24

4.0 CONCLUSIONS AND RECOMMENDATIONS

The monitoring and mitigation requirements in the Peace II SEIR call for annual reporting for the PBHSP. Annual reports include recommendations for ongoing monitoring and any adaptive management actions required to mitigate any measured loss or prospective loss of riparian habitat that may be attributable to the Peace II Agreement.

The following describes the main conclusions of this annual report and provides recommendations for future monitoring, reporting, and mitigation, if any.

4.1 Main Conclusions and Recommendations

4.1.1 Conclusions

The main conclusions of the PBHSC Annual Report for WY 2024 are:

- Based on the analysis of NDVI time series and air photos, the quality (greenness) of the riparian habitat vegetation decreased or remained the same across most of the Prado Basin from 2023 to 2024. All the observed decreases were relatively minor and within the range of one-year changes observed historically. However, some of these decreases were notable because they were slightly greater than the average one-year change in NDVI observed over the historical period. Air photos also reveal notable changes in the vegetation in three of these areas (MC-2, MC-5 and Upper Mill Creek), including reductions in coverage and browning. These decreases occurred during a period of cooler-than-average temperatures, stable or increasing groundwater levels, and above-average precipitation and stream discharge in WY 2024. However, the conditions were warmer and dryer in WY 2024 compared to the previous WY 2023.
- Based on the analysis of NDVI spatial change maps and air photos, there were two notable areas of decreases in greenness observed in the Prado Basin between 2023 and 2024: (i) along the SAR in the lower portion of Prado Basin; and (ii) along the lower portion of Chino Creek behind Prado Dam. These decreases were likely caused by reduced growth of perennial vegetation due to lower precipitation compared to the previous year, as well as some scouring along the edges of the creeks and river from the previous wet year. None of the reductions in greenness were related to declining groundwater levels during the period of Peace II Agreement implementation.
- Over this past year from 2023 to 2024, groundwater levels at the PBHSP monitoring wells along Chino Creek, Mill Creek and the SAR in the Prado Basin remained stable or showed slight changes of +/- 1 foot. These changes were likely due to another wet year and increased stream discharge, although it was not as wet as the previous year.
- Since groundwater-level measurements commenced at the PBHSP monitoring wells in 2015, there have been some increasing and decreasing trends in groundwater levels observed along the reaches of Chino Creek, Mill Creek, and SAR. From September 2016 to September 2024, groundwater levels throughout most of riparian vegetation extent have changed less than +/- 5 feet. There are some notable areas of change:
    - Groundwater levels have declined the most in the northern portion of Mill Creek just south of the PB-2 monitoring well. From 2016 to 2022 groundwater levels declined by about eight feet likely due to increased pumping at the CDA wells to the north. During

2023 and 2024, groundwater levels increased by about four feet in this area, for a net change in groundwater levels of -4 feet since 2016. Recent observations of the air photos in 2024 have noted a decline in the greenness of the riparian vegetation in this northern area of Mill Creek reach.

— In the northern reach of Chino Creek, groundwater levels increased by about ten feet from 2016 to 2024. These increases in groundwater levels were likely due to decreased groundwater pumping in the area.

- The depth to groundwater in the northernmost reach of Mill Creek where the groundwater levels have declined the most (near PB-2) is estimated at 10-15 ft-bgs in WY 2024. Future declines in groundwater levels in this area could result in adverse impacts to the riparian habitat.

4.1.2 Recommendations

Based on the conclusions above, the PBHSP monitoring and reporting should continue to monitor and assess the extent and quality of the riparian habitat and the factors that can influence it, as has been done through WY 2024. As described above, there were declines in groundwater levels from 2016 to 2022 beneath the northern portion of Mill Creek; however, over the last two years, groundwater levels have recovered about halfway from their lowest observed levels in 2022. During the period of the lowest groundwater levels in 2022, there were no observed negative impacts on the riparian vegetation in this area. However, over this past year, there were some observed declines in the greenness of the riparian vegetation in this area. Factors that could have resulted in these changes were assessed as part of this analysis and no direct cause was identified. Therefore, we recommend additional focused monitoring along northern Mill Creek in WY 2025, as described below.

The triennial vegetation surveys scheduled for the summer of 2025 should be tailored to focus on the northern portion of Mill Creek and should include new or expanded sites to get a more comprehensive understanding of what is happening on the ground. In addition to gathering the measurements that have been acquired by the vegetation surveys in the past, the biologists conducting the surveys should also provide a professional opinion on: (i) any observed changes in vegetation structure and composition, (ii) potential causes of the change, and (iii) recommendations for additional monitoring or studies. This information will help verify and document the current vegetation conditions relative to conditions in the recent past and is crucial for assessing any potential impact on the extent and quality of the riparian habitat that could be caused by the lowering of groundwater levels in this area. Since the PBHSP is an adaptive management plan, any recommended enhancements to the monitoring program based on the vegetation surveys can be reviewed and incorporated by the PBHSC as appropriate. If mitigation measures are deemed necessary, the results of the PBHSP will provide guidance for their development.

4.2 Recommended Mitigation Measures and/or Adjustments to the AMP

This annual report has documented some preliminary observations in the degradation in the quality of riparian habitat along Mill Creek. As described in the recommendations, this preliminary assessment warrants further monitoring and evaluation to confirm the degradation and determine if it is contemporaneous with decreasing groundwater levels during the implementation of the Peace II Agreement. No mitigation measures or adjustments to the AMP are proposed currently. However, continued monitoring could inform appropriate mitigation measures if deemed necessary in future annual reports.

4.3 Recommended PBHSP for Fiscal Year 2025/26

Based on preliminary analysis of the PBHSP data for WY 2024, a draft *Technical Memorandum Recommended Scope and Budget of the Prado Basin Habitat Sustainability for FY 2025/26* was submitted to the PBSHC on March 12, 2025. On March 19, 2025, Watermaster's Engineer presented the recommended scope and budget for FY 2025/26 to the PBHSC for consideration. There were no changes recommended by the PBHSC on the proposed FY 2025/26 scope of work, and a final scope of work and budget was submitted to the PBHSC and will go through the Watermaster and the IEUA FY 2025/26 budgeting process in May and June of 2025. The scope of work for the PBHSP for FY 2025/26 is shown in Table 4-1 as a line-item cost estimate.

The following describes the scope of work by major task for the PBHSP for FY 2025/26:

Task 1. Groundwater Monitoring Program

The monitoring of groundwater levels in the Prado Basin is a key component of the PBHSP because declining groundwater levels could be a factor related to Peace II implementation that adversely impacts riparian vegetation. Sixteen monitoring wells were installed specifically for the PBHSP in 2015. These wells, plus monitoring wells HCMP-5/1 and RP2-MW3, are monitored for groundwater levels. The eighteen monitoring wells are equipped with integrated pressure-transducers/data-loggers (hereafter referred to as transducers) that measure and record water-level measurements and temperature readings every fifteen minutes. At twelve of the eighteen wells, the transducers also collect high frequency measurements of EC. The inclusion of the high-frequency temperature and EC data was a recommendation resulting from the evaluation of the pilot monitoring program in the Annual Report for WY 2022, as discussed in Task 2, and will be used to evaluate groundwater/surface water interactions. As transducers require replacements at the end of their useful life, they will be replaced with transducers that measure EC. During 2024, elevation surveys of the thalweg in creeks adjacent to the monitoring well sites were performed, which will enhance the assessment of surface/groundwater interactions using the high-frequency data collected by the transducers.

This task includes quarterly field visits to all eighteen PBHSP monitoring wells to download the data from the transducers, and the processing, checking, and uploading of the water level, temperature, and EC data to the PBHSP database. The scope of this task is the same as the previous fiscal year.

Task 2. Surface-Water Monitoring Program

Surface-water data from the Santa Ana River and the tributaries that cross Prado Basin are used to evaluate groundwater/surface-water interactions and their importance to the impact on groundwater levels and riparian habitat, and to characterize the influence of surface-water discharge on the riparian habitat.

From FY 2018/19 to FY 2022/23, a pilot monitoring program was conducted to determine if high-frequency data enhances and better reveals the interpretation of groundwater/surface-water interactions previously studied for the PBHSP. The pilot monitoring program included the installation of transducers that record EC, temperature, and water levels at 15-minute intervals at two locations in Chino Creek and the same high-frequency monitoring at four nearby monitoring wells (PB-7 and PB-8 clusters). Additionally, during the first two years of the pilot monitoring program, surface water and groundwater-quality samples were collected to support the high-frequency data.

Key conclusions from the analysis of the pilot monitoring program data in the Annual Report for WY 2022 were that the pilot program could be discontinued and, in its place: conduct high-frequency monitoring of EC, temperature, and water level for each pair of PBHSP monitoring wells (Task 1), most of which was already being collected, and collect quarterly field measurements for EC and temperature of the surface water flowing in the streams adjacent to the monitoring wells (Task 2.1).

Task 2.1 is to collect field measurements of temperature and EC at four surface water sites in Chino Creek and Mill Creek near the PB-1, PB-2, PB-7, and PB-8 wells and to process and upload the data to the database. The addition of the manual surface water measurements was new last fiscal year and was another monitoring recommendation in the Annual Report for WY 2022 in place of the pilot monitoring program. The continued collection of this data will further support the analyses of groundwater/surface water interactions. The effort to collect, process, and upload the manual measurements is minimal since it can be done during the quarterly field visits to the monitoring wells to download the transducer data. The scope of this sub task is consistent with the work performed for the previous fiscal year.

Task 2.2 includes the annual collection of the surface water data from four publicly-available data sets which include: the USGS daily discharge measurements at six sites along the Santa Ana River and its tributaries; daily discharge and water-quality data from POTWs that are tributary to Prado Basin; ACOE daily measurements of reservoir elevation and releases from the reservoir at Prado Dam; and Watermaster's quarterly surface-water-quality monitoring at two sites along the Santa Ana River. The USGS, POTW, and ACOE data for WY 2025 will be collected, processed, checked, and uploaded to the PBHSP database. This sub task does not include the processing, checking, and uploading of the Watermaster-collected quarterly water quality data on the Santa Ana River data, which is performed under a Watermaster task for the Maximum Benefit Monitoring Program. The scope of this sub task is consistent with the work performed for the previous fiscal year.

Task 3. Climate Monitoring Program

Climatic data are evaluated in the vicinity of the Prado Basin to characterize trends and to determine if these trends contribute to impacts on the riparian habitat. The climate monitoring program utilizes two types of publicly available, spatially-gridded datasets. Task 3 includes the annual collection of these spatially-gridded datasets for WY 2025 (October 2024 – September 2025), and the checking and uploading of the data to the PBHSP database. The scope of this task is consistent with the work performed for the previous fiscal year.

Task 4. Riparian Habitat Monitoring Program

Monitoring the extent and quality of the riparian habitat in the Prado Basin is a fundamental component of the PBHSP to characterize how the riparian habitat changes over time. To characterize the impacts of Peace II implementation on the riparian habitat (if any) it is necessary to understand the long-term historical trends of its extent and quality, and the factors that have affected it. The current riparian habitat monitoring program consists of both regional and site-specific components. The proposed riparian habitat monitoring program for FY 2025/26 is described in the subsections below.

Regional Monitoring:

The regional monitoring of riparian habitat is performed via two independent methods that complement each other: mapping and analysis of the riparian habitat using (i) air photos and (ii) the normalized distribution vegetation index (NDVI) derived from the Landsat remote-sensing program. Tasks 4.1, 4.2, and 4.3 are for the collection and compilation of the regional monitoring data, including:

- Perform a custom flight (via outside professional services) to acquire a high-resolution air photo (three-inch pixel) of the Prado Basin during summer 2025. The cost for the air photo is shared with OCWD.
- Catalog and review in ArcGIS the extent of the riparian vegetation in the 2025 high-resolution air photo in of the Prado Basin
- Collect, review, and upload the Landsat NDVI data through the 2025 growing season.

Site-Specific Monitoring:

The site-specific monitoring of the riparian habitat consists of periodic field surveys of the riparian vegetation at selected locations. These surveys provide an independent measurement of vegetation quality that can be used to "ground truth" the regional monitoring of the riparian habitat, as well as the occurrence of the PSHB, a pest that is known to increase tree mortality in the Prado Basin. The USBR along with the OCWD[28] has conducted field surveys once every three years since 2007 at 31-39 sites. The most recent triennial field survey was conducted in the summer of 2022 and included two new sites along the northern portion of Mill Creek to increase monitoring at this location where there is potential for impacts to the riparian habitat from the observed decline in groundwater levels.

Task 4.4 involves conducting the next field surveys during the summer of 2025. The methodology for the 2025 field vegetation surveys is proposed to be modified from the previous survey as follows:

- Expand monitoring at a few sites along northern Mill Creek, where groundwater levels were historically low in 2022, and where there are now notable decreases in the vegetation greenness indicated by the NDVI and air photo in 2024. Expanded monitoring may involve adding additional survey plots or increasing the plot size in these areas of concern. The objective is to gather more data and information to verify the notable changes observed from the regional monitoring. This will aid in analyzing the potential causes of vegetation health declines, such as delayed response to groundwater level declines or invasive species. This data will be important in determining whether mitigation efforts will be needed in the future.
- Reduce the number of sites where the monitoring is performed. In the 2022 vegetation survey, 39 sites were monitored, most of which have triennial data starting from either 2007 or 2016. There is an opportunity to focus on key representative areas where field data are important for verifying regional assessment monitoring and where the Peace II implementation has potential impact riparian vegetation. There is potential to reduce the number of sites monitored by about 35-40 percent.

Currently, there is some uncertainty regarding the USBR's ability to conduct the vegetation surveys in the summer of 2025 as they have done in previous years. The USBR, a federal agency, is now subject to new polices and laws that restrict work-related travel. If the USBR is unable to perform the surveys, an external

[28] OCWD staff provides assistance to the USBR in the field as in-kind services.

biological consultant will be contracted to carry out the work, with the USBR providing background information and training.

The cost to perform the field vegetation surveys is estimated as $50,000 based on the 2022 expenses. The final cost will be refined and finalized as the methodology and scope are updated, and once the biological consultant for the 2025 surveys is determined.

Task 5. Prepare Annual Report of the PBHSC

This task involves the analysis of all data sets collected by the PBHSP through WY 2025, including the data collected in Tasks 1 through 4 and for other as-needed factors that can impact the riparian habitat, such as wildfires, habitat mitigation programs, or construction/development in the basin. The results and interpretations generated from the data analysis will be documented in the *Annual Report for Prado Basin Habitat Sustainability Committee for Water Year 2025*. This task includes the effort to prepare an administrative draft report for Watermaster and IEUA staff review, a draft report for the review by the PBHSC, and a final report including comments and responses. A PBHSC meeting will be conducted in May 2026 to review the draft report and facilitate comments on the report. The scope of this task is consistent with the work performed for the previous fiscal year.

Task 6. Project Management and Administration

This task includes the effort to prepare the PBHSP scope, schedule, and budget for the subsequent fiscal year. A draft *Technical Memorandum Recommended Scope and Budget of the Prado Basin Habitat Sustainability Program for FY 2026/27* will be submitted to the PBHSC in February/March 2026. A PBHSC meeting will be conducted in March 2026 to review the draft recommended scope and budget and facilitate comments. Also included in this task is project administration, including management of staffing and monthly financial reporting. The scope of this task is consistent with the work performed for the previous fiscal year.

Table 4-1. Work Breakdown Structure and Cost Estimate
Prado Basin Habitat Sustainability Program - Fiscal Year 2025/26

			Labor Total		Other Costs, dollars					Totals, dollars			
	Task Description	No. of sites	Person Days	Total, dollars	Travel	Equipment Rental	Outside Pro	Total	Notes	Recommended Budget 2025/26	Budget Prior FY 2024/25	IEUA Share 2025/26	CBWM Share 2025/26
Task 1. Groundwater Monitoring Program			**19.6**	**$33,177**				**$1,150**		**$34,327**	**$32,164**	-	**$34,327**
1.1	Download Transducer Data from PBHSP Wells (Quarterly)	18	11.0	$16,637	$950	$200		$1,150		$17,787	$16,759		
1.2	Process, Check and Upload Water Level, Temperature, and EC Transducer Data from PBHSP Wells (Quarterly)	18	8.6	$16,539				$0		$16,539	$15,405		
Task 2. Surface Water Monitoring Program			**5**	**$9,202**				**$200**		**$9,402**	**$8,044**	-	**$9,402**
2.1	Collect , Process, and Upload Field Measurements of Temperature and EC at Four Surface Water Sites (Quarterly)	4	3.5	$6,208		$200		$200		$6,408	$4,876		
2.2	Collect, Check, and Upload Surface Water Discharge and Quality Data from POTWs, USGS; and Dam Level Data from the ACOE (Annual)		1.8	$2,994				$0		$2,994	$3,168		
Task 3. Climate Monitoring Program			**1.4**	**$2,953**				**$250**		**$3,203**	**$2,846**	**$1,602**	**$1,602**
3.1	Collect, Check, and Upload Climatic Data (Annual)		1.4	$2,953			$250	$250		$3,203	$2,846		
Task 4. Riparian Habitat Monitoring Program			**16.5**	**$34,714**				**$63,000**		**$97,714**	**$40,648**	**$48,857**	**$48,857**
4.1	Perform a Custom Flight to Acquire a High-Resolution 2025 Air Photo of the Prado Basin		1.5	$3,432			$13,000	$13,000	(a)	$16,432	$16,060		
4.2	Catalog, and Review the Extent of the Riparian Vegetation in the 2025 Air Photo of the Prado Basin		2.5	$5,596				$0		$5,596	$5,432		
4.3	Collect, Check, and Upload 2025 Landsat NDVI Data to the PBHSP Database		9.3	$18,146				$0		$18,146	$19,156		
4.4	Conduct the Field Vegetation Monitoring for 2025		3.3	$7,540			$50,000	$50,000		$57,540			
Task 5. Prepare Annual Report of the PBHSC			**46.5**	**$93,209**				**$120**		**$93,329**	**$94,054**	**$46,664**	**$46,664**
5.1	Analyze Data and Prepare Admin Draft Report for CBWM/IEUA		35.3	$68,212				$0		$68,212	$68,762		
5.2	Incorporate CBWM/IEUA Comments and Prepare Draft Report: Submit Draft Report to PBHSC		3.5	$7,271				$0		$7,271	$8,720		
5.3	Meet with PBHSC to Review Draft Report		5.0	$11,690	$120			$120		$11,810	$10,480		
5.4	Incorporate PBHSC Comments and Finalize Report		2.8	$6,036				$0		$6,036	$6,092		
Task 6. Project Management and Administration			**10.1**	**$24,218**				**$120**		**$24,338**	**$22,062**	**$12,169**	**$12,169**
6.1	Prepare Scope and Budget for FY 2025/26		3.3	$7,340				$0		$7,340	$7,502		
6.2	Meet with PBHSC to Review Scope and Budget for FY 2025/26		3.3	$7,748	$120			$120		$7,868	$7,312		
6.3	Project Administration and Financial Reporting		3.6	$9,130				$0		$9,130	$7,248		
	Totals		**99**	**$197,472**	**$1,190**	**$400**	**$63,250**	**$64,840**		**$262,312**	**$199,818**	**$109,292**	**$153,020**

(a) This is half of the cost for the outside professional. OCWD will pay the other half.

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Appendix A

NDVI

A.1 BACKGROUND

Multi-spectral remote-sensing measurements of the Earth's surface from satellites are a verifiable means of deriving complete spatial coverage of environmental information. Remote-sensing measurements have been collected in a consistent manner over time. They are updated regularly and can be analyzed retrospectively, which has made these measurements useful in various types of ecological and environmental monitoring, including vegetation monitoring (USDA, 1996; Schidt and Karnieli, 2000; Campbell, 2007; Lillesand et al., 2008; Xie et al., 2008; Jones and Vaughnan, 2010).

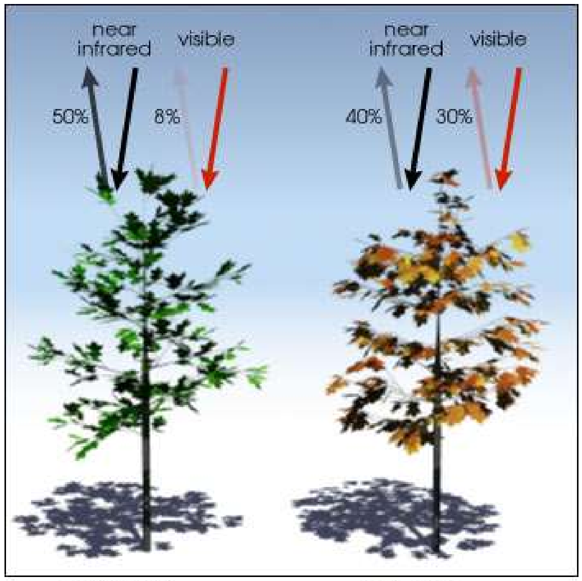
Remote sensing-based methods of vegetation monitoring commonly use vegetation indices that can be calculated from the wavelengths of light absorbed and reflected by vegetation (Jensen, 2007). NDVI, or the normalized difference vegetation index, is a widely used numerical indicator of vegetation extent and quality that is calculated from remote-sensing measurements (Ke et al., 2015; Xue,J and Su, B., 2017). Moreover, NDVI is an index of greenness correlated with photosynthesis and can be used to assess temporal and spatial changes in the distribution, productivity, and dynamics of vegetation (Pettorelli, 2013). NDVI is calculated from visible and near-infrared radiation reflected by vegetation using the following formula:

$$NDVI = \frac{(NIR - VIS)}{NIR + VIS}$$

Where: **NIR** = the spectral reflectance of near infrared radiation
VIS = the spectral reflectance of visible (red) radiation

During photosynthesis, healthy vegetation absorbs incoming visible light and reflects a large portion of near-infrared radiation. Unhealthy or dormant vegetation absorbs less visible light and reflects less near--infrared radiation. The figure[1] illustrates NDVI:

[1] Nasa.gov



$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72 \qquad \frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

Near-infrared radiation and visible light spectral reflectance are both expressed as ratios of the reflected radiation over the incoming radiation (values between 0 and 1); therefore, NDVI estimates range between -1.0 and 1.0. Negative NDVI estimates correspond to standing water, and low positive values (0 to 0.1) correspond to non-vegetated areas, such as barren rock and sand, snow, and water. NDVI estimates ranging from 0.1 to 1.0 correspond to vegetated areas, with very low-end estimates indicating sparse, unhealthy, or dormant vegetation, and increasing estimates towards 0.9 indicating higher amounts of dense, healthy green vegetation.

Advantages and Limitations.

NDVI was chosen as a method for characterizing and monitoring the riparian habitat for the PBHSP for the following reasons:

- Peace II activities could cause regional changes in groundwater levels, which potentially could result in regional impacts to the riparian habitat that is dependent on shallow groundwater. The regional scale of NDVI makes it an appropriate "first indicator" of regional changes in the extent and quality of riparian vegetation. And, it has been widely used in the past to support similar environmental monitoring and management programs (Peters et al., 2002; Pinzon et al., 2004; Wang et al., 2004; Weiss et al., 2004; Intera, 2014; Verbesselt et al, 2010; Gandhi et al., 2015).
- There is a long time-series of historical NDVI (early 1980s to present) that spatially covers the entire Prado Basin. These datasets can be used to characterize the history of the spatial extent and quality of the riparian vegetation prior to and after the implementation of Peace II activities (2007).
- In the future, it is likely that multi-spectral remote sensing will continue to collect the commonly measured spectral bands that are used to calculate NDVI (red and near-infrared) and that these data will be available for use as part of the PBHSP at a low cost.

Like most monitoring tools, NDVI has its limitations, which can reduce its reliability and usefulness. Important examples include:

- Cloud cover, water vapor, and atmospheric contaminants can lead to false decreases in NDVI estimates compared to clear days (Tanre et al., 1992; Achard and Estreguil, 1995; Chen et al., 2004; Hird and McDermid, 2009).
- Satellite degradation, sensor errors, and data transmission errors can lead to false NDVI estimates (James and Kalluri, 1994).
- Changes in soil moisture can lead to changes in NDVI estimates that are not necessarily related to changes in vegetation (Pettorelli, 2013).
- NDVI is a composite view of plant species diversity, form, structure, density, and vigor. As such, changes in NDVI may be caused by various changes in riparian habitat (Markon et al., 1995; Markon and Peterson, 2002). In other words, NDVI does not provide a complete picture of how and why vegetative changes are occurring; it simply indicates a change in vegetation.
- In densely vegetated areas, NDVI estimates have been shown to plateau during the growing season, indicating that NDVI can underestimate the green biomass in densely vegetated areas (Tucker et al., 1986).

These limitations demand that NDVI data be screened and filtered to identify or remove errors and noise. To reduce or eliminate noise, processing algorithms can be applied to "smooth" the time-series data and reveal patterns of change over time. For example, a smoothing technique applied in this report was the averaging of all NDVI from the growing season months. The average values are then plotted on time-series charts to display long-term trends in growing season vegetation quality.

The limitations also demand that NDVI not be interpreted in isolation. Interpretations of NDVI (vegetative changes) should be (i) verified with other georeferenced datasets, such as air photos and field vegetation surveys, and (ii) explained by comparison to datasets of causal factors of vegetative changes, such as water availability.

A.2 LANDSAT PROGRAM AND NDVI

The USGS and the National Aeronautics and Space Administration (NASA) jointly manage the Landsat Program[2], a series of Earth-observing satellite missions that began in 1972 with sensors that observe the Earth's surface and transmit information to ground stations that receive and process multi-spectral, remote-sensing data. Landsat satellites use technology that collects scenes of remote sensing measurements at the same time and location on the Earth's surface at a temporal frequency of about every two weeks. Landsat remote sensing measurements (Landsat imagery) is acquired in scenes that are approximately 106 by 115 miles. Landsat imagery is the only data source with more than thirty-years of continuous records of global land surface conditions at a spatial resolution of tens of meters (Tuck et al., 2004). Landsat imagery is among the most widely used satellite imagery in ecology and conservation studies (Pettorelli, 2013), and the data have been available for no cost since about 2010.

The United States Geological Survey (USGS), in compliance with the Global Climate Observing System[3], produces spectral indices products from Landsat imagery to support land surface change studies, which includes NDVI from 1982 to present (USGS, 2016). The USGS uses remote sensing imagery from the Landsat satellites—*Landsat 4, Landsat 5, Landsat 7, Landsat 8, and Landsat 9* (*Landsat 4, 5, 7, 8, and 9*)—

[2] Nasa.gov

[3] Global Climate Observing System Link

to generate NDVI estimates of the Earth's surface at a 30 x 30-meter pixel resolution. To apply the necessary atmospheric corrections and generate a surface reflectance product, the USGS uses a specialized software called Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) to post-process the Landsat imagery (USGS 2015; 2017a). This surface reflectance product is then used to determine NDVI, among the other spectral indices. The spectral indices products are available for the USGS Landsat Collection 2 Level-2.[4]

A.3 Collection, Review, and Analysis of NDVI for the PBHSP

Collection

NDVI from the Landsat imagery for the period 1982 to 2024 were collected from the USGS, using the Earth Resources Observation and Science (EROS) Center Science Processing Architecture (ESPA) On Demand Interface[5] (USGS 2017b). The interface requires a bulk request in the form of a text file list of specific Landsat scenes using the Landsat scene identifier ID.[6] To obtain complete spatial coverage of the Prado Basin area, NDVI was requested for all Landsat scenes for Path 040, Rows 036 and 037.[7] Table 1 below summarizes the Landsat satellites and periods for which NDVI was obtained to produce a near-continuous NDVI record.

Table 1. Landsat Satellites

Satellite	Instrument	Launched	Ended	Period of NDVI Data Obtained from USGS
Landsat 4	Thematic Mapper	July 16, 1982	December 14, 1993	1982 - 1983
Landsat 5	Thematic Mapper	March 1, 1984	June 5, 2013	1984 - 2011
Landsat 7	Enhanced Thematic Mapper Plus	April 15, 1999	January 19, 2024	1999 - 2023
Landsat 8	Operational Land Imager	February 11, 2013	Still active	2013 - 2024
Landsat 9	Operational Land Imager 2 and Thermal Infrared Sensor 2	September 27, 2021	Still active	2021-2024

[4] Prior to 2022, this program utilized NDVI from the USGS Landsat Collection 1 Level-1, but that collection has been discontinued by the USGS. In 2022, NDVI from the entire period of record from 1984 to 2022 was obtained and uploaded to the project database to have a consistent record of NDVI from the same collection so that there are no changes in the NDVI analyzed in time series that were attributable to the difference in the spectral indices products from different Landsat Collections over time .

[5] USGS Link

[6] Landsat imagery is captured in scenes that are about 106 by 114 miles. Each Landsat scene has a unique scene ID based on the specific Landsat satellite, Landsat path number, Landsat row number, and date the image was collected.

[7] The Prado Basin is in an area of the Landsat path 040 that straddles Rows 036 and 037. Landsat scenes from Path 040 Row 036 and Path 040 Row 037 overlap each other throughout most of the Prado Basin region, but both are required to obtain complete spatial coverage of the Prado Basin.

NDVI from scenes produced from the *Landsat 4*, *5, 7, 8, and 9* satellites were obtained from the USGS for the period 1982 through 2024. The source and frequency of availability of NDVI from the USGS varies over the period of record:

- From 1982 to 1989, NDVI is from Landsat 4 and 5 and is patchy, ranging from a frequency of eight days to one year.
- From 1990 to 1999, NDVI is from Landsat 5 at a frequency of about 16 days.
- From 1999 to 2011, NDVI is from Landsat 5 and 7 at a frequency of seven to eight days.
- In 2012, NDVI is from Landsat 7 at a frequency of 14 to 16 days.
- From 2013 to 2023, NDVI is from Landsat 7 and 8 at a frequency of seven to eight days.
- From 2021 to 2023, NDVI is from Landsat 7, 8, and 9 at a frequency of one to eight days.
- Since January 2024, NDVI is from Landsat 8 and 9 at a frequency of seven to eight days.

NDVI were cataloged, processed, and uploaded into HydroDaVE^{SM}, a database management software that manages gridded datasets and features tools for viewing and extracting data.[8] There is some overlap of NVDI data in areas where there is NVDI from Landsat scenes from Rows 036 and 037. HydroDaVE has the ability to compute a stacked average for Landsat scenes from Rows 036 and 037 for each NDVI pixel they overlay[9] when viewing and extracting NDVI data.

Review

Spatial NDVI were reviewed for disturbances that can be caused by cloud cover, unfavorable atmospheric conditions, or satellite equipment malfunction. In HydroDaVE^{SM}, maps were prepared of spatial NDVI for the entire Prado Basin region for each date. The maps were reviewed and documented to identify specific dates for exclusion due to cloud cover or other disturbances. Erroneous NDVI estimates were discernable because NDVI patterns of permanent landscape features were distorted and/or NDVI estimates were clearly not consistent with estimates typically observed for a particular area both seasonally and over time. On average, about 31 percent of the NDVI were identified as erroneous and excluded from the analysis. Most of which were rejected because of cloud coverage, which was further verified by referencing and viewing the specific Landsat scene on the USGS *EarthExplorer* website.[10]

After excluding erroneous NDVI estimates, there was one date for 1982, and there were no dates for 1983; as such, the time-series data discussed throughout Section 3 of the report include NDVI estimates for 1984 to 2024.

NDVI estimates derived from *Landsat 7* satellite imagery from mid-2003 to 2023 were further reviewed date-by-date for the occurrence of spatial data gaps, resulting from the failure of the Scan Line Corrector (SLC) on the *Landsat 7* satellite, which accounts for the satellite's forward motion. SLC failure results in data gaps along scan line paths of variable widths and occurrences. An estimated 22 percent of any given

[8] Hydrodave Link

[9] Not all dates will have Landsat scenes for both Rows 036 and 037 if cloud cover was greater than 20 percent in one of them; Landsat scenes with a percent cloud cover greater than 20 percent were not obtained from the USGS for this study.

[10] Earthexplorer Link

Landsat 7 scene is lost because of SLC failure; however, the imagery acquired between these gaps is valid and useable for analysis.[11] All NDVI estimates derived from *Landsat 7* satellite imagery from 2003 to 2023 were evaluated spatially date-by-date to determine if the valid portion of the data covers the defined areas of interest used for the temporal analysis of NDVI in the time series discussed in Section 3 of this report. Date-by-date analysis is necessary because the spatial position and size of the data gaps from the *Landsat 7* satellite vary for each date. Generally, areas of interest for NDVI analysis that are larger than about 400 square meters cannot use any NDVI determined from *Landsat 7* satellite imagery because it would include data gaps within the area; while areas of interest less than 400 square meters can use NDVI determined from the *Landsat 7* satellite imagery if the data gap area is not within the area of interest. During 2012, the *Landsat 7* satellite was the only Landsat satellite collecting data. Therefore, there are no data for the areas of interest larger than 400 square meters during 2012. After the launch of the *Landsat 9* satellite in 2022, there were several dates without spatial data gaps from the *Landsat 7* satellite.

[11] Landsat Link

Analyses of Time-series Data

HydroDaVE[SM] contains features to calculate and extract a spatial average NDVI for a designated area and time period. The NDVI spatial average for each available date is plotted in time-series charts to analyze seasonal and temporal changes for a defined area. Time-series charts of NDVI for various areas in the Prado Basin are first introduced in Section 3.1 of this report.

When viewing time-series charts of NDVI for the period of record, it should be noted that a methodological factor that can affect observed NDVI trends is the difference between the technology of the *Landsat 4, 5, and 7* satellites*,* and the *Landsat 8 and 9* satellites. The *Landsat 4, 5, and 7* satellites use thematic mapper technology to scan the land surface, whereas *Landsat 8* and *Landsat 9* use operational land imager sensors. It has been well documented that the NDVI estimates obtained from the operational land imager sensors used on the *Landsat 8 and 9* satellites generate slightly higher index values for vegetated land cover (Xu and Guo 2014; She et al., 2015). In order to analyze the time-series of NDVI derived across all Landsat satellites for the period of record, a bias-correction factor of -0.05, derived from literature review (Li et al., 2014; Flood, 2014: and Ke et al., 2015), was used to transform all Landsat 8 and 9 NDVI estimates such that all historical NDVI estimates could be analyzed collectively (Roy et al., 2016). The *Landsat 9* satellite was launched into orbit in 2022, and from 2022 to 2023, NDVI was available from *Landsat 7, 8, and 9* satellites. During 2023, data was collected from both the *Landsat 8 and 9* satellites on some of the same dates. On these dates, only NDVI from the *Landsat 9* satellite was used. The *Landsat 7* satellite stopped collecting data in January 2024 and since then, NDVI has been available from *Landsat 8 and 9* satellites.

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Appendix B

Mann-Kendall Analysis of NDVI

B.1 Introduction

The Mann-Kendall statistical trend test (Mann-Kendall test) was performed on the average growing-season NDVI metrics (NDVI) for the period of 1984 to 2024 for all 18 areas where NDVI are analyzed for the *Annual Report of the Prado Basin Habitat Sustainability Committee Water Year 2024*. The Mann-Kendall test was utilized to evaluate whether the average growing-season NDVI increased, decreased, or remained stable over time.

B.2 Methods

The Mann-Kendall test is a non-parametric statistical trend test. It is analogous to parametric trend testing such as regression (linear regression) except the data do not need to have a particular probability distribution (normal) and be accurately described by a particular measure of centrally tendency (mean, standard deviation, etc.) (Helsel and Hirsch, 2002).

To perform the test, the NDVI values are ordered chronologically and the signs (+/–) are recorded for all of the possible differences between a given NDVI value and every NDVI value that preceded it in the time series. The Mann-Kendall test statistic **S** is defined as the number of positive differences (+) minus the number of negative differences (–). From **S** and the number of NDVI values, **n**, the **τ** coefficient (analogous to the **r** correlation coefficient in linear associations) is then calculated. The **τ** coefficient represents the strength of the monotonic relationship between time and NVDI values with a possible range of -1 to 1. A perfect positive trend would yield a **τ** coefficient equal to 1, and a perfect negative trend would yield a **τ** coefficient equal to -1.

The Mann-Kendall test utilizes the null hypothesis that there is no trend. If the **S** test statistic and **τ** coefficient are significantly different than zero, the null hypothesis is rejected, and a trend exists. The level of statistical significance is expressed as a p-value between 0 and 1. The smaller the p-value the stronger the evidence that the null hypothesis should be rejected. In this study, a p-value of less than or equal to 0.05 was used to determine if a trend existed. In summary, the three possible outcomes of the test are

- Increasing trend (p-value ≤ 0.05, $\tau > 0$)
- No trend (p-value > 0.05)
- Decreasing trend (p-value ≤ 0.05, $\tau < 0$)

B.4 Data Analysis and Results

The Mann-Kendall **S** test statistic, **τ** coefficient and p-value were computed for average-growing season NDVI from 1984 to 2024 for the 18 areas in Prado Basin, using the python package *pyMann-Kendall* (Hussain, 2019). Tables B-1 through B-3 list the results of the Mann-Kendall test for the three time periods of interest: 1984 through 2024 (entire period of record); 1984 through 2006 (period prior to the Peace II Agreement); and 2007 through 2024 (period after the Peace II Agreement implementation).

Table B-1. 1984 to 2024

Area	n (number of NDVI values)	S Test Statistic	τ coefficient	p-value	Trend
Riparion Vegetation Extent	40	118	0.15	1.73E-01	No Trend
Chino Creek Area	40	522	0.67	1.28E-09	Increasing
Mill Creek Area	40	-18	-0.02	8.43E-01	No Trend
Upper Mill Creek Area	40	310	0.40	3.18E-04	Increasing
CC-1	41	596	0.73	2.34E-11	Increasing
CC-2	41	550	0.67	6.99E-10	Increasing
CC-3	41	542	0.66	1.23E-09	Increasing
CC-4	41	306	0.37	6.13E-04	Increasing
MC-1	41	508	0.62	1.24E-08	Increasing
MC-2	41	102	0.12	2.57E-01	No Trend
MC-3	41	264	0.32	3.14E-03	Increasing
MC-4	41	184	0.22	3.98E-02	Increasing
MC-5	41	112	0.14	2.12E-01	No Trend
MC-6	41	266	0.32	2.92E-03	Increasing
SAR-1	41	-80	-0.10	3.75E-01	No Trend
SAR-2	41	214	0.26	1.67E-02	Increasing
SAR-3	41	394	0.48	1.01E-05	Increasing
LP	41	-10	-0.01	9.19E-01	No Trend

Table B-2. 1984 to 2006

Area	n (number of NDVI values)	S Test Statistic	τ coefficient	p-value	Trend
Riparion Vegetation Extent	23	45	0.18	2.45E-01	No Trend
Chino Creek Area	23	123	0.49	1.27E-03	Increasing
Mill Creek Area	23	-119	-0.47	1.83E-03	Decreasing
Upper Mill Creek Area	23	-29	-0.11	4.60E-01	No Trend
CC-1	23	129	0.51	7.23E-04	Increasing
CC-2	23	141	0.56	2.18E-04	Increasing
CC-3	23	135	0.53	4.02E-04	Increasing
CC-4	23	5	0.02	9.16E-01	No Trend
MC-1	23	89	0.35	2.01E-02	Increasing
MC-2	23	-55	-0.22	1.54E-01	No Trend
MC-3	23	-51	-0.20	1.87E-01	No Trend
MC-4	23	-35	-0.14	3.69E-01	No Trend
MC-5	23	41	0.16	2.91E-01	No Trend
MC-6	23	-65	-0.26	9.10E-02	No Trend
SAR-1	23	11	0.04	7.92E-01	No Trend
SAR-2	23	-139	-0.55	2.68E-04	Decreasing
SAR-3	23	-25	-0.10	5.26E-01	No Trend
LP	23	85	0.34	2.65E-02	Increasing

Table B-3. 2007 to 2024

Area	n (number of NDVI values)	S Test Statistic	τ coefficient	p-value	Trend
Riparion Vegetation Extent	17	30	0.22	2.32E-01	No Trend
Chino Creek Area	17	80	0.59	1.14E-03	Increasing
Mill Creek Area	17	58	0.43	1.89E-02	Increasing
Upper Mill Creek Area	17	84	0.62	6.29E-04	Increasing
CC-1	18	99	0.65	2.06E-04	Increasing
CC-2	18	113	0.74	2.21E-05	Increasing
CC-3	18	79	0.52	3.13E-03	Increasing
CC-4	18	71	0.46	8.01E-03	Increasing
MC-1	18	115	0.75	1.57E-05	Increasing
MC-2	18	71	0.46	8.01E-03	Increasing
MC-3	18	65	0.42	1.53E-02	Increasing
MC-4	18	27	0.18	3.25E-01	No Trend
MC-5	18	67	0.44	1.24E-02	Increasing
MC-6	18	115	0.75	1.57E-05	Increasing
SAR-1	18	81	0.53	2.44E-03	Increasing
SAR-2	18	109	0.71	4.30E-05	Increasing
SAR-3	18	105	0.69	8.17E-05	Increasing
LP	18	-21	-0.14	4.49E-01	No Trend

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Appendix C

Draft 2022 Prado Basin Vegetation Survey Report

United States Department of the Interior

BUREAU OF RECLAMATION
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Denver, CO 80225-0007

IN REPLY REFER TO:
86-68560
1.3.11

VIA ELECTRONIC MAIL ONLY

Memorandum

To: Leslie Cleveland, Water Resources Manager
Southern California Area Office (SCAO-7200)

From: Aaron Murphy, Ecologist
Hydraulic Investigations and Laboratory Services (86-68560)

Subject: Prado Basin Vegetation Survey

Please find attached the final report for the Prado Basin Vegetation Survey (EcoLab-LCP23-2023-03). This memorandum documents the vegetation surveys and data analysis conducted in the Prado Basin, CA in October 2022. These surveys were done to support the Inland Empire Utilities Agency (IEUA) and Chino Basin Watermaster at the request of the Southern California Area Office (SCAO). Any questions about the surveys or memorandum should be addressed to Aaron Murphy at 303-445-2157 (amurphy@usbr.gov) or Scott O'Meara at 303-445-2216 (someara@usbr.gov).

Attachment

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Prado Basin Vegetation Survey – October 2022

Riverside and San Bernardino Counties, California
Chino Basin Watermaster and Inland Empire Utilities Agency
Prado Basin Habitat Sustainability Program

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Prado Basin Vegetation Survey – October 2022

Riverside and San Bernardino Counties, California
Chino Basin Watermaster and Inland Empire Utilities Agency
Prado Basin Habitat Sustainability Program

Technical Service Center

Hydraulic Investigations and Laboratory Services
Ecological Research Laboratory

EcoLab-LCP23-2023-03

Aaron Murphy, Ecologist
Scott O'Meara, Botanist

Cover Photo: Misty morning at the Orange County Water District office. (Reclamation/Aaron Murphy)

Contents

Introduction

The United States Bureau of Reclamation (Reclamation) has been monitoring riparian vegetation within the Prado Flood Control Basin (Prado Basin) since 2003 to support the Inland Empire Utilities Agency (IEUA) and Chino Basin Watermaster (Watermaster). This report details vegetation monitoring surveys conducted in October 2022 by Reclamations' Technical Service Center. Similar vegetation monitoring surveys were conducted by Reclamation in 2007, 2013, 2016, and 2019.

The IEUA, Watermaster, and the Orange County Water District (OCWD) are concerned about the quality of water flowing into the Santa Ana River. In the southern Chino Basin, as agricultural/dairy land uses are converted to urban, there is more water recycled and reused, both of which result in less groundwater pumping and the potential for poor quality groundwater to become rising groundwater to the Santa Ana River. Groundwater pumping by a regional municipal well field across the southern Chino Basin was proposed in the Watermaster's Optimum Basin Management Program to control groundwater levels in southern Chino Basin, including the Prado Basin, and to limit rising groundwater and its water-quality impacts to the Santa Ana River and downstream beneficial users.

In the Prado Basin, riparian habitat could be impacted by decreasing groundwater levels caused by the groundwater pumping plan. Riparian habitats are an ecologically important part of the landscape. They contain higher levels of species richness than other habitats and are essential to promoting regional biodiversity. Conservation of the riparian habitat of the Prado Basin is important to IEUA, Watermaster, OCWD, Reclamation, and other entities involved in water and habitat conservation.

Riparian habitat along Mill and Chino Creeks, and in the Prado Basin, is dominated by native plants, including: Goodding's willow (*Salix gooddingii*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), sandbar willow (*Salix hindsiana*), Fremont cottonwood (*Populus fremontii*), and black cottonwood (*Populus trichocarpa*). Riparian species are generally phreatophytic, meaning they must maintain root contact with water. A decrease in groundwater elevation could negatively affect recruitment, density, and vigor of existing trees.

The riparian area in the Prado Basin is also breeding habitat for two endangered songbirds, Least Bell's Vireo (*Vireo bellii pusillus*) and Southwestern Willow Flycatcher (*Empidonax trailii extimus*), as well as for the Yellow-billed Cuckoo (*Coccyzus americanus*), a threatened species. An active and successful management program has made this area vital to the recovery of the Least Bell's Vireo.

Study Area

There are approximately 6,000 acres of riparian vegetation in the Prado Basin (Figure 1). This constitutes the largest riparian area of willow woodlands in Southern California, and it is home to rare, threatened, and endangered species. One endangered songbird, the Least Bell's Vireo (Vireo bellii pusillus) builds nests within dense riparian shrubs. This species is a California state and federally listed endangered species, and the Prado Basin is designated as critical habitat. In addition to ecological concerns, the Prado Basin is important for flood control, water storage, and water quality improvement.

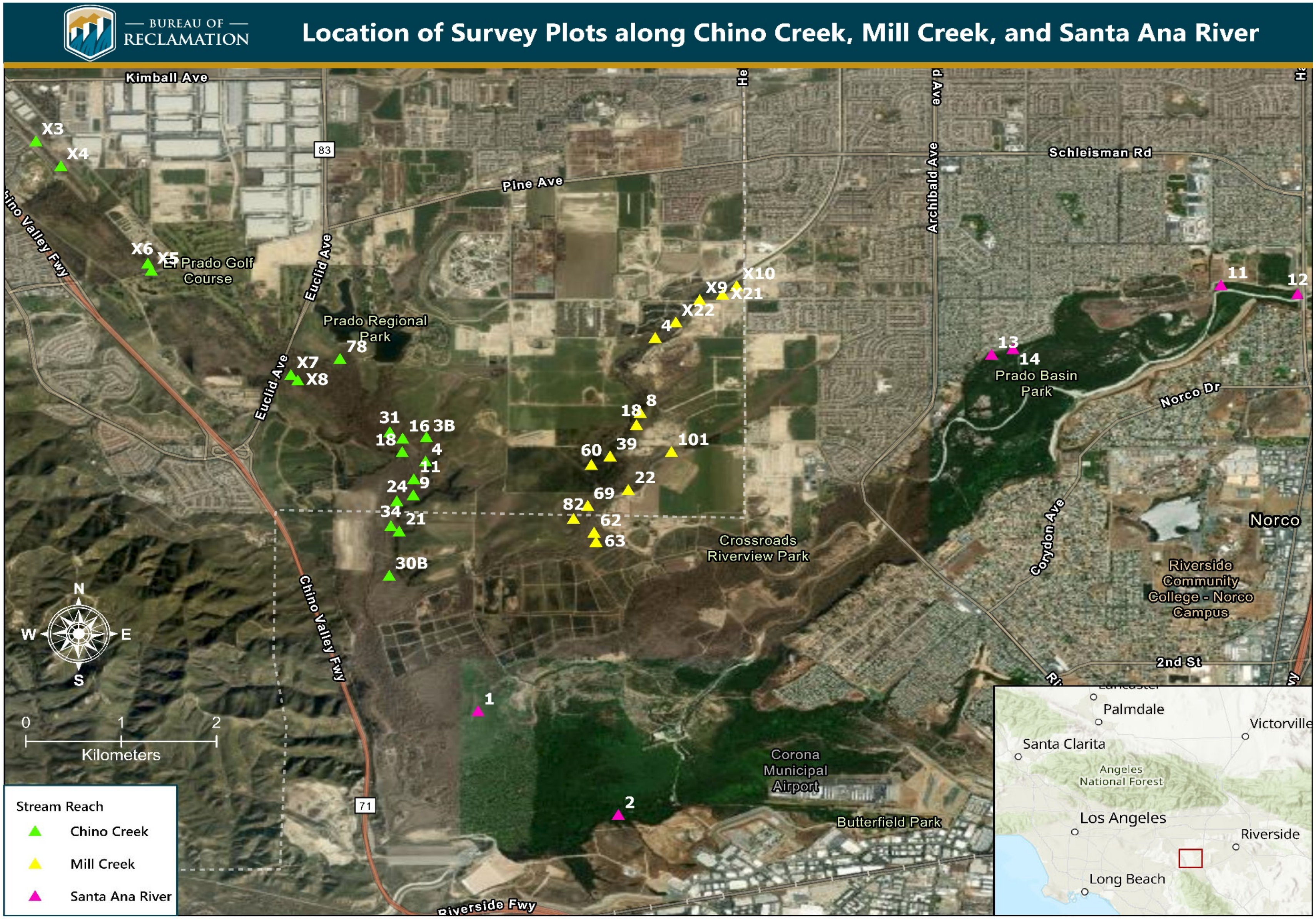

Figure 1. Map of Prado Basin study area with locations of 2022 survey plots.

Methods

The field sampling protocol developed in 2003 has been modified over time to achieve overall study goals with the available resources.

Monitoring History Performed by Reclamation in Prado Basin for IEUA/Watermaster

- *June 2003* - Mill Creek was chosen as the study area and Chino Creek was chosen as the control area for vegetation monitoring based on analysis of a depth-to-water hydraulic model by Wildermuth Environmental Inc. (WEI).
- *November 2003* - Aerial photographs were taken of the entire Prado Basin, including the riparian areas along Mill Creek, Chino Creek, the Santa Ana River, and Temescal Creek.
    - Aerial photographs were used to delineate riparian areas into cover types. Wetland and deep-water habitats were mapped and classified according to the United State Fish and Wildlife Service (USFWS) wetland hierarchical classification system (Cowardin et al, 1979).
- *March 2004* - Pilot data were collected at Mill Creek (18 plots) and Chino Creek (15 plots) to determine necessary sample size and sampling methodology.
- *October 2007* - Permanent plots were established at locations near the 2004 pilot locations and marked with t-posts. A sampling methodology was established; vegetation data were collected and trees were tagged.
- *October 2013* – The monitoring protocol was adjusted. Herbaceous vegetation was excluded as it was deemed less relatable to groundwater and too labor intensive to monitor. Variable radius plots were established at each monitoring site and vegetation data were collected.
- *October 2016* - Additional permanent plots were established at 14 locations adjacent to shallow monitoring wells along Mill Creek, Chino Creek, and the Santa Ana River. Data were collected at 37 permanent plots (23 survey previously and 14 new) using the 2013 monitoring protocol.
- *September 2019* – The 37 permanent plots surveyed in 2016 were surveyed using the 2013/2016 protocol. No new plots were established, but additional trees were tagged and recorded (Figure 1).
- *October 2022* – The 37 permanent plots surveyed in 2019 were surveyed along with two additional plots established along Mill Creek bringing the total number of plots to 39 (Figure 1). The monitoring protocol was modified to eliminate the collection of tree diameter at breast height, tree height, and lowest leaf height since these variables were not used in the assessment of riparian health.

Initial Monitoring (2003 & 2007)

The original monitoring plan used a fixed area sampling method to measure species composition, density, and basal area. Nested variable quadrats based on vegetation layer were used at each sampling point. Live and dead trees, saplings, shrubs, and seedlings were counted by species within their respective quadrat sizes.

For overstory species, diameter at breast height (DBH), height, and/or stem diameter 30 cm above the ground for shrubs, were measured. Canopy cover was estimated using four spherical densiometer measurements per plot, 5 meters from the plot center in each of the four cardinal directions. Photo points were also taken from the center of the quadrat in each of the four cardinal directions. In 2007, plots were permanently marked with t-posts and trees were tagged in order to conduct identical measurements over time.

Modified Monitoring (2013, 2016, & 2019)

From 2013 to 2019 monitoring was conducted at the locations established in 2007. An additional 14 plots were established in 2016: 6 on Chino Creek (18 total plots), 2 on Mill Creek (13 total plots), and 6 on the Santa Ana River (6 total plots). This brought the basin study total to 37 monitoring plots across three stream reaches.

Shrubs and saplings (DBH <8 cm) were the only component of the understory monitored. Herbaceous vegetation was excluded after 2007 as it was deemed less relatable to groundwater and is more labor intensive to monitor. Within the plots, the DBH was measured for each sapling, or Diameter at Root Collar (DRC) for shrubs. Shrub stems branching below 10 cm counted as individual stems, and downed trees were not counted. Species, height, and distance/azimuth from the center point were also recorded for each plant.

Trees with DBH >8 cm were monitored within variable radius plots: 5 or 10 meters to contain approximately 10 trees. Each tree within the plot was identified to species and was visually assessed for the presence of shot-hole borer (*Euwallacea* sp.) and for health condition (Live/Dead/Stressed). Tree measurements included DBH, total height and low-crown height (Crown Ratio), and percent canopy cover. Canopy cover was estimated using four spherical densiometer measurements per plot, 5 meters from the plot center in each of the four cardinal directions.

For each variable (DBH, height, percent canopy cover, basal area, stem density, and crown ratio), the average value was derived for each plot surveyed during each survey year. The percentage of Live/Dead/Stressed trees was calculated. Species composition was evaluated at the site level. The presence of shot-hole borer was also evaluated.

Current Monitoring (2022)

Monitoring was conducted at the 37 locations established between 2007 - 2016. Two additional plots were established along the northern part of Mill Creek (Figure 1).

Understory Sampling

Shrubs and saplings (trees with DBH <8 cm) are the only component of the understory monitored. Herbaceous vegetation was excluded after 2007 as it was deemed less relatable to groundwater and is more labor intensive to monitor. Saplings and shrubs were assessed for health condition (Live/Dead/Stressed) and identified to species level. Shrubs often have multiple stems that branch below 10 cm above the ground and the number of stems was counted. Downed trees were not counted.

Overstory Sampling

Trees with DBH >8 cm are monitored within variable radius plots. Plots were designed to have radii of 5 or 10 meters and to contain approximately 10 trees. The radius of the plot is held constant across sampling years regardless of changes to tree count. Each tree within the plot was identified to species and was visually assessed for the presence of shot-hole borer (*Euwallacea* sp.). Adult beetles burrow exit holes through the bark and the damage takes on a "shotgun blast" appearance.

Each tree was assessed for health condition (Live/Dead/Stressed). The Stressed condition was applied to trees that had dead sections or other visible damage, but that were clearly still alive. Canopy cover was recorded using four spherical densiometer measurements per plot, approximately 1 meter from the plot center in each of the four cardinal directions.

Plot Photos

Photographs were taken in each of the cardinal directions from the center of the plot. Photos are not included in this report due to file size, but will be provided to West Yost on behalf of Watermaster/IEUA.

Data Analysis

For each plot the percentage of Live/Dead/Stressed trees was calculated, along with the percent infested by shot-hole borer. The average percent canopy cover and number of trees per hectare was also calculated for each plot. Species composition was evaluated at the stream reach level.

Results

This section presents results from surveys conducted in 2022 along the three stream reaches, Chino Creek, Mill Creek, and Santa Ana River. A summary of measured and calculated variables for each plot can be found in Attachment 1.

Canopy Cover

Mean canopy cover exceeded 70% at all 3 steam reaches in 2022 (Table 1). Mean canopy cover along Chino Creek (81.5%) was higher than along Mill Creek (76.2%) and the Santa Ana River (72.7%). All measurements of mean canopy cover per plot can be found in Attachment 1.

Table 1. Mean (standard error), maximum, and minimum canopy cover found at the plot level within each stream reach, Prado Basin 2022.

	Chino Creek	Mill Creek	Santa Ana River
Mean Cover	81.5% (6.6)	76.2% (7.9)	72.7% (13.4)
Maximum Cover	100%	100%	98.7%
Minimum Cover	4.2%	0.0%	19.3%

Shrubs

Mule fat (*Baccharis salicifolia*), Mexican elderberry (*Sambucus mexicana*), and tree tobacco (*Nicotiana glauca*) shrubs were found in four plots along Mill Creek (Table 2). No shrubs were observed within the surveyed plots along Chino Creek or Santa Ana River.

Table 2. Summary of shrub coverage at Mill Creek survey plots, Prado Basin 2022.

Mill Creek Plot	Species	Total Stems
8	*Sambucus mexicana*	10
X9	*Baccharis salicifolia*	13
X22	*Baccharis salicifolia*	8
X22	*Nicotiana glauca*	3
62	*Baccharis salicifolia*	7

Saplings

Saplings (DBH < 8cm) were found along Chino Creek (80 total saplings observed), Mill Creek (23), and the Santa Ana River (8) in 2022. In addition to common riparian species such as Goodding's and arroyo willow, sapling species included: boxelder (*Acer negundo*), velvet ash (*Fraxinus velutina*), sycamore (*Platanus* sp.), eucalyptus (*Eucalyptus* sp.), and tree-of-heaven (*Ailanthus altissima*).

Eucalyptus are non-native trees that can form monotypic groves and outcompete native species. Five eucalyptus saplings were found in Plot 18 along Chino Creek in 2019 and all were still living in 2022. There are currently no tagged eucalyptus trees within Plot 18.

Tree-of-heaven is a clonal invasive species that forms dense thickets and is designated a moderate threat by the California Invasive Plant Council (CAL-IPC). One tree-of-heaven sapling was observed in Plot 10 along Mill Creek. There are no tagged tree-of-heaven trees in Plot 10. However, additional tree-of-heaven saplings were observed outside the plot radius.

The highest densities of saplings were found along Chino Creek (Table 3). In Plot 21, all tagged trees were burned during the Euclid Fire (June 2018) and Gooding's willow saplings have re- sprouted near dead remnants. In Plot 1 (Santa Ana River), a fire burned all tagged trees in 2021 and several Gooding's willow saplings have emerged in the plot.

Overstory Trees

Goodding's willow was the most abundant overstory species found in all stream reaches (Table 4). Other species observed included velvet ash, Fremont cottonwood, arroyo and red willow, boxelder, sycamore, tree-of-heaven, and eucalyptus.

Table 3. Mean (standard error) values for density (saplings/ha) of live saplings. Percentages of Live(L)/Dead (D)/Stressed (S) saplings and species at each stream reach, Prado Basin 2022.

Metrics	Chino Creek	Mill Creek	Santa Ana River
Density (saplings/ha)	259.9 (65.2)	72.2 (30.2)	42.4 (26.8)
Sapling Health			
Live	60.0%	65.2%	66.7%
Dead	21.3%	17.4%	0.0%
Stressed	18.8%	17.4%	33.3%
Species Composition			
Goodding's willow	68.8%	87.0%	100.0%
Arroyo willow	10.0%	-	-
Boxelder	11.3%	-	-
Eucalyptus	6.3%	-	-
Velvet ash	3.8%	4.3%	-
Sycamore	-	4.3%	-
Tree-of-heaven	-	4.3%	-

Table 4. Percentages of Live/Dead/Stressed overstory trees and species composition found at each stream reach, Prado Basin 2022.

Tree Health	Chino Creek	Mill Creek	Santa Ana River
Live	58.3%	47.7%	46.0%
Dead	16.6%	18.9%	26.5%
Stressed	25.1%	33.3%	27.4%
Species Composition			
Goodding's willow	76.8%	95.5%	74.3%
Velvet ash	9.5%	1.8%	-
Arroyo willow	5.2%	-	13.3%
Boxelder	4.7%	-	-
Eucalyptus	2.4%	-	4.4%
Red willow	1.4%	-	-
Sycamore	-	0.9%	-
Tree-of-heaven	-	0.9%	-
Fremont cottonwood	-	0.9%	8.0%

The proportion of live, dead, and stressed trees on each plot was highly variable throughout the Prado Basin in 2022. At the stream reach level, Chino Creek had the highest percentage of live trees and lowest percentage of dead trees (Figure 2). More than 25% of trees at all locations were classified as stressed. The highest percentage of dead trees (26.5%) was found in the Santa Ana River area. The plots in the Santa Ana stream reach have been impacted by fire (Plot 1) and extensive grape vine infestations (Plot 2 and Plot 13) since the 2019 surveys.

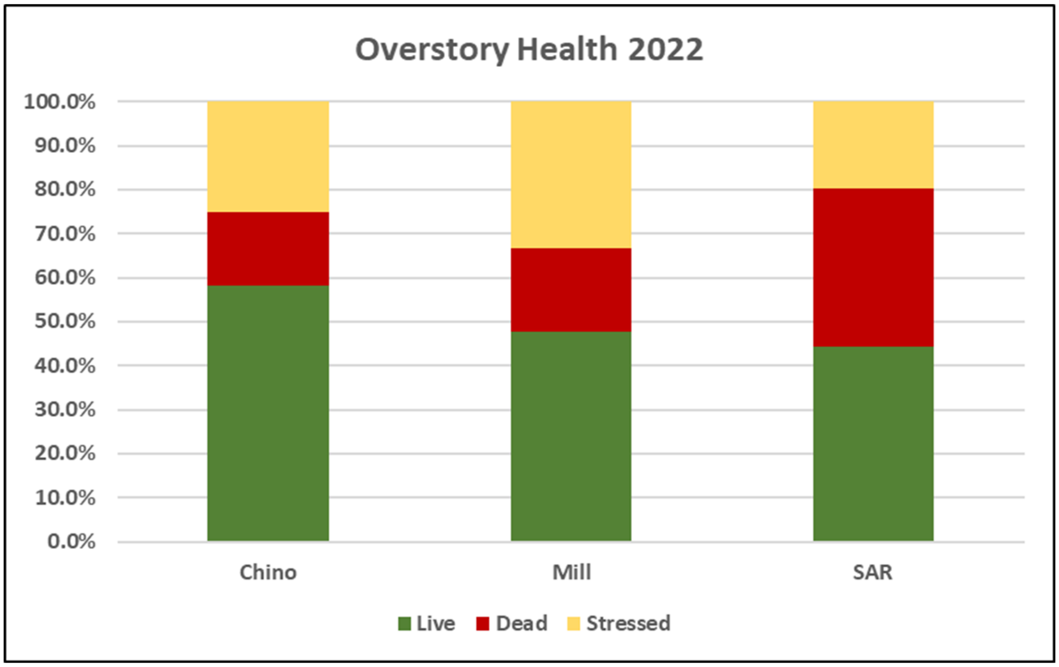

Figure 2. Percentages of Live, Dead, and Stressed trees at each site, Prado Basin 2022.

The health of live and stressed trees was assessed to compare changes from 2016 to 2019 with changes from 2019 to 2022 (Figure 3). Live trees changed at the same percentage in both time periods. Among stressed trees, 49% changed from stressed to live between 2019 and 2022. This was higher than the 29% change from 2016 to 2019.

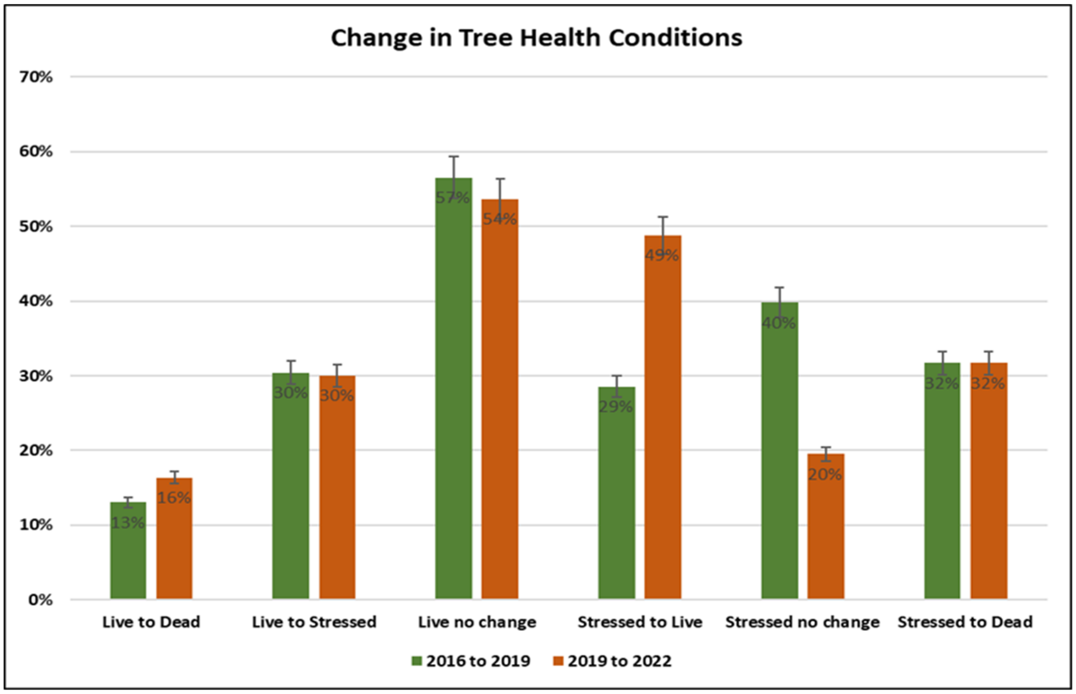

Figure 3. Changes in health conditions for live and stressed trees between 2016 and 2022. Shown with standard error bars.

Shot-Hole Borer

The shot-hole borer is a burrowing beetle found on a wide range of host plants, that spreads fungal pathogens within the vascular system. The beetles are known to prefer healthy trees and were first documented in the vegetation surveys in 2016.

The presence of shot-hole borer was noted in plots along all stream reaches (Table 5). Shot-hole borer was documented as present if there was obvious damage to the tree. Evidence of shot-hole borer damage was found on live (3), stressed (15), and dead (1) trees and in Gooding's willow, velvet ash, arroyo willow, and boxelder. No saplings were found with shot-hole borer damage.

Table 5. Percentage of trees with shot-hole borer observations at each stream reach in Prado Basin.

Shot-hole Borer	Chino Creek	Mill Creek	Santa Ana River
2016	28.1%	56.5%	44.2%
2019	2.5%	9.2%	0.0%
2022	3.3%	9.0%	1.8%

Temporal Comparison

Changes in overstory health between 2019 and 2022 were evaluated for all stream reaches. At Chino Creek and Mill Creek the percentage of live, unstressed trees increased by 12-13%, while the percentage along the Santa Ana River decreased by 9% (Figure 4). The percentage of dead trees in the Santa Ana River reach increased by 20%. Much of the increase in dead trees in the Santa Ana

River plots could be explained by the impacts of a fire at Plot 1 and grapevine competition in Plots 2 and 13. Extensive grapevine was observed wrapped around trees in Plots 2 and 13 during the 2022 surveys. Grapevine can damage trees by breaking off tree tops or limbs and by reducing the sunlight that reaches leaves.

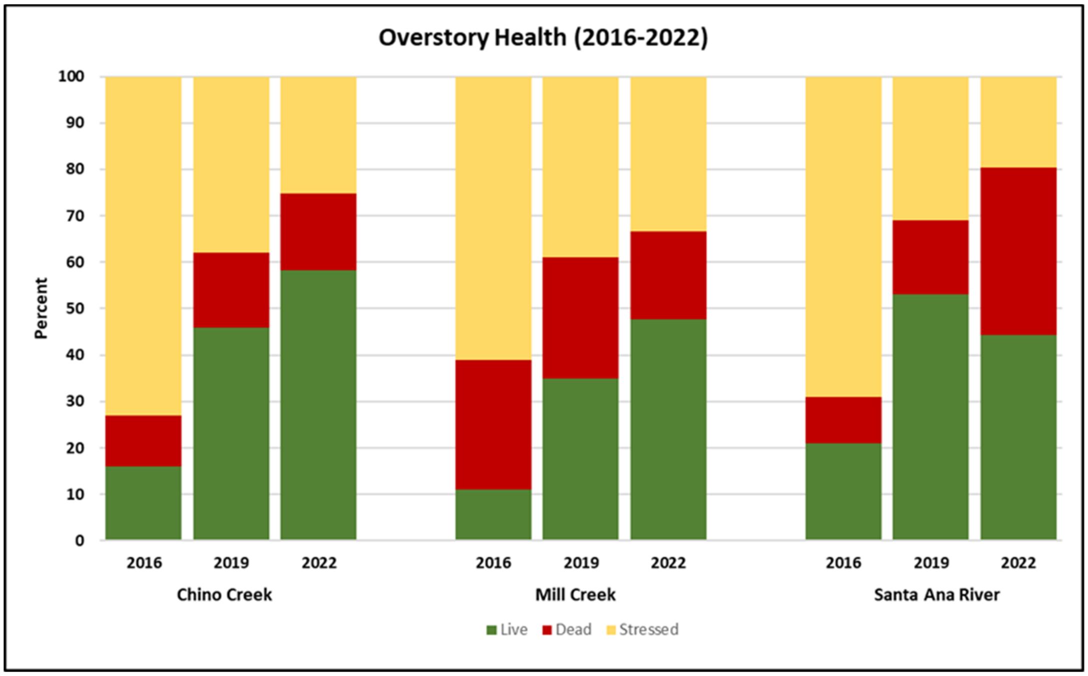

Figure 4. Overstory health from 2016 to 2022 along Chino Creek, Mill Creek, and the Santa Ana River.

Canopy cover is an estimate of how much of the ground is covered by overstory vegetation. Differences in cover between sampling years are to be expected due to natural variation and climatic changes. Fire, flood, or extreme weather events can also impact the canopy cover particularly at the plot level. There have been no meaningful changes to mean canopy cover along Chino Creek or Mill Creek since 2013 (Figure 5). Mean canopy cover in the Santa Ana River plots decreased by 20% from 2019 to 2022, primarily because of losses at Plot 1 (fire) and Plot 13 (grapevine competition).

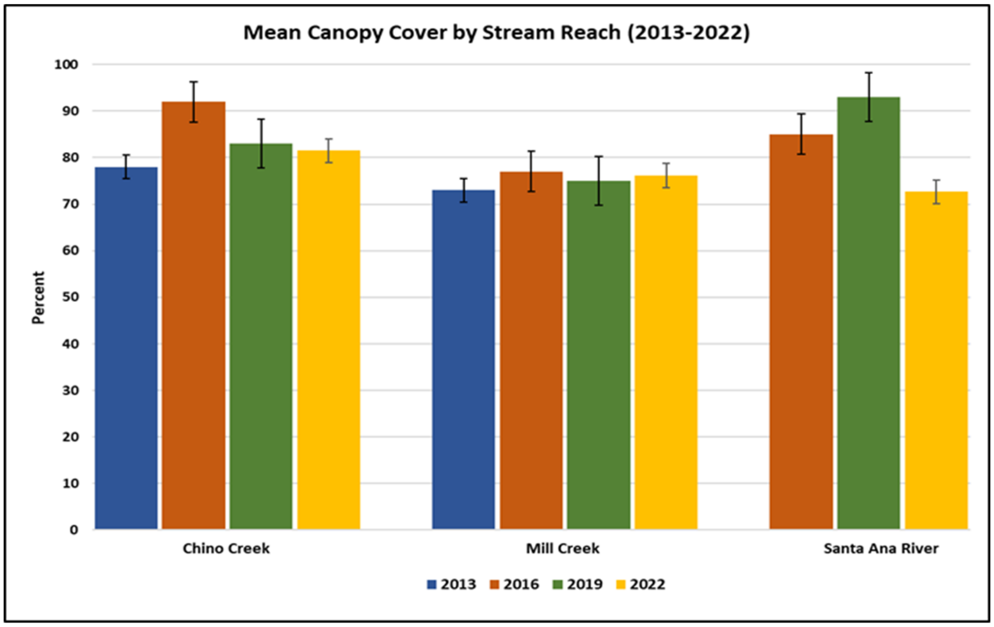

Figure 5. Mean canopy cover and standard error bars from 2013 to 2022 along Chino Creek, Mill Creek, and the Santa Ana River.

Changes to sapling recruitment were also evaluated. From 2019 to 2022 changes to sapling density along all three stream reaches were minimal (Figure 6).

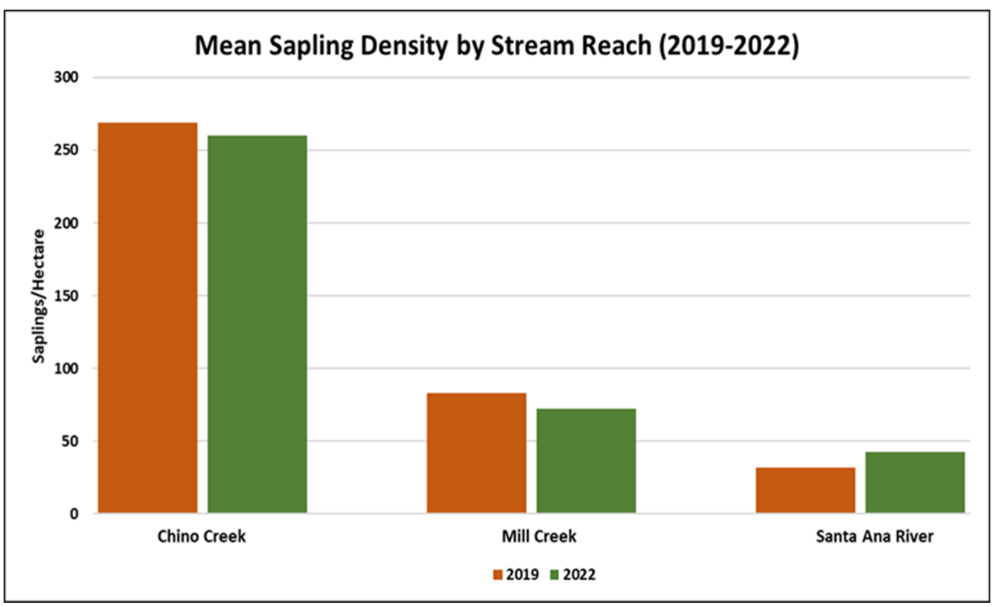

Figure 6. Mean sapling density from 2019 to 2022 along Chino Creek, Mill Creek, and the Santa Ana River.

Discussion

The riparian zone in the Prado Basin is highly variable and dynamic. Vegetation along all three stream reaches is affected by flood, wind, and fire events, as well as variations in precipitation and growing seasons. The presence of the invasive polyphagous shot-hole borer may further confuse potential stream reach effects. Trees in all reaches have fallen and re-sprouted, often with multiple stems, further confounding the analysis. Due to these variables, as well as the modifications to the monitoring protocol over time, it is difficult to derive long-term trends or conclusions.

Remotely sensed imagery allows for a more complete interpretation of riparian health. The monitoring conducted during this study was limited to 39 small plots spread throughout a 4,300-acre riparian zone. NDVI for the entire Prado Basin can provide a more complete overview of changes and identify potential trouble spots. The most effective use of the field monitoring data in Prado Basin may be to validate the remote sensing data, which is better suited for a full-scale analysis of the Prado Basin at a more frequent time interval.

The observed canopy cover can be compared to NDVI data for each plot to provide a measure of ground truthing. Canopy cover across all stream reaches was compared for 2013 to 2022 (Figure 5). The mean canopy cover percentage for Chino Creek and Mill Creek plots has remained relatively consistent. Canopy cover in the Santa Ana River plots was reduced by 20% in 2022, primarily due to losses from a fire in Plot 1 and grapevine competition in Plots 2 and 13.

Based on the field surveys, overstory health improved along Chino Creek and Mill Creek from 2019 to 2022 but slightly declined along the Santa Ana River (Figure 4). The percentage of dead trees along the Santa Ana River increased in 2022, due to a fire in Plot 1 and grapevine competition in Plots 2 and 13. The increase in live, unstressed trees along Chino and Mill Creeks was somewhat surprising given the drought conditions of the last several years. Changes to sapling recruitment could also indicate potential problems with the riparian habitat. However, there was no change in sapling density along any stream reach from 2019 to 2022 (Figure 6).

A simple analysis was conducted to compare how live and stressed trees changed between 2016 to 2019 and from 2019 to 2022 (Figure 3). Live trees changed to stressed or dead at approximately the same percentage during both time periods. The same percentage of stressed trees changed to dead during both time periods, but the percentage of stressed trees that changed to live was greater from 2019 to 2022. The percentage of trees infested with shot-hole borer along each stream reach remained consistent from 2019 to 2022 (Table 5).

Environmental monitoring programs should be regularly reevaluated to ensure the best available tools are being used. Remotely sensed NDVI data may provide a more complete picture of the health of the riparian vegetation than ground-based surveys and was used by Watermaster and IEUA for the Prado Basin Habitat Suitability Program to monitor during the 2019 surveys. Uncrewed aerial systems (UAS) can carry a variety of sensors and could provide data on canopy cover, canopy height, and other overstory parameters (Cromwell et al 2021, Jin et al 2020, Miraki & Sohrabi 2022,). The complex habitat and extensive tree cover in the Prado Basin would likely limit the ability of UAS to exactly duplicate the current ground truthing, but could cover a much larger area in a shorter amount of time. Assessing the canopy cover over permanent sites from above, instead of below, should be possible using UAS and simple RGB sensors. Either satellite or UAS remote sensing would provide data over a much larger area than targeted, ground based surveys.

Acknowledgements

We would like to thank the staff of the OCWD for their help in conducting the Prado Basin vegetation monitoring. Their expertise and assistance were essential to completing the survey.

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Jin C, Oh C-y, Shin S, Wilfred Njungwi N, Choi C. (2020). A comparative study to evaluate accuracy on canopy height and density using UAV, ALS, and fieldwork. *Forests*. 2020; 11(2):241. https://doi.org/10.3390/f11020241

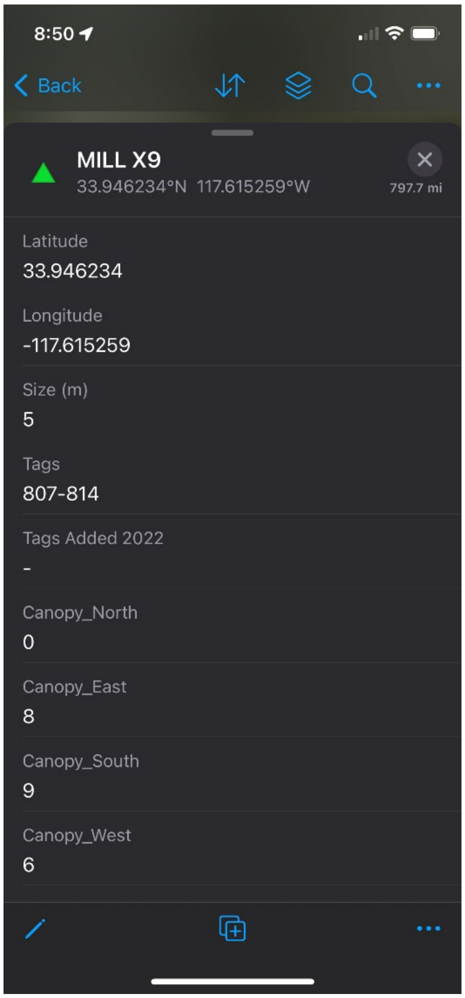
Miraki, M. & Sohrabi, H. (2022). Using canopy height model derived from UAV imagery as an auxiliary for spectral data to estimate the canopy cover of mixed broadleaf forests. *Environmental Monitoring and Assessment*, 194(45). https://doi.org/10.1007/s10661-021-09695-7

Attachment 1. Plot Summary Data

SITE	PLOT	COVER (%)	LIVE (%)	STRESSED (%)	DEAD (%)	SHB PRESENT	SHB (%)	TREES PER HECTARE
CHINO	4	86	63	5	32	NO	0	637
CHINO	9	99	50	33	17	NO	0	764
CHINO	11	94	73	9	18	NO	0	382
CHINO	16	27	50	29	21	NO	0	573
CHINO	18	81	100	0	0	NO	0	1401
CHINO	21	4	75	0	25	NO	0	1019
CHINO	24	99	64	27	9	NO	0	891
CHINO	31	98	68	16	16	YES	11	700
CHINO	34	91	0	100	0	NO	0	764
CHINO	78	95	33	42	25	NO	0	541
CHINO	30B	98	50	25	25	NO	0	1273
CHINO	3B	100	43	43	14	NO	0	1273
CHINO	X3	69	100	0	0	NO	0	891
CHINO	X4	45	40	60	0	YES	40	1019
CHINO	X5	96	78	22	0	NO	0	1401
CHINO	X6	100	50	29	21	NO	0	2292
CHINO	X7	84	33	67	0	YES	33	318
CHINO	X8	100	39	33	28	YES	6	3056
MILL	4	0	0	50	50	YES	50	95
MILL	8	64	0	100	0	NO	0	509
MILL	X9	94	50	50	0	YES	8	2292
MILL	X10	88	73	18	9	YES	18	1655
MILL	18	98	40	30	30	YES	10	414
MILL	22	94	0	67	33	YES	50	1273
MILL	39	91	33	33	33	NO	0	255
MILL	60	45	11	67	22	NO	0	477
MILL	62	79	40	20	40	YES	20	764
MILL	63	100	0	0	100	NO	0	159
MILL	69	70	83	17	0	NO	0	223
MILL	82	97	55	27	18	NO	0	446
MILL	101	94	57	30	13	YES	4	955
MILL	X21	91	80	20	0	NO	0	191
MILL	X22	38	78	22	0	NO	0	350
SAR	1	19	44	0	56	NO	0	286
SAR	2	79	33	61	6	YES	11	923
SAR	11	95	67	17	17	NO	0	891
SAR	12	99	53	0	47	NO	0	1910
SAR	13	46	20	0	80	NO	0	637
SAR	14	97	50	0	50	NO	0	1019

Attachment 2. 2022 Data Collection

In 2022, paper data sheets were replaced with forms created in ESRI's ArcGIS FieldMaps application. This reduced the amount of paper used and allowed the data collected to be uploaded to ArcGIS Online almost instantly. This method worked as expected and no issues were encountered.



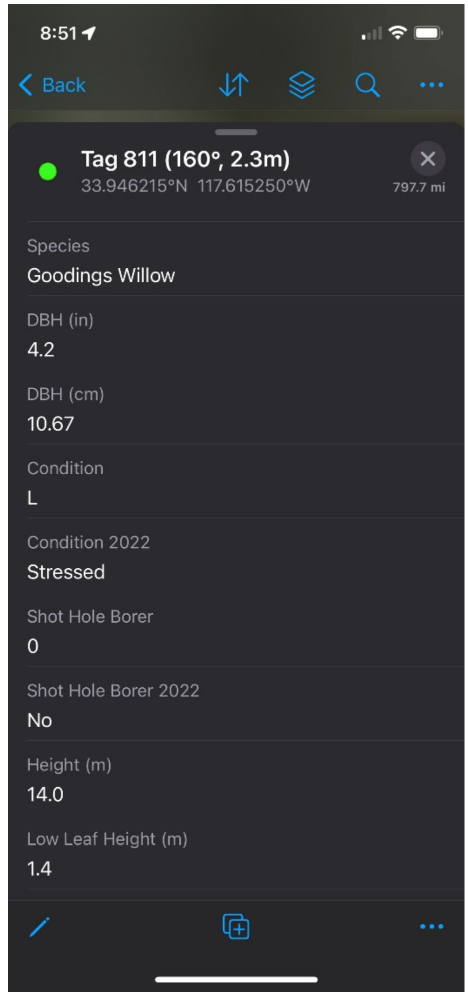


Figure 1. Images of the field collection app in FieldMaps. The screenshot on the left is the form used to collect canopy cover at each plot center and save photographs. The screenshot on the right is the form used to collect individual tree data.

Appendix D

Response to Draft Annual Report of the Prado Basin Habitat Sustainability Program for Water Year 2024

ORANGE COUNTY WATER DISTRICT (SHERYL PARSONS AND KEVIN O'TOOLE)

Kevin and I have reviewed the Prado Basin Habitat Sustainability Committee annual report and wanted to share the following questions and comments for your consideration:

Comment 1 – Applicability and Overreliance on NDVI for Habitat Health Assessment

"A limitation of NDVI data is that it is a composite view of plant species diversity, form, structure, density, and vigor. As such, changes in NDVI may be caused by various changes in riparian habitat (Markon et al., 1995; Markon and Peterson, 2002). In other words, NDVI does not provide a complete picture of how and why vegetative changes are occurring; it simply indicates a change in vegetation." PDF – page 21. It remains unclear how NDVI relates specifically to riparian habitat. Would habitat conversion from riparian to xeric plans species show up in NDVI. If so, how? Have other aerial image derived products been considered, (e.g. NDMI or vegetation type mapping)? Should an alternative monitoring approach be used instead of NDVI, if effects on specifically riparian vegetation, not just vegetation as a whole, can't be identified via NDVI?

Response:

As stated in the report, NDVI is not species-specific and therefore, does not distinguish riparian habitat from other vegetation, such as xeric species; however, the regional scale of NDVI makes it an appropriate 'first indicator' of regional changes in the extent and quality of the vegetation.

NDVI is considered the standard index for vegetation health and is among the most widely used satellite imagery in ecology and conservation studies (Pettorelli, 2013). It was selected for the Prado Basin Habitat Sustainability Program (PBHSP) based on peer-reviewed studies and recommendations from outside experts. Additionally, NDVI data derived from Landsat imagery, is available to download for no cost from the USGS. Landsat imagery is the only data source with more than thirty-years of continuous records of global land surface conditions at a spatial resolution of tens of meters and is, therefore, the best dataset for comparing vegetation before and after implementation of the Peace II agreement. Appendix A of the report provides more background information on NDVI and discusses additional advantages and limitations of NDVI.

In addition to NDVI, the PBHSP has considered other spectral indices derived from Landsat imagery such as the Normalized Difference Moisture Index (NDMI), as a potential complementary indicator of vegetation health. Recently, the use of NDMI for monitoring vegetation health has become more popular and is often used in conjunction with NDVI to assess vegetation health. An advantage of NDMI is that it measures the moisture content and can allow an earlier indication of the negative impacts of drought or declining groundwater levels on vegetation, likely before changes in NDVI or greenness in the vegetation are observed.

The PBHSP includes the collection of additional riparian habitat data—such as aerial photographs and triennial field vegetation surveys—which are used to validate, compare, and augment the NDVI interpretations. These vegetation surveys document the shrub and tree species present at the monitoring sites.

The analysis presented in this 2024 Annual Report provides the first indication of a potential decline in vegetation greenness within the Mill Creek reach, an area that has experienced declining groundwater levels. The PBHSP is designed to adapt based on findings and interpretations. For instance, if results suggest that vegetation health is being impacted by declining groundwater levels—potentially linked to the Peace II Agreement—then additional tools such as NDMI or enhanced species mapping using aerial imagery could be incorporated into the monitoring framework.

As outlined in the response to Comment #2 below, the vegetation surveys scheduled for this summer will help verify and document any observed impacts. These findings will inform recommendations for future studies or monitoring efforts necessary to understand the extent and causes of vegetation changes, if appropriate.

Comment 2 – Concerns Over Observed Declines and Lack of Response on Mill Creek

"Groundwater levels have declined the most in the northern portion of Mill Creek just south of the PB-2 monitoring well. From 2016 to 2022 groundwater levels declined by about eight feet likely due to increased pumping at the CDA wells to the north. During 2023 and 2024, groundwater levels increased by about four feet in this area, for a net change in groundwater levels of -4 feet since 2016. Recent observations of the air photos in 2024 have noted a decline in the greenness of the riparian vegetation in this northern area of Mill Creek reach." PDF- page 127-128

"The depth to groundwater in the northernmost reach of Mill Creek where the groundwater levels have declined the most (near PB-2) is estimated at 10-15 ft-bgs in WY 2024. Future declines in groundwater levels in this area could result in adverse impacts to the riparian habitat." – PDF page 128

Based on the decrease in water level attributed to the CDA, which are larger than what the model predicted, and observed declines in NDVI and vegetation brownness in the upper Mill Creek area, it does not seem appropriate to continue to monitor with a "business as usual" approach. The lack of response or recommendation for increased monitoring in this area begs the question - "what magnitude or frequency of observed impact would trigger an increase in monitoring and/or modification to the operation of the CDA". Recommend describing and quantifying what the triggers for increased monitoring are and what options could be considered as well as a plan for modifying CDA operation or what mitigation options could be if significant impacts were observed and attributed to the CDA.

For example, the 2022 USBR vegetation survey added two sites in the upper portion of Mill Creek to increase monitoring in the area of observed drawdown. Since vegetation decline has been identified in this area, are additional survey sites being considered to increase monitoring? However, additional monitoring may not be sufficient as a course of action – operational changes and/or mitigation should be discussed.

Response:

The declines in groundwater levels of 8 feet observed between 2016 and 2021 occurred at a well just to the north of riparian habitat in the northern portion of Mill Creek. From 2021 to 2024 groundwater levels increased by 4 feet for a net decline of 4 feet at this location. The Annual Reports for 2021, 2022, and 2023 documented no impact to the riparian habitat in this northern portion of Mill Creek that was occurring during these declines in groundwater levels. And the NDVI time series show an increasing trend or no trend in between 2021 and 2023.

The decreases in NDVI observed in 2024 at the northern Mill Creek were all within the historical variability of NDVI change, meaning that in the past NDVI decreased or increased from one year to the next more than it did from 2023 to 2024. Additionally, the Mann-Kendall trend analysis showed that there are no long-term declining trends in NDVI at any of these areas along Mill Creek, including the post-Peace II Agreement period of 2007 to 2024. However, it was observed that there were a few sites along Mill Creek with notable changes in NDVI (greater than the average year-to-year change) and some browning of the vegetation in the air photos. Factors that could have resulted in these changes were assessed as part of the 2024 analysis and no direct cause was identified; and groundwater levels either increased or remained steady in these areas.

The triennial vegetation surveys for 2025 are scheduled for this summer and will help verify and document current vegetation conditions relative to the recent past. To further assess the change in vegetation observed in 2024 from the air photos, the vegetation surveys will be tailored to focus on these areas. This may include adding additional sites or expanding the boundaries of existing sites to get a more comprehensive understanding of what is happening on the ground. In addition to gathering data of % live/stressed/dead trees and the species composition, the biologists conducting the surveys will be asked to provide their professional opinion on any observed changes in vegetation structure and composition, potential causes of the change, and recommendations for additional monitoring or studies. As the PBHSP operates under an adaptive management framework, recommended enhancements to the monitoring and mitigation program can be reviewed and incorporated by the Committee as needed.

Mitigation measures to address observed declines in vegetation can only be developed once the cause of these changes is identified. However, since groundwater levels along Mill Creek have increased since reaching their lowest levels in 2022, and production at the CDA wells has decreased over the same period, an initial level of mitigation is already taking place. Additional recommendations for mitigation will depend on the results of the 2025 vegetation surveys.

Section 4.1.2 Recommendations of the report has been updated to the following to incorporate the information about the 2025 vegetation surveys above and the PBHSP:

"Based on the conclusions above, the PBHSP monitoring and reporting should continue to monitor and assess the extent and quality of the riparian habitat and the factors that can influence it, as has been done through WY 2024. As described above, there were declines in groundwater levels from 2016 to 2022 beneath the northern portion of Mill Creek; however, over the last two years, groundwater levels have recovered about halfway from their lowest observed levels in 2022. During the period of the lowest groundwater levels in 2022, there were no observed negative impacts on the riparian vegetation in this area. However, over this past year, there were some observed declines in the greenness of the riparian vegetation in this area. Factors that could have resulted in these changes were assessed as part of this analysis and no direct cause was identified. Therefore, we recommend additional focused monitoring along northern Mill Creek in WY 2025, as described below.

The triennial vegetation surveys scheduled for the summer of 2025 should be tailored to focus on the northern portion of Mill Creek and should include new or expanded sites to get a more comprehensive understanding of what is happening on the ground. In addition to gathering the measurements that have been acquired by the vegetation surveys in the past, the biologists conducting the surveys should also provide a professional opinion on: (i) any observed changes in vegetation structure and composition, (ii) potential causes of the change, and (iii) recommendations for additional monitoring or studies. This information will help verify and document the current vegetation conditions relative to conditions in the recent past and is crucial for assessing any potential impact on the extent and quality of the riparian habitat that could be caused by the lowering of groundwater levels in this area. Since the PBHSP is an adaptive management plan, any recommended enhancements to the monitoring program based on the vegetation surveys can be reviewed and incorporated by the PBHSC as appropriate. If mitigation measures are deemed necessary, the results of the PBHSP will provide guidance for their development.*”*

Comment 3 – Clarification on OCWD monitoring well data usage in 2024 Report

It is OCWD’s understanding that the Chino Valley Model (CVM) was last updated in 2020 and per the report, it is undergoing an update in 2025. It is therefore assumed the OCWD monitoring wells that were installed in 2020 and 2021 are not included in the CVM outputs contained in the 2024 PBHSC Report, but it was unclear if they are considered in the interpretation of data and results - please clarify. If they are not being used then we suggest that they not be included geographically in figures as this would be misleading (Figures 2-2, 3-10a and 3-10b). Similarly, if they are being used to determine changes in groundwater elevation, they should be included in Figures 3-11 and 3-12.

Will the model update incorporate lithology and other geologic data from construction of new monitoring wells to expand and improve the CVM deeper in Prado Basin or will only water levels be used to evaluate the accuracy of the model update? Suggest that an evaluation and comparison be provided to show how CVM update benefits from additional data in and around Prado Basin.

If long-term trends indicated decreases in water level attributed to the desalters and there are observed decreases in vegetation NDVI and brownness, recommend performing a focused report on specifically on Mill Creek to evaluate long-term GW trends vs. year-over-year and surface water flows vs. GW levels.

Response:

Yes, the CVM was last updated in 2020 and the 2025 update is nearing completion. The OCWD monitoring wells are not part of the CVM outputs presented in the 2024 PBHSC Report. This is because the report focuses on changes in groundwater levels across the entire Prado Basin area, as predicted by the model from 2018 (end of the model calibration period) to 2030 (end of the Peace II Agreement); this is shown in Figure 3-23 of the Annual Report. Wells are not included in “CVM output.” Rather, the model-predicted groundwater levels (output) is provided as a raster aligned with the model grid. However, model-generated groundwater-elevation estimates within a model grid cell can be extracted and viewed as a time series for a model grid cell aligned with a well location. This is shown in Figure 3-14 of the Annual Report for the PBHSP monitoring wells.

Groundwater-level monitoring data at the OCWD monitoring wells in the southern portion of Prado Basin are being collected by the Watermaster annually and utilized for the analysis of groundwater levels for the PBHSP. Figure 2-2 shows wells in the study area where groundwater-level data were collected in water year 2024 and includes the OCWD monitoring wells in the Prado Basin. Monitoring data at some of the OCWD monitoring wells in the Prado Basin are used to prepare the analysis of historical (2016) and current groundwater elevation contours for the PBHSP Study Area. These wells are shown on Figures 3-10a and 3-10b and are labeled by the groundwater-elevation measurement at the well that was used to generate the groundwater-elevation contours. The groundwater-elevation contours in Figure 3-10a and 3-10b are then used to generate the change in groundwater levels for the monitoring period in Figure 3-11. It is important to keep the OCWD monitoring wells on these maps/figures because they show the OCWD wells where data were collected in the last year (Figure 2-2) and used to generate groundwater-elevation contours (Figures 3-10a and 3-10b) and subsequently used generate the net change in groundwater levels over the monitoring period. Figure 3-11 shows the net change in groundwater elevations over the monitoring period (2016-2024), but does not include the well locations because they are already shown in Figures 3-10a and 3-10b and they would cover up the color-ramp symbology of the change in groundwater levels.

The wells shown in Figures 3-10a and 3-10b represent key monitoring locations where data are collected annually to generate groundwater-elevation contours and assess net changes in groundwater levels. Over the past year, three OCWD monitoring wells (PD9/1, PD10/1, and PD12/1) were removed from the key well network due to inconsistent measurements and limited data availability. Additionally, the reference point elevations for these wells had not been professionally surveyed and were instead estimated using a digital elevation model (DEM), resulting in groundwater elevation measurements that were not reliably comparable to those from other wells in the area.

Since the draft Annual Report was prepared, these OCWD wells have been professionally surveyed, and the updated reference point elevations are now being used to calculate groundwater elevations. Further coordination with OCWD field staff at the Prado Basin office revealed that these wells are, in fact, being measured monthly; however, the data had not been included in the dataset provided to the Watermaster. With the updated elevation data and more frequent measurements, these three OCWD wells are expected to be reinstated in the key well network for next year's groundwater elevation contouring.

As part of the 2025 model update, Watermaster conducted a comprehensive inventory of well data collected since 2018, the cutoff date for the 2020 model. This effort resulted in approximately 80 new well logs, including 33 located in the Prado Basin area, 23 of which are owned by OCWD. Watermaster carefully analyzed the new well logs and incorporated hydrogeologic data into the 2025 model update where appropriate. This data was used to (1) update the layer elevations and thicknesses in the model to improve representation of the basin's hydrostratigraphy and (2) improve the understanding and spatial characterization of aquifer property distributions and values.

In addition to the well data, the 2025 model update also includes (1) updates to the streambed elevations and cross-section geometry of the Santa Ana River and (2) a finer delineation of the riparian habitats to support improved evapotranspiration calculations.

The calibration well network in the 2025 model has also been expanded in Prado. While the 2020 model featured nine calibration wells in Prado, the 2025 update includes twelve, five of which are owned by OCWD. This expanded network provides improved spatial coverage within the region.

Sections 3.2.3 and 3.5.2 have comprehensive figures that compare long-term trends in groundwater pumping/ groundwater elevations and surface water to the trends in the quality of the riparian vegetation as indicated by the NDVI for Mill Creek reach. Most of the focused discussion is on the recent changes and whether observed trends in groundwater levels and surface water may be contributing to them. Future reports can include further evaluation on long-term groundwater trends and surface water flows.

CHINO BASIN WATERMASTER
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STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Turner Basins 5-10 Project Description and Initial Concept Plan (Business item II.B.)

Issue: To provide advice and assistance to the Watermaster Board in consideration of an opportunity to preserve existing recharge benefits and enhance recharge in Management Zone 2 by developing Turner Basins 5-10. [Discretionary Function]

Recommendation: Approve the preparation of a project description and initial concept plan for Turner Basins 5-10 Recharge Project or other alternative(s) as determined.

Financial Impact: The estimated cost to develop the project description and initial concept plan is $55,000, which can be funded through a carryover of unexpended O&M funds from fiscal year 2024/25.

ACTIONS:

Appropriative Pool – June 12, 2025	**[Final]: Provided advice and assistance**
Non-Agricultural Pool – June 12, 2025	**[Final]: Provided advice and assistance**
Agricultural Pool – June 12, 2025	**[Final]: Provided advice and assistance**
Advisory Committee – June 19, 2025	**[Final]: Provided advice and assistance**
Watermaster Board – June 26, 2025	**[Recommended]: Support recommendation**

BACKGROUND

The Turner Basins parcels are owned and under the jurisdiction of the San Bernardino County Flood Control District (SBCFCD). They form an integral component of the Recharge Program as outlined in the Recharge Master Plan. Originally conceived as flood control infrastructure, the basins have evolved over time to serve dual purposes, including significant groundwater recharge activities. These multi-functional basins are strategically located to capture and utilize various water sources, thereby contributing to the region's water sustainability efforts.

Turner Basins 1 through 4 are situated within the City of Ontario, specifically southwest of the intersection of 4th Street and Archibald Avenue. Turner Basin 1 primarily receives stormwater from the Cucamonga Creek Channel and can also accommodate storm, recycled, or imported water from the Deer Creek Channel. This basin's outflow feeds directly into Turner Basin 2, creating a seamless network of water management. Meanwhile, Turner Basins 3 and 4 collect water from local street drains and similarly integrate storm, recycled, or imported water sourced from the Deer Creek Channel.

In contrast, Turner Basins 5 through 10, located on the eastern side of Archibald Avenue at the northern end of Cucamonga-Guasti Regional Park, fulfill a slightly different role within the system. Turner Basins 5 and 8 currently receive local runoff and storm flows directed from the Deer Creek Channel. Notably, Basin 5 discharges into an unlined channel that facilitates water flow beneath Archibald Avenue into Turner Basin 4. However, Turner Basins 6 and 7 serve as recreational fishing lakes within Guasti Regional Park and are not utilized for groundwater recharge purposes.

Over the years, Turner Basins 1 through 4 have seen significant investments aimed at enhancing the region’s water capture and infiltration capacity. These efforts have been instrumental in establishing the basins as a reliable resource for the region's water recharge initiatives. The infrastructure developments within these basins can be categorized into two major phases, reflecting the evolution of their functionality and capacity.

2003–2005 Developments:

- Construction of a rubber dam and control building for the Cucamonga Creek Diversion to Turner 1 area.
- Installation of telemetry systems, including a radio tower, to facilitate remote monitoring and control.
- Implementation of pipelines and telemastered control valves to enable efficient water transfer from Turner Basin 1 to Turner Basin 2.
- Level sensors to monitor water levels accurately.
- Development of a Deer Creek diversion structure to channel water into Turner Basins 1 and 4.
- Decommissioning of an Ontario potable well to optimize water usage for recharge purposes.
- Integration of a recycled water turnout into the Deer Creek Channel.
- Provision for imported water exclusively for Turner Recharge operations.
- Deployment of lysimeters and monitoring wells to assess water infiltration and quality.

2005–Present Developments:

- Expansion to include cells 4B and 4C within Turner Basin 4 for increased water storage and management.
- Installation of SolarBee circulation pumps to enhance water movement and quality.
- Construction of a diversion structure to manage overflow from Guasti Regional Park.
- Development of a diversion structure to direct Deer Creek flows into Turner Basins 8, 5, and 4.

From 2005 through 2024, Turner Basins 3 and 4 collectively contributed approximately 5% of the total stormwater recharge, 3.6% of recycled water recharge, and 0.4% of imported water recharge. These figures underscore their critical role in the region's water management strategy, highlighting both their utility and potential for further development. The integration of these basins within the Recharge Program not only exemplifies strategic water management but also serves as a model for sustainable practices that balance environmental stewardship with community needs.

The table below details the water recharged in each basin by type, underscoring the significance of the Turner system for Watermaster's recharge program.

	FYs 05-25				FYs 05-25 (AF)		
	SW	IW	RW		SW	IW	RW
College Hts	0.6%	13.4%	0.0%	College Hts	1257.8	33369.2	0.0
Upland	4.2%	10.1%	0.0%	Upland	8101.3	25329.3	0.0
Montclair	9.0%	38.5%	0.0%	Montclair	17613.9	96254.5	0.0
Brooks	4.1%	2.2%	8.8%	Brooks	8004.2	5589.4	18608.9
8TH	9.4%	1.4%	11.5%	8TH	18320.8	3460.1	24413.0
Ely	12.5%	0.4%	9.8%	Ely	24434.4	1080.7	20774.0
Grove	3.0%	0.0%	0.0%	Grove	5870.1	0.0	0.0
Turner 1&2	9.2%	0.7%	3.5%	Turner 1&2	18005.2	1783.4	7393.5
Turner 3&4	5.0%	0.4%	3.6%	Turner 3&4	9750.0	995.2	7600.2
Lower Day	4.3%	7.4%	0.0%	Lower Day	8361.7	18538.3	0.0
Etiwanda	2.8%	4.8%	0.0%	Etiwanda	5513.5	11874.0	0.0
Victoria	4.2%	0.9%	8.2%	Victoria	8155.5	2291.8	17428.5
San Sevaine	8.4%	13.9%	6.5%	San Sevaine	16332.8	34777.3	13792.2
Hickory	3.2%	2.0%	7.1%	Hickory	6416.5	4985.6	14988.4
Banana	2.2%	0.6%	8.2%	Banana	4372.0	1519.3	17372.1
Jurupa	2.2%	0.7%	0.0%	Jurupa	4238.3	1762.2	0.1
RP3	8.8%	2.2%	28.8%	RP3	17122.2	5574.6	60928.2
Declez	6.7%	0.2%	4.0%	Declez	13123.7	607.6	8373.1
				Average	10833.0	13877.4	11759.6

(SW – Storm water, IW – Imported Water, RW-Recycled Water)

DISCUSSION

The San Bernardino County Flood Control District (SBCFCD) has recently expressed interest in the utilization in the future of the Turner Basins for development purposes other than being a part of the regional Recharge Program. This interest stems from the County's assessment that the basins, along with other similar facilities, are no longer deemed essential for primary flood control purposes of protection of life and property throughout the region. Consequently, the County is exploring the possibility of repurposing these basins for alternative uses. The 4-Party Agreement between the County, Watermaster, IEUA and Chino Basin Water Conservation District which governs the operations of the facilities expires in 2032.

Watermaster staff seeks advice and assistance from the parties, committees and Watermaster Board for direction on the potential loss of safe yield from repurposing Turner basins 3-4 and exploring opportunities to mitigate lost recharge in basins 3-4 and enhance recharge through basins 5-10 if feasible. One proposal under consideration involves conducting a detailed evaluation of Turner Basins 5 through 10. Currently, Basins 5 and 8 receive local runoff and stormwater flows originating from the Deer Creek Channel. Turner Basin 5 discharges into an unlined channel that conveys flow beneath Archibald Avenue before entering Turner Basin 4. Meanwhile, Basins 6 and 7 serve as recreational fishing lakes within Guasti Regional Park and are not presently utilized for groundwater recharge but could in the future.

In 2019, the infiltration rates for Turner Basins 5 and 8 were found to be approximately 0.2 feet per day, compared to the higher infiltration rates of approximately 0.5 feet per day observed in Turner Basins 1 through 4. While these variations may suggest differing geological conditions below each basin, the surface area of Turner Basins 5 and 8 is comparable to that of Turner Basins 3 and 4, hinting at similar potential benefits for storage capacity if further investments are made.

To advance this initiative, an estimated budget of $55,000 has been proposed by West Yost to prepare a comprehensive project description, assess recharge benefits through model simulations, draft a technical memorandum, and provide project management services. Funding for this effort may be sourced from carryover funds or by reallocating resources within Program Element 2 of the West Yost budget, as approved during the May 2025 Board meeting. The proposed analysis aims to determine the feasibility of repurposing these basins for optimized water management and alternative applications, aligning with the County's long-term strategic objectives and the need to maintain adequate groundwater recharge facilities to support the growing communities throughout the region.

At the June 12, 2025 Pool Committee meetings, the item was presented and the recommendation to develop an Initial Concept plan was unanimously approved and moved to the Advisory Committee for further advice and assistance. At the June 19, 2025 Advisory Committee Meeting, there was unanimous support to move the Watermaster Board for approval.

ATTACHMENT
1. Turner Basins Map

ATTACHMENT 1

Figure 1: Turner Basin Configuration and Numbering

Google Earth Photo from March 2023

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Fiscal Year 2025/26 Proposed Pay Schedule Effective July 1, 2025 (Business Item II.C.)

Issue: The item is to consider the Fiscal Year 2025/26 Salary Schedule for approval. [Normal Course of Business]

Recommendation: Approve the Fiscal Year 2025/26 Pay Schedule as presented.

Financial Impact: The salaries in the recommended Pay Schedule for the twelve (12) budgeted Watermaster positions are included in the FY 2025/26 Watermaster Budget of $11,925,729. The approved FY 2025/26 budget was adopted by the Watermaster Board on May 22, 2025.

ACTIONS:
Watermaster Board – Date [Recommended]: Approve as presented

BACKGROUND

As a CalPERS contracted employer and to comply with statutory and regulatory requirements, Chino Basin Watermaster developed a Pay Schedule which must be approved by the Watermaster Board in open session (pursuant to California Code of Regulations (CCR) § 570.5) and must contain the required pay information for current hourly and salaried employees and potential positions which could be filled as approved. Each time a change is made to the pay schedule, it also needs to be approved by the Board in open session and uploaded to the Watermaster's website to ensure continued compliance with CalPERS' requirements. Pay schedules are required to be retained for a period of 5 years.

The current pay schedule for Fiscal Year 2024/25 (Attachment 1) was approved by the Board on June 27, 2024 (Attachment 1), and became effective on July 1, 2024. The current pay schedule along with prior schedules are currently posted on the Watermaster website and are accessible at this link.

DISCUSSION

The currently approved FY 2025/26 labor budget for all categories is $2,628,569 which includes salaries of $1,494,499 and payroll burden of $1,134,070. This is a 6% overall increase from FY 2024/25 due to a proposed 3% cost of living adjustment (COLA) as well as projected inflationary increases to overall benefits as was presented by staff and approved through the Watermaster budget process in May 2025. The Personnel Committee supported the 3% COLA at its meeting on June 17, 2025. The salaries budget was developed with twelve (12) full-time employees and currently Watermaster employs eleven (11) full-time employees.

The General Manager's employment contract is effective April 15, 2024 through April 14, 2027 unless there is a specified change by the Board. In Section 5a of the General Manager's contract, COLA increases beginning in FY 2025/26 must be approved from year to year at the Board's discretion. No changes to the proposed salary schedule have been made at this time for this position.

As with past practice, Watermaster uses January to January CPI data, organizational-wide efforts, and the recommendations for the Watermaster FY 2025/26 salaries and benefits as included in the recently approved FY 2025/26 budget. The proposed Fiscal Year 2025/26 Pay Schedule contains a 3% COLA as shown in Attachment 2 for the Board's consideration and approval.

Once approved, the FY 2025/26 Pay Schedule will supersede the previous FY 2024/25 Pay Schedule and will become effective on July 1, 2025. Following approval from the Board, staff will make the FY 2025/26 Pay Schedule publicly available by posting it to the Watermaster website.

ATTACHMENTS
1. FY 2024/25 Pay Schedule (Approved by Board on June 27, 2024)
2. FY 2025/26 Proposed Pay Schedule – Effective July 1, 2025 (Draft)

ATTACHMENT 1

CHINO BASIN WATERMASTER | **FISCAL YEAR 2024/25** | **Effective Date: July 1, 2024**

PAY SCHEDULE | Approved by Board: June 27, 2024

Revision Date: March 26, 2024

POSITION	TYPE								LOW			MONTHLY MEDIAN			HIGH
General Manager	1								$22,115.60	$23,221.47	$24,382.80	$25,601.33	$26,882.27	$28,225.60	$29,636.53
					HOURLY							MONTHLY			
		STEP A	STEP B	STEP C	STEP D	STEP E	STEP F	STEP G	STEP A	STEP B	STEP C	STEP D	STEP E	STEP F	STEP G
Water Resources Management and Planning Director	2	$81.13	$85.19	$89.45	$93.92	$98.62	$103.55	$108.73	$14,062.53	$14,766.27	$15,504.67	$16,279.47	$17,094.13	$17,948.67	$18,846.53
Director of Administration	2	$77.79	$81.68	$85.76	$90.05	$94.55	$99.28	$104.24	$13,483.60	$14,157.87	$14,865.07	$15,608.67	$16,388.67	$17,208.53	$18,068.27
Water Resources Technical Manager	3	$61.82	$64.91	$68.16	$71.57	$75.15	$78.91	$82.86	$10,715.47	$11,251.07	$11,814.40	$12,405.47	$13,026.00	$13,677.73	$14,362.40
Data Services and Judgment Reporting Manager	3	$61.82	$64.91	$68.16	$71.57	$75.15	$78.91	$82.86	$10,715.47	$11,251.07	$11,814.40	$12,405.47	$13,026.00	$13,677.73	$14,362.40
Water Resources Sr. Associate	3	$47.56	$49.94	$52.44	$55.06	$57.81	$60.70	$63.74	$8,243.73	$8,656.27	$9,089.60	$9,543.73	$10,020.40	$10,521.33	$11,048.27
Water Resources Associate	3	$35.94	$37.74	$39.63	$41.61	$43.69	$45.87	$48.16	$6,229.60	$6,541.60	$6,869.20	$7,212.40	$7,572.93	$7,950.80	$8,347.73
Sr. Field Operations Specialist	3	$33.25	$34.91	$36.66	$38.50	$40.43	$42.45	$44.57	$5,763.33	$6,051.07	$6,354.40	$6,673.33	$7,007.87	$7,358.00	$7,725.47
Field Operations Specialist	3	$28.83	$30.27	$31.78	$33.37	$35.04	$36.79	$38.63	$4,997.20	$5,246.80	$5,508.53	$5,784.13	$6,073.60	$6,376.93	$6,695.87
Sr. Accountant	3	$47.56	$49.94	$52.44	$55.06	$57.81	$60.70	$63.74	$8,243.73	$8,656.27	$9,089.60	$9,543.73	$10,020.40	$10,521.33	$11,048.27
Executive Assistant II - Board Clerk	3	$42.10	$44.21	$46.42	$48.74	$51.18	$53.74	$56.43	$7,297.33	$7,663.07	$8,046.13	$8,448.27	$8,871.20	$9,314.93	$9,781.20
Executive Assistant I - Board Clerk	3	$32.98	$34.63	$36.36	$38.18	$40.09	$42.09	$44.19	$5,716.53	$6,002.53	$6,302.40	$6,617.87	$6,948.93	$7,295.60	$7,659.60
Sr. Administrative Analyst	3	$38.48	$40.40	$42.42	$44.54	$46.77	$49.11	$51.57	$6,669.87	$7,002.67	$7,352.80	$7,720.27	$8,106.80	$8,512.40	$8,938.80
Administrative Analyst	3	$32.06	$33.66	$35.34	$37.11	$38.97	$40.92	$42.97	$5,557.07	$5,834.40	$6,125.60	$6,432.40	$6,754.80	$7,092.80	$7,448.13
Accountant	3	$32.06	$33.66	$35.34	$37.11	$38.97	$40.92	$42.97	$5,557.07	$5,834.40	$6,125.60	$6,432.40	$6,754.80	$7,092.80	$7,448.13
Administrative Assistant	3	$28.72	$30.16	$31.67	$33.25	$34.91	$36.66	$38.49	$4,978.13	$5,227.73	$5,489.47	$5,763.33	$6,051.07	$6,354.40	$6,671.60
Office Specialist/Receptionist	3	$23.95	$25.15	$26.41	$27.73	$29.12	$30.58	$32.11	$4,151.33	$4,359.33	$4,577.73	$4,806.53	$5,047.47	$5,300.53	$5,565.73

Classifications:

Type 1: Exempt - Executive Management

Type 2: Exempt - Mid-Management/Supervisor

Type 3: Non-Exempt (Operations)

Type 3: Non-Exempt (Administration)

ATTACHMENT 2

CHINO BASIN WATERMASTER — **FISCAL YEAR 2025/26** — **Effective Date: July 1, 2025**

PAY SCHEDULE — Approved by Board:

Revision Date: June 18, 2025

POSITION	TYPE	FTE COUNT								MONTHLY LOW			MONTHLY MEDIAN			MONTHLY HIGH
General Manager	1	1								$22,115.60	$23,221.47	$24,382.80	$25,601.33	$26,882.27	$28,225.60	$29,636.53
			HOURLY							*MONTHLY*						
			STEP A	STEP B	STEP C	STEP D	STEP E	STEP F	STEP G	STEP A	STEP B	STEP C	STEP D	STEP E	STEP F	STEP G
Water Resources Management and Planning Director	2	1	$83.56	$87.74	$92.13	$96.74	$101.58	$106.66	$111.99	$14,483.73	$15,208.27	$15,969.20	$16,768.27	$17,607.20	$18,487.73	$19,411.60
Director of Administration	2	1	$80.12	$84.13	$88.34	$92.76	$97.40	$102.27	$107.38	$13,887.47	$14,582.53	$15,312.27	$16,078.40	$16,882.67	$17,726.80	$18,612.53
Water Resources Technical Manager	3	1	$63.67	$66.85	$70.19	$73.70	$77.39	$81.26	$85.32	$11,036.13	$11,587.33	$12,166.27	$12,774.67	$13,414.27	$14,085.07	$14,788.80
Data Services and Judgment Reporting Manager	3	1	$63.67	$66.85	$70.19	$73.70	$77.39	$81.26	$85.32	$11,036.13	$11,587.33	$12,166.27	$12,774.67	$13,414.27	$14,085.07	$14,788.80
Water Resources Sr. Associate	3	0	$48.99	$51.44	$54.01	$56.71	$59.55	$62.53	$65.66	$8,491.60	$8,916.27	$9,361.73	$9,829.73	$10,322.00	$10,838.53	$11,381.07
Water Resources Associate	3	1	$37.02	$38.87	$40.81	$42.85	$44.99	$47.24	$49.60	$6,416.80	$6,737.47	$7,073.73	$7,427.33	$7,798.27	$8,188.27	$8,597.33
Sr. Field Operations Specialist	3	1	$34.25	$35.96	$37.76	$39.65	$41.63	$43.71	$45.90	$5,936.67	$6,233.07	$6,545.07	$6,872.67	$7,215.87	$7,576.40	$7,956.00
Field Operations Specialist	3	1	$29.69	$31.17	$32.73	$34.37	$36.09	$37.89	$39.78	$5,146.27	$5,402.80	$5,673.20	$5,957.47	$6,255.60	$6,567.60	$6,895.20
Sr. Accountant	3	1	$48.99	$51.44	$54.01	$56.71	$59.55	$62.53	$65.66	$8,491.60	$8,916.27	$9,361.73	$9,829.73	$10,322.00	$10,838.53	$11,381.07
Executive Assistant II - Board Clerk	3	0	$43.36	$45.53	$47.81	$50.20	$52.71	$55.35	$58.12	$7,515.73	$7,891.87	$8,287.07	$8,701.33	$9,136.40	$9,594.00	$10,074.13
Executive Assistant I - Board Clerk	3	1	$33.97	$35.67	$37.45	$39.32	$41.29	$43.35	$45.52	$5,888.13	$6,182.80	$6,491.33	$6,815.47	$7,156.93	$7,514.00	$7,890.13
Sr. Administrative Analyst	3	0	$39.63	$41.61	$43.69	$45.87	$48.16	$50.57	$53.10	$6,869.20	$7,212.40	$7,572.93	$7,950.80	$8,347.73	$8,765.47	$9,204.00
Administrative Analyst	3	1	$33.02	$34.67	$36.40	$38.22	$40.13	$42.14	$44.25	$5,723.47	$6,009.47	$6,309.33	$6,624.80	$6,955.87	$7,304.27	$7,670.00
Accountant	3	0	$33.02	$34.67	$36.40	$38.22	$40.13	$42.14	$44.25	$5,723.47	$6,009.47	$6,309.33	$6,624.80	$6,955.87	$7,304.27	$7,670.00
Administrative Assistant	3	0	$29.58	$31.06	$32.61	$34.24	$35.95	$37.75	$39.64	$5,127.20	$5,383.73	$5,652.40	$5,934.93	$6,231.33	$6,543.33	$6,870.93
Office Specialist/Receptionist	3	0	$24.67	$25.90	$27.20	$28.56	$29.99	$31.49	$33.06	$4,276.13	$4,489.33	$4,714.67	$4,950.40	$5,198.27	$5,458.27	$5,730.40
TOTAL FULL-TIME EMPLOYEE COUNT		11														

Classifications:

Type 1: Exempt - Executive Management

Type 2: Exempt - Mid-Management/Supervisor

Type 3: Non-Exempt (Operations)

Type 3: Non-Exempt (Administration)

CHINO BASIN WATERMASTER

9641 San Bernardino Road, Rancho Cucamonga, CA 91730
909.484.3888   www.cbwm.org

STAFF REPORT

DATE: June 26, 2025

TO: Board Members

SUBJECT: Selection of Firm to Perform Peer Review of the 2025 Safe Yield Reevaluation Final Report (Business Item II.D.)

Issue: Staff recommends S.S. Papadopulos & Associates, Inc. (SSP&A) to perform the Peer Review of the 2025 Safe Yield Final Report [Normal Course of Business]

Recommendation: Approve and authorize the General Manager to execute the contract with S.S. Papadopulos & Associates, Inc. (SSP&A), as approved to form by Watermaster legal counsel, to perform Peer Review of the 2025 Safe Yield Reevaluation Final Report in the amount of $95,628 plus up to a 15% change order authority.

Financial Impact: The cost to perform the peer review is $95,628 which will be billed to account 7614- “Implementation of the Safe Yield Court Order”. No additional funding or special assessments will be necessary. All costs will be funded by the FY 2024/25 carryover balance in account 7614. Waternaster received three (3) proposals with a range of costs from $47,780 to $96,196.

ACTIONS:
Watermaster Board – June 26, 2025 [Recommended]: Approve and authorize the General Manager to execute the contract on behalf of Watermaster.

BACKGROUND

The court-ordered update to the Chino Basin groundwater model is now complete and the technical analysis for the 2025 Safe Yield Reevaluation is in its final stages. A workshop to showcase preliminary results was held on March 25, 2025. Prior to the release of the Final Administrative Draft of the technical analysis report, the Watermaster Board requested, at its March 27, 2025 meeting, that an independent peer review of the groundwater model results and methodologies be conducted prior to finalizing the report for the Board's consideration.

The process for selecting the consulting firm for the peer review was discussed with the Pool Committees and Advisory Committee during their April 2025 meetings. The Advisory Committee recommended that the Watermaster Board support the selection of the consulting firm from a "select" list of bidders as detailed in "Option 1" of the April 17, 2025 staff report. Option 1 in the staff report was presented as follows.

1. Solicit firms from a "select" List of Bidders to provide a quote from a uniform Scope of Work.
    a. Establish Scope of Work
    b. Solicit "select" List of Bidders – maximum of five (5) firms
    c. Contact firms to determine interest, availability, and ability to meet the timelines
    d. Schedule Pre-bid conference meetings/calls
    e. Receive proposals
    f. Rate firms based on the following matrix
        i. 20% Experience
        ii. 45% Approach
        iii. 35% Price
    g. Watermaster contract approval process
        i. Pools/Advisory/Board

Following this process, Watermaster received 3 proposals. Watermaster staff then proceeded to grade the proposals based on the matrix identified above. Out of the three proposals Watermaster interviewed the top two and is now bringing forward the recommended firm for the Watermaster Board's consideration, to perform the peer review.

DISCUSSION

Based on the evaluation of proposals received in response to the Request for Proposals (RFP) for the Peer Review of the 2025 Safe Yield Reevaluation Process and Results (SYEPR), staff recommends the selection of S.S. Papadopulos & Associates, Inc. (SSP&A) as the peer review consultant. The RFP outlined a comprehensive Scope of Work (SOW) that includes evaluating Watermaster's implementation of the court-approved 2022 Safe Yield Reset Methodology, reviewing assumptions and calculations used to estimate Net Recharge, assessing the calibration and storage level determinations of the Chino Valley Model (CVM), and identifying any additional issues relevant to the calculation of Net Recharge. The selected firm is responsible for presenting findings to the Advisory Committee and Watermaster Board and participating in key meetings through October 2025.

SSP&A received the highest evaluation score among the three proposals reviewed. Their proposal demonstrated deep technical and modeling expertise, including leadership in MODFLOW and USGS methodologies, and a strong understanding of the local hydrogeologic context. The firm's approach was noted for its technical rigor, structured methodology, and robust project management and communication plans. SSP&A also disclosed relevant work in California and affirmed that there is no conflict of interest. Their qualifications, project team, and proposed methodology align closely with the objectives of the peer review engagement and position them to provide a thorough and credible evaluation of the 2025 SYEPR within the accelerated timeline requested by Watermaster.

Finalizing the contract for the peer review engagement includes preparing and signing all necessary documents, and formalizing the project scope, deliverables, and timelines. The target start date for the engagement is set for July 1, 2025, ensuring alignment with the required accelerated timeline to timely bring this back to the Court in October 2025.

ATTACHMENTS
1. Proposed Consultant Retention Agreement between Chino Basin Watermaster and S.S. Papadopulos & Associates, Inc. (SSP&A)

2. S.S. Papadopulos & Associates, Inc. (SSP&A) Proposal

CONSULTANT RETENTION AGREEMENT

This Consultant Retention Agreement ("Agreement") is entered into by and between the Chino Basin Watermaster ("Watermaster") and S.S. Papadopulos & Associates, Inc. (SSP&A), a Maryland corporation registered to do business in the State of California ("Consultant"), effective as of the first day of July, 2025 ("Effective Date"), with respect to the following facts and intentions:

A. As part of its 2025 Safe Yield Evaluation, Watermaster requires the services of a highly qualified consultant with the requisite knowledge, skill, ability and expertise to (1) evaluate Watermaster's implementation of the court-approved 2022 Safe Yield Reset methodology; (2) review assumptions and calculations used to estimate net recharge in the Chino Basin ("Basin"); (3) review elements relating to the Chino Valley Model ("CVM") model calibration and determination of storage levels in the Basin; and (4) review other issues relevant to the Calculation of net recharge (Collectively "Services");

B. Consultant represents to Watermaster that it is fully qualified and available to perform the Services for and as requested by Watermaster; and,

C. Watermaster and Consultant agree to enter into this Agreement for performance of the Services on the terms and conditions stated in this Agreement.

NOW, THEREFORE, the parties agree as follows:

1. **Term of Agreement.** This Agreement will become effective as of the date of this Agreement ("Effective Date") and will terminate upon the completion of the Services (as defined below) or as may be terminated earlier pursuant to the terms of this Agreement, whichever occurs first. The period during which this Agreement is in effect, including any extensions agreed upon by the parties, is referred to as the "Term".

2. **Services.** Watermaster retains Consultant to perform, and Consultant accepts Watermaster's retention and agrees to perform, the Services as specified by Watermaster in the attached Peer Review of the 2025 Safe Yield Evaluation Process and Results Scope of Work dated May 22, 2025. ("Scope of Work" attached hereto as **Attachment A.)**

3. **Schedule.** Consultant shall complete the Services pursuant to the timelines described in the Scope of Work. The Services must be completed, including recommendations that result in updates by model inputs, model scenarios or model runs by September 18, 2025. Consultant must present its final Peer Review report, in person, to the Watermaster Board on September 25, 2025. Consultant must be available for all October regular meetings of the Pool Committees, Advisory Committee, and Watermaster Board.

4. **Compensation.**

4.1 Compensation. Watermaster shall compensate Consultant for the Services as stated below:

$95,628 for consulting services performed as specified in consultant's proposal.

4.2 Expenses. Consultant will be responsible for any and all expenses that may be incurred in performing the Services, including all direct and indirect costs, insurance, fees and costs for business and professional licenses and credentialing, mileage and overhead, except as otherwise expressly agreed in writing by Watermaster in advance with respect to particular expenses (“Expenses”).

4.3 Method of Payment.

4.3.1 Consultant must submit monthly invoices to Watermaster for fees and Expenses incurred to that date. The monthly invoices must include an accurate and detailed summary of the Services performed and the hours spent on each task, itemization of any reimbursable Expenses, and documentation and receipts acceptable to Watermaster supporting any such Expenses or fees.

4.3.2 Watermaster will verify the Services, fees and Expenses detailed on the invoice and will confirm that the Services described therein have been satisfactorily completed and that appropriate documentation has been provided.

4.3.3 Watermaster will pay undisputed invoiced amounts within thirty (30) calendar days. Watermaster will communicate with Consultant regarding any disputed amounts or amounts to which inadequate documentation has been provided by Consultant.

4.3.4 Watermaster reserves the right to withhold payment for fees and Expenses relating to Services that are not completed as scheduled, are completed unsatisfactorily, are behind schedule, are otherwise performed in an inadequate or untimely fashion, or are unsupported by documentation, each as determined by Watermaster, with such payments to be released and paid to Consultant promptly when the Services are determined by Watermaster to be satisfactorily completed and supported. Watermaster also reserves the right to withhold payment upon termination of this Agreement in the event Consultant threatens not to comply or fails to comply with its obligations (including post-termination obligations) and/or breaches or threatens to breach this Agreement in any material respect.

5. Affirmation of Independent Contractor Status.

5.1 Independent Contractor. Watermaster and Consultant each expressly understand, agree and intend that Consultant is an independent contractor in the performance of each and every part of this Agreement, and is solely responsible for all costs and expenses arising in connection with the performance of the Services, except as expressly set forth in this Agreement. Consultant is responsible for obtaining any business permits or licenses required to enable it to operate as an independent contractor and perform the Services. All Services are to be performed solely at the risk of Consultant, and Consultant agrees to take all precautions necessary for the proper performance of the Services. Consultant is solely responsible for any and all claims, liabilities, damages or debts of any type whatsoever that may arise on account of the activities of Consultant and its agents. Consultant has and retains control of, and supervision over, the performance of its obligations hereunder, including scheduling and day-to-day control over the performance of the Services, and except as expressly provided herein, Watermaster will have no right to exercise any control whatsoever over the activities or operations of Consultant. Notwithstanding the foregoing, however, Consultant may not subcontract all or any portion of the performance of the Services, assign performance of the Services to any entity(ies) or individual(s), or assign any former employee or Consultant of Watermaster to perform the Services, unless, in any such case, Watermaster has provided its prior express written approval.

5.2 Taxes and Related Matters. Consultant will be solely responsible for all tax and other government-imposed responsibilities relating to the performance of the Services, including payment of all applicable federal, state, local and social security taxes, unemployment insurance, workers' compensation and self-employment or other business taxes and licensing fees. Consultant will be solely responsible for payment of all compensation owed to its agents with respect to the Services, including all applicable federal, state and local employment taxes, and will make deductions for all taxes and withholdings required by law. No federal, state or local taxes of any kind will be withheld or paid by Watermaster on behalf Consultant and/or its agents. Consultant acknowledges that the compensation paid pursuant to this Agreement will not be considered "wages" for purposes of the Federal Insurance Contributions Act ("FICA"), unemployment or other taxes. Watermaster will issue Consultant an IRS Form 1099 with respect to payments made under this Agreement, and Consultant must promptly provide to Watermaster a completed IRS Form W-9 and other documentation as may be needed from time to time by Watermaster. Consultant will be responsible for performing all payroll and record-keeping functions required by law. The compensation provided hereunder is not intended to constitute "nonqualified deferred compensation" within the meaning of Section 409A of the Internal Revenue Code of 1986, as it may be amended from time to time ("Section 409A"). No provision of this Agreement may be interpreted or construed to transfer any liability for failure to comply with any tax obligations, including failure to comply with the requirements of Section 409A, from Consultant to Watermaster.

5.3 No Employee Benefits from Watermaster. As an independent contractor, neither Consultant nor its agents will be eligible for benefits from Watermaster or any related entity, including workers' compensation, unemployment insurance, expense reimbursement, health, dental, vision, life or disability insurance, paid holidays, paid sick leave, vacation or other paid time off, pension or 401(k) plans, educational assistance, continuing education reimbursement, or any other employee benefit that may be offered now or in the future.

5.4 No Third-Party Beneficiaries. This Agreement is between Watermaster and Consultant, and creates no individual rights for any agents of Consultant. No agent of Consultant will be deemed to be a third-party beneficiary hereunder, nor will any agent of Consultant be deemed to have any employment or contractual relationship with Watermaster as a result of this Agreement or his, her or its performance of services for Consultant. The parties acknowledge that all individuals performing Services on behalf of Consultant are solely the employees and/or agents of Consultant. Watermaster will not be responsible for payments due and owing to any subconsultants or other agents of Consultant; provided however, that in the event Consultant fails timely to pay any such subconsultants or agents, if Watermaster deems it appropriate to make payments directly to any such subconsultants or agents on behalf of Consultant, notwithstanding that it may have no legal obligation to do so, Consultant will reimburse Watermaster therefor, and Watermaster may offset any amounts due and owing to Consultant by any amounts it has paid to any such agents of Consultant.

6. **Termination of Agreement.** This Agreement will expire at the end of the Term, unless terminated earlier as follows:

6.1 Termination upon Written Notice. Either party may terminate this Agreement during the Term by providing the other party with thirty (30) days' written notice of such termination or with any shorter notice period upon which the parties may agree

7. 6.2 Termination for Cause by Watermaster. Watermaster may terminate this Agreement immediately for "Cause." Cause includes, but is not be limited to, the following, as determined in Watermaster's sole discretion: (i) failure of Consultant or its agents to comply in any material respect with this Agreement, including failure to perform the Services in a satisfactory manner, breach of any other agreement between the parties, or violation of any applicable Watermaster policy, procedure or guideline, including Watermaster's policy against harassment; (ii) serious personal or professional misconduct by Consultant or its agents (including dishonesty, fraud, misappropriation, criminal activity or gross or willful neglect of duty); (iii) breach or threatened breach of Consultant's duties to Watermaster (including theft or misuse of Watermaster property or time) by Consultant or its agents; (iv) conduct that threatens public health or safety, or threatens to do immediate or substantial harm to Watermaster's Business (as defined below), including potentially subjecting Watermaster to civil or criminal liability; (v) falsification by Consultant or its agents of any business-related document, including invoices, or the making of any materially false or misleading statement by Consultant or its agents to or in connection with Watermaster; (vi) an investigation that could have an adverse impact on Watermaster is commenced with respect to Consultant and/or its agents by a regulatory agency or governmental authority; (vii) failure or refusal of Consultant or its agents to submit to a legally-permissible drug screening, testing and/or medical examinations; (viii) the professional license(s), and/or qualifications of Consultant and/or its agents deemed necessary by Watermaster to perform the Services (if applicable) are not maintained or renewed, or are revoked or suspended by an authorized regulatory agency; or (ix) any other willful or substantial misconduct, deficiency, failure of performance, breach or default by Consultant or its agents, including failing to provide Services for any reason on multiple occasions when requested by Watermaster. Watermaster's exercise of its right to terminate for Cause will be without prejudice to any other remedy to which it may be entitled at law, in equity, or under this Agreement. In the event of termination for Cause by Watermaster, the only compensation due to Consultant will be payment of fees incurred up to the date of termination and outstanding reimbursable Expenses **Obligations of Consultant.**

7.1 Best Abilities; Good Workmanship; Time of the Essence. Consultant understands that time is of the essence with respect to the performance of the Services. Consultant will proceed with diligence and the Services will be performed in accordance with the highest professional workmanship, service and ethical standards in the field and to the satisfaction of Watermaster. If Consultant's workmanship does not conform to these standards, in Watermaster's subjective judgment and discretion, and Watermaster so notifies Consultant, Consultant agrees immediately to take all action necessary to remedy the nonconformance. Any costs incurred by Consultant to correct such nonconformance will be at Consultant's sole expense. To the extent Consultant fails to correct such nonconformance to Watermaster's satisfaction, or Watermaster deems Consultant incapable of correcting such nonconformance to Watermaster's satisfaction, Watermaster may elect to have a third party (including a subconsultant of Consultant) correct such nonconformance at Consultant's sole expense.

7.2 Compliance with Law and Policies. Consultant and its agents will comply with all federal, state and local laws, rules and regulations applicable to it and its agents, including the Occupational Safety and Health Act ("OSHA"), non-discrimination laws, immigration law and work authorization requirements, tax and withholding obligations, and wage and hour requirements (including those related to classification of employees, and payment of minimum wage and overtime), in the performance of the Services. Consultant will be responsible for providing, at Consultant's expense, and in Consultant's name, all licenses and permits usual or necessary for conducting the Services. Consultant and its agents will comply with Watermaster's Code of Ethics as it may be amended from time to time, except to the extent that the Code of Ethics is inconsistent with this Agreement or with local law, rules and/or regulations. Consultant and its agents also will comply with other Watermaster policies that may be applicable to them, as they may be modified from time to time, including Watermaster's policies against harassment and discrimination.

7.3 Insurance. Consultant shall procure and maintain in full force and effect during the performance of the Services pursuant to this Agreement, the following insurance:

7.3.1 Commercial General Liability. Commercial general liability insurance for bodily injury (including death), personal injury, property damage, owned and non-owned equipment, blanket contractual liability, completed operations, explosion, collapse, underground excavation and removal of lateral support covering Consultant's performance of the Services under this Agreement, which coverage shall be at least as broad as Insurance Services Office (ISO) Occurrence form CG 0001, and with a limit in an amount of not less than Two Million Dollars ($2,000,000). If insurance with a general aggregate limit or products-completed operations aggregate limit is used, either the general aggregate limit shall apply separately to the Task Order (with the ISO CG 2503, or ISO CG 2504, or insurer's equivalent endorsement provided to Watermaster) or the general aggregate limit and products-completed operations aggregate limit shall be twice the required occurrence limit.

7.3.2 Workers' Compensation and Employer's Liability Insurance. Workers' compensation insurance covering its employees in performance of the Services under this Agreement in accordance with statutory requirements and employer's liability insurance with limits of not less than One Million Dollars ($1,000,000) each accident, One Million Dollars ($1,000,000) disease policy limit, and One Million Dollars ($1,000,000) disease each employee.

7.3.3 Automobile Liability. Automobile liability insurance for bodily injury and property damage which coverage shall be at least as broad as ISO Business Auto Coverage (Form CA 0001), covering Symbol 1 (any auto), and with a limit in an amount of not less than One Million Dollars ($1,000,000) each accident.

7.3.4 Professional Liability. Professional Liability insurance in the amount of One Million Dollars ($1,000,000) per occurrence with a Two Million Dollar ($2,000,000) policy aggregate for protection from claims arising out of Consultant's wrongful acts, negligent actions, errors or omissions in performance of the services under this Contract. This coverage form may be "claims made" and include defense expense within the limit of liability. The policy shall contain a two-year extended reporting period under which claims can be made for errors or omissions arising from the services.

7.3.5 General. The commercial general and automobile liability policies shall contain, or be endorsed to contain the following provisions: (1) Watermaster, its elected officials, officers, agents and employees shall be named as additional insureds; (2) Consultant's insurance shall be primary insurance as respects Watermaster, its elected officials, officers, agents and employees and any insurance, self-insurance or other coverage maintained by Watermaster, its elected officials, officers, agents and employees shall not contribute to it; (3) any failure to comply with the reporting or other provisions of the policies including breaches and warranties shall not affect coverage provided to Watermaster, its elected officials, officers, agents and employees; and (4) the Consultant's insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

Each insurance policy shall state, or be endorsed to state, that coverage shall not be canceled by the insurance carrier, except after thirty (30) days prior written notice has been given to Watermaster in accordance with the standard ISO Accord form. Consultant shall provide thirty (30) days written notice to Watermaster prior to the non-renewal of any policy or policies required by this Agreement. All insurance coverage, as initially provided and as modified or changed, shall be subject to reasonable approval by Watermaster. Any deductible or self-insured retention must be declared to and approved by Watermaster. Prior to the performance of the Services under this Agreement and at any subsequent time, upon request by Watermaster, Consultant shall provide Watermaster with Certificates of Insurance evidencing the above coverages. The Consultant shall, upon demand of Watermaster, make available for inspection by Watermaster certified copies of such policy or policies of insurance and the receipts for payment of premiums for all policies required to be furnished by Consultant. Consultant shall be responsible for requiring and confirming that each subconsultant meets the minimum insurance requirements specified above. The above insurance coverage shall not limit the indemnification obligations of Consultant as provided below and the failure to maintain the required coverages shall constitute a material breach of this Agreement.

7.4 Confidential Information. In connection with the performance of the Services, Consultant and its agents will have access to information that has been developed by, created by or provided to Watermaster (including without limitation, information created or developed by Consultant and/or its agents) that has commercial value to Watermaster's Business, and is not generally known to the public or others, or is otherwise required to be kept confidential by Watermaster (all of which is referred to as "Confidential Information").

7.4.1 Confidential Information includes any information (whether in paper or electronic form, or contained in the memory of Consultant and/or its agents, or otherwise stored or recorded) that is not generally known and relates to Watermaster's Business, if such information has been expressly or implicitly protected by Watermaster from unrestricted use by persons not associated with Watermaster. Confidential Information includes, but is not limited to, information contained in or relating to: the manner and details of Watermaster's operation, organization and management; passwords; concepts; programs; trade secrets; product designs; innovations; source codes and documentation; software; data; protocols; best practices; plans and proposals; processes and techniques; projects; the identities and contact information of, and details regarding Watermaster's relationship with, actual and prospective stakeholders, Consultants and vendors; fees and charges by Watermaster; pricing data and related information; applicant and employee personnel information; financial information; and legal and business strategies and plans, as well as any other information marked "confidential", "proprietary", "secret" or the like. Confidential Information also includes information of Watermaster's affiliates, customers, vendors, Consultants, referral sources, Consultants, partners, stakeholders, directors, officers, shareholders, investors, employees and other third parties that was disclosed or entrusted to Watermaster or to Consultant and/or its agents in the course of business and/or in the course of performing the Services with the expectation of confidentiality.

7.4.2 Consultant agrees that the Confidential Information made available to it and its agents will be used solely for the purpose of performing the Services and will be kept strictly confidential by Consultant and its agents. Consultant agrees that, unless authorized in writing by Watermaster's General Manager, neither Consultant nor its agents will, directly or indirectly, disclose or use any Confidential Information for their own benefit or for the benefit of any individual or entity other than Watermaster, either during the Term or thereafter. In addition, without Watermaster's prior written consent, Consultant will not modify, disassemble, reverse engineer or decompile any Confidential Information, or copy, retransmit or otherwise reproduce for, or distribute to third parties, any Confidential Information. Nothing contained in this Agreement will require Watermaster to transmit any Confidential Information to Consultant, or be construed as granting any license or any other rights with respect to Watermaster's proprietary rights or Confidential Information.

7.4.3 If, during the Term or at any time thereafter, Consultant or its agents receive a request to disclose any Confidential Information, whether under the terms of a subpoena, court order, or other governmental order or otherwise, Consultant and/or its agents will notify Watermaster immediately of the details of the request (unless prohibited from doing so by applicable law), including providing a copy thereof, and will consult with Watermaster on the advisability of taking legally available steps to resist or narrow such request. If disclosure of such Confidential Information is required to prevent Consultant and/or its agents from being held in contempt or subject to other penalty, Consultant and its agents will furnish only such portion of the Confidential Information as, in the written opinion of legal counsel satisfactory to Watermaster, Consultant and/or its agents are legally compelled to disclose, and Consultant and its agents will use their best efforts to assist Watermaster in obtaining an order or other reliable assurance that confidential treatment will be accorded to the disclosed Confidential Information.

7.5 Ownership, Return of Property and Duties upon Termination. All Confidential Information, reports, recommendations, documents, drawings, plans, presentations, specifications, technical data, databases, charts, files and other information developed by or provided to Consultant and/or its agents in connection with Consultant's affiliation with Watermaster are and will remain the property of Watermaster. Upon termination of this Agreement for any reason, or at such earlier time as Watermaster may request, Consultant and its agents will immediately: (i) discontinue any use of the name, logo, trademarks, or slogans of Watermaster; (ii) discontinue all representations or statements from which it might be inferred that any continuing relationship exists between Consultant and/or its agents and Watermaster; (iii) provide to Watermaster reproducible copies (including electronic versions if available, in native format and with all supporting materials such as fonts, graphics and attachments) of all work product prepared or modified by Consultant and/or its agents and not previously provided to Watermaster, whether completed or not; (iv) return to Watermaster all tangible and intangible Confidential Information, property, documents and other information of Watermaster, in whatever form or format, including originals and all copies of documents, drawings, computer printouts, notes, memoranda, specifications, hard drives, flash drives, disks or storage media of any kind, including all copies, summaries and compilations thereof, in the possession, custody or control of Consultant and/or its agents; (v) subject to record retention obligations, promptly and permanently delete any Confidential Information stored in the internal and/or personal email account(s), computer(s), electronic devices, voicemails, storage media and cloud-based storage (including external hard drives, flash drives, and discs) of Consultant and/or its agents, and certify the same to Watermaster; and (vi) provide Watermaster with any and all passwords, source codes, security codes, administrative access information and/or other information in the possession of Consultant and/or its agents necessary to enable Watermaster to get the benefit of the Services. All of the foregoing will be at the sole expense of Consultant. No failure of Watermaster to enforce the disposition of materials under this Section, or to enforce it fully or promptly, will constitute, or be interpreted or construed as, a waiver of any right of Watermaster under this Agreement, nor will it affect in any way the characterization of any material as Confidential Information or give Consultant any rights or license as to any such Confidential Information of Watermaster, whether by implication, estoppel, act of law, or any other theory or reason.

7.7 Reasonable Restrictions. Consultant and its agents acknowledge and agree that the requirements set forth in this Section are reasonable in time and scope, and do not unduly burden Consultant and/or its agents.

8. No Authority to Bind Watermaster. Neither Consultant nor its agents have any authority, right or ability to bind or commit Watermaster in any way or incur any debts or liabilities in the name of or on behalf of Watermaster (including, without limitation, by entering into contracts or agreeing to contract terms) without the express prior written consent of Watermaster in each individual instance, and will not attempt to do so or imply that it may do so. Consultant and its agents agree not to advertise, promote or represent to any third party that Consultant or its agents are agents of Watermaster. Consultant and its agents may represent only that the parties have an independent contractor relationship pursuant to which Consultant has accepted an opportunity to provide Consultant's customary services to Watermaster. Consultant and its agents will refrain from using Watermaster's name in any advertisement, promotion, business card, website, or similar manner without Watermaster's prior written consent. Consultant and its agents will not add to, delete from or modify any documentation or forms provided by Watermaster, except with the prior written consent of Watermaster.

9. **Indemnification.** Consultant agrees to indemnify, defend (with counsel selected by Watermaster) and hold harmless Watermaster and its affiliates, successors, agents, employees, Consultants, insurers, officers and directors ("Watermaster Indemnified Parties") from and against any and all claims, demands, damages, costs, losses, taxes, penalties, assessments, judgments, interest payments, and expenses of whatever kind and nature, to the fullest extent permitted by law, including attorneys' fees and expert witness costs, directly or indirectly arising out of or resulting from or on account of: (i) any claim, demand, and/or determination that Watermaster is the employer (whether sole, joint and/or common law) of any agent provided by Consultant to perform the Services and any statutory or common law claims brought by Consultant's agents arising from or relating to the employment relationship or other affiliation or termination thereof, such as claims under the California Fair Employment and Housing Act, the California Family Rights Act, the California Government Code, the California Business and Professions Code, the California Paid Sick Leave Law and related local laws, and the California Labor Code, or similar federal statutes, all as amended, for discrimination, harassment, workers' compensation, unemployment or unpaid compensation or benefits; misclassification or failure to make withholdings or is otherwise liable for obligations owed by Consultant to its agents (including under California Labor Code section 2810.3 if and to the extent applicable); (ii) any claim, demand or charge based upon acts or omissions of Consultant or its agents in relation to the Services (including failure to maintain appropriate credentials or insurance); (iii) any claim for negligence or misconduct against any of Watermaster Indemnified Parties in connection with the engagement of Consultant and/or arising under or relating to this Agreement, including without limitation any unauthorized effort by Consultant or its agents to bind Watermaster with respect to third parties or the failure of Consultant or its agents to comply with their obligations under this Agreement; (iv) any claim for injury to or death of any person or for damage to or destruction of property resulting from any act or omission of Consultant or its agents arising under or relating to this Agreement, including any motor vehicle accident; and, (v) any misappropriation, misuse or theft of Confidential Information, unfair competition, breach of contract (including breach of this Agreement), or other acts or omissions of Consultant or its agents that harm or damage (or threaten to harm or damage) any of Watermaster Indemnified Parties or their business, goodwill or reputation. Such obligations will not be construed to negate, abridge, or otherwise reduce other rights or obligations of indemnity that would otherwise exist as to a Watermaster Indemnified Party, and do not limit Watermaster's rights under any applicable law to seek additional relief. The indemnification obligations of Consultant under this Section will not be subject to any limitation on amount or type of damages, compensation or benefits payable by or for Watermaster under workers' compensation laws, unemployment statutes, disability or other employee benefit acts, any applicable insurance policy, or any other federal, state or local law or regulation.

10. **Limitation of Liability.** Watermaster will not be liable to Consultant or its agents for any incidental, indirect, special, consequential, punitive or reliance damages of any nature whatsoever, regardless of the foreseeability thereof (including, but not limited to, any claim for loss of services, lost profits or lost revenues) arising under or related to this Agreement, whether based on breach of contract, tort, breach of warranty, negligence or any other theory of liability in law or in equity. Consultant's remedy, if any, for any breach of this Agreement, will be solely in damages, and Consultant may look solely to Watermaster for recovery of such damages. Consultant waives and relinquishes any right Consultant may otherwise have to obtain injunctive or equitable relief against any third party with respect to any dispute arising under this Agreement. Notwithstanding anything to the contrary in this Agreement, Watermaster's entire liability, and Consultant's ability to recover damages, at law or in equity with respect to any and/or all claims, damages, losses, costs or causes of action arising from or related to this Agreement (other than any action for payment of the Services and invoices related thereto) may not exceed the aggregate dollar amount paid by Watermaster to Consultant under this Agreement.

11. General Provisions.

11.1 Entire Agreement. This Agreement, along with other documents incorporated herein, constitutes the entire agreement between Watermaster and Consultant relating to the subject matter hereof and supersedes all prior oral and written understandings, communications and agreements relating to such subject matter, whether verbal or written, implied or otherwise. In the event of a conflict between any provisions appearing in any other writing and in this Agreement, the provisions of this Agreement will be controlling. Unless otherwise agreed by the parties, all services performed by Consultant for Watermaster during the Term of this Agreement will be governed by this Agreement.

11.2 Assignment. This Agreement is not assignable by Consultant, and any purported transfer or assignment is void. This Agreement, or Watermaster's interest in this Agreement, may be assigned and transferred by Watermaster, temporarily or permanently, whether expressly, by operation of law or otherwise, and Consultant agrees to perform the Services for the benefit of any such assignee.

11.3 Nonexclusive Nature of Agreement. This Agreement does not grant Consultant and/or its agents an exclusive privilege or right to supply Services to Watermaster. Other than as expressly set forth in this Agreement, Watermaster makes no representations or warranties as to a minimum or maximum procurement of Services. Nothing in this Agreement will be construed as limiting in any manner the ability of Consultant and/or its agents to procure other engagements consistent with their obligations to Watermaster hereunder, including the post-Term obligations.

11.4 Use of Name, Likeness and Biography. Watermaster will have the right (but not the obligation) to make public announcements concerning the affiliation of Consultant and its agents with Watermaster. Watermaster will have the right (but not the obligation) to use, publish and broadcast, and to authorize others to do so, the name, likeness and biographical material of Consultant and its agents to advertise, publicize and promote the business of Watermaster.

11.5 Amendments; Waiver. This Agreement may not be amended except by a writing executed by all of the parties hereto. No delay or omission by Watermaster in exercising any right under this Agreement will operate as a waiver of that or any other right. No waiver by either party of a right or remedy hereunder will be deemed to be a waiver of any other right or remedy or of any subsequent right or remedy of the same kind.

11.6 Provisions Subject to Applicable Law; Modification; Severability. All provisions of this Agreement will be applicable only to the extent that they do not violate any applicable law. If any term, provision, covenant, paragraph or condition of this Agreement is held to be invalid, illegal, or unenforceable by any court or arbitrator of competent jurisdiction, as to such jurisdiction that provision will be limited ("blue-penciled") to the minimum extent necessary so this Agreement will otherwise remain enforceable in full force and effect. To the extent such provision cannot be so modified, the offending provision will, as to such jurisdiction, be deemed severable from the remainder of this Agreement, and the remaining provisions of this Agreement will be construed to preserve to the maximum permissible extent the intent of the parties and the purpose of this Agreement.

11.7 Notices. All notices, demands, consents, waivers, and other communications under this Agreement will be deemed to have been duly given when (i) delivered by hand; (ii) when received by the addressee, if sent by registered mail (return receipt requested), a nationally recognized overnight delivery service (signature requested) or electronic mail, in each case to the addresses or mail addresses set forth below (or to such other addresses as either party may designate upon written notice):

If to Consultant:

S.S. Papadopulos & Associates, Inc. (SSP&A)
Attn: Vivek Bedekar
1801 Rockville Pike
Suite 220
Rockville, MD 20852
Email: vivekb@sspa.com

If to Watermaster:

Chino Basin Watermaster
Attn: Todd M. Corbin
9641 San Bernardino Road
Rancho Cucamonga, California 91730
Email: tcorbin@cbwm.org

With a copy (which will not constitute notice) to:

Brownstein Hyatt Farber Schreck, LLP
1021 Anacapa Street, 2nd Floor
Santa Barbara, California 93101
Attention: Scott Slater
Email: sslater@bhfs.com

11.8 Construction. The Section headings in this Agreement are for convenience and reference only, and the words contained therein in no way will be held to explain, modify, amplify or aid in the interpretation, construction, or meaning of the provisions of this Agreement. The word "including" will mean "including but not limited to." The word "agents" includes employees, consultants, subconsultants, agents, owners and other representatives. Both parties participated in the drafting of this Agreement, and each had the opportunity to consult with counsel of their own choosing in connection therewith. The rule that ambiguities in an agreement will be construed against the drafter does not apply to this Agreement.

11.9 Force Majeure. Each party's obligations hereunder will be suspended during the duration of events beyond that party's reasonable control (including labor strikes, lockouts, enactment of laws or regulations, civil unrest, pandemics, diseases, measures implemented by any governmental authority, and acts of God), provided such party makes reasonable efforts to perform and resumes performance at the earliest opportunity. If Consultant suspends the Services for a period in excess of five (5) calendar/business days, Watermaster may elect to terminate this Agreement immediately thereafter by providing written notice thereof, notwithstanding anything to the contrary in this Agreement.

11.10 Governing Law; Venue; Fees. This Agreement is entered into and will be governed by and construed and enforced in accordance with the laws of the State of California. Any action brought to enforce any right or obligation under this Agreement will be subject to the exclusive jurisdiction of the courts of the State of California and will be brought in the Court maintaining jurisdiction over the case *Chino Basin Municipal Water District v. City of Chino*, San Bernardino Superior Court Case No. RCV RS 51010. The parties irrevocably consent to the exclusive jurisdiction of such court (and of the appropriate appellate courts therefrom) in any such action, suit or proceeding. The substantially prevailing party in any action related to this Agreement, including the breach or enforcement hereof, will be entitled to recover its costs and reasonable attorneys' fees and expenses, including expert witness fees, to the fullest extent permitted by applicable law.

11.11 Legal and Equitable Remedies. Because Consultant's services are personal and unique, and because Consultant and its agents will have access to and become acquainted with the Confidential Information (as defined above), Watermaster will have the right to enforce this Agreement and any of its provisions by injunction, specific performance or other equitable relief, without bond or other security, without prejudice to any other rights and remedies that Watermaster may have for a breach of this Agreement, and Consultant and its agents waive the claim or defense that Watermaster has an adequate remedy at law.

11.12 Authority; Counterparts. Each party represents and warrants that it has full power and authority to enter into this Agreement. This Agreement may be executed in separate counterparts, each of which will be deemed an original, and both of which taken together will constitute one and the same instrument. A facsimile, pdf, DocuSigned or emailed signature will have the same force and effect as an original signature.

ACKNOWLEDGED AND AGREED:

[INSERT]	**Chino Basin Watermaster**
By: ______________________ [Name]	By: ______________________ Todd M. Corbin
Its: ______________________ [Title]	Its: General Manager

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ATTACHMENT 2

S.S. Papadopulos & Associates, Inc.
Environmental & Water Resource Consultants

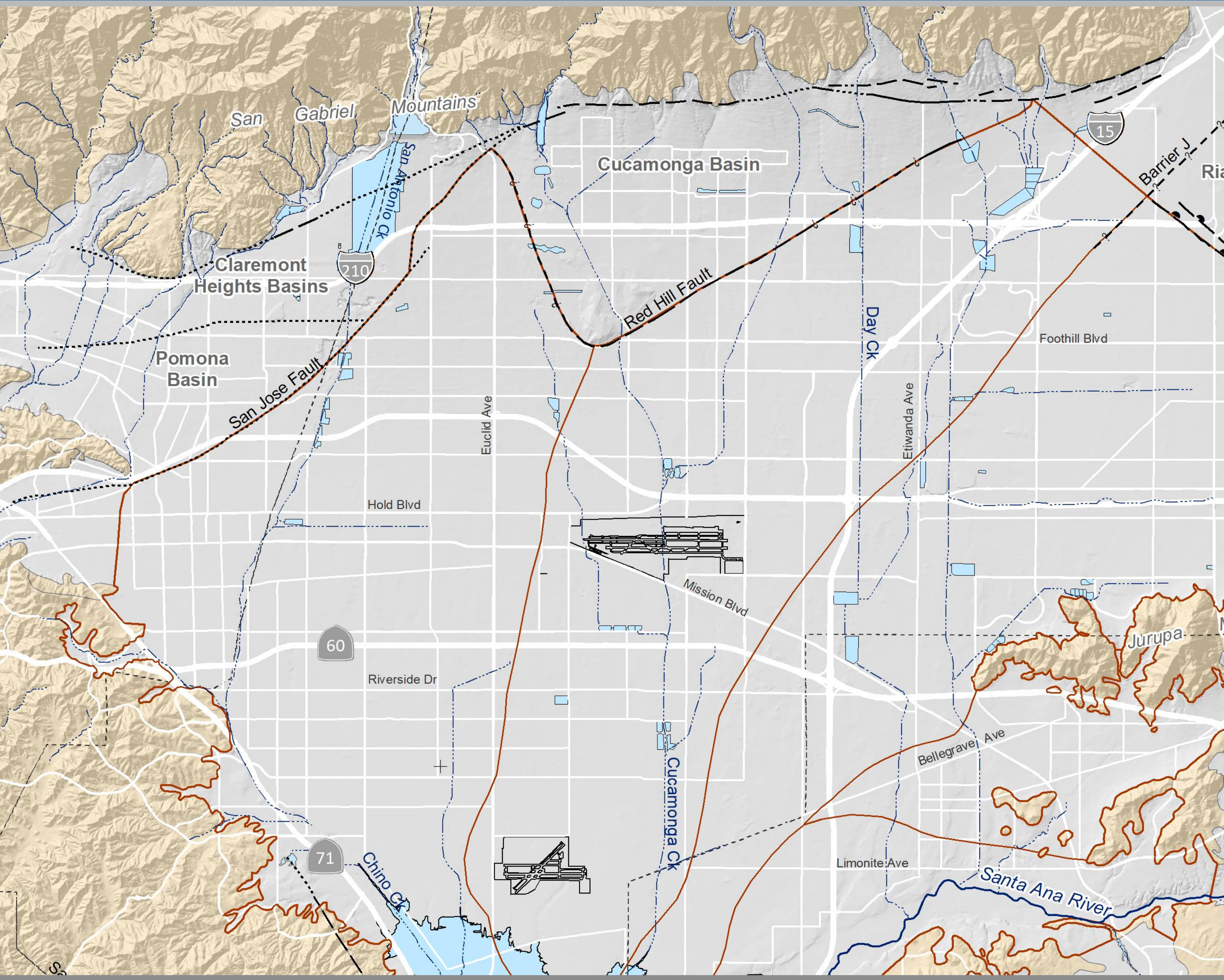


Image source: Figure from Chino Basin Watermaster 2020 State of the Basin Report by West Yost.

PROPOSAL

Peer Review of 2025 Safe Yield Evaluation Process and Results

Submitted to the Chino Basin Watermaster June 9, 2025

June 9, 2025

SUBMITTED ELECTRONICALLY

Todd Corbin
General Manager
Chino Basin Watermaster
9641 San Bernardino Road
Rancho Cucamonga, CA 91730
tcorbin@cbwm.org

SUBJECT: **Proposal – Peer Review of 2025 Safe Yield Evaluation Process and Results**

Dear Mr. Corbin,

S.S. Papadopulos and Associates, Inc. (SSP&A) is hereby expressing strong interest in the Chino Basin Watermaster's (Watermaster's) Peer Review of the 2025 Safe Yield Evaluation Process and Results (SYEPR) project. We appreciate the invitation to support this important evaluation effort and thank you for the opportunity to submit our proposal.

This complex project requires a team of specialized experts to provide a rigorous and independent peer review that provides the Watermaster with an accurate final report that empowers you to move forward with confidence. SSP&A has assembled that team specifically for this engagement. We bring critical technical experience with the modeling tools central to this evaluation, including MODFLOW, PEST-IES, Hydrus, and HSPF, as well as deep understanding of issues such as safe yield determination, boundary condition estimation, model calibration, associated uncertainties, and local geological understanding.

To supplement our in-house capabilities, we have added specialists from our long-term teaming partners Paradigm Environmental (an Ulteig Company) for their expertise in surface water modeling with Hydrological Simulation Program–Fortran (HSPF) and development of Loading Simulation Program C++ (LSPC), and from Wood Rodgers for local hydrogeologic expertise in reviewing aquifer properties as well as in-person engagement with CBW staff and consultants. To support the review process and maintain strong communication with Watermaster staff and stakeholders, our team will meet for biweekly calls and has already reserved time for the scheduled meetings. We are fully available for the in-person Watermaster Board presentation on September 25, the Pool Committees on October 9, the Advisory Committee on October 16, and the Watermaster Board meeting on October 23, 2025.

We look forward to the opportunity to work with the Watermaster and to contribute meaningfully to the 2025 Safe Yield Evaluation through independent and constructive peer-review services. Please contact Vivek Bedekar with questions or to discuss our proposed approach, schedule, and fees.

Sincerely,

Matthew J. Tonkin, PhD
President and Principal-in-Charge
matt@sspa.com

Vivek Bedekar

Vivek Bedekar, PhD, PE
Project Manager
vivekb@sspa.com

Section 1.
Experience and Qualifications

Introduction

S.S. Papadopulos & Associates Inc. (SSP&A) is a groundwater and environmental consulting firm providing specialty services in water resources, groundwater modeling, contaminant fate-and-transport, geochemistry, and environmental remediation. SSP&A's reputation is built upon pioneering achievements from the development of analytical methods for determining aquifer properties, to the origination of the precursors to today's standard numerical groundwater modeling tools. We continue our industry leadership by creating numerical simulators that are used worldwide for flow and transport modeling, authoring and publishing software for hydrologic analyses, providing technical and professional training, leading research and development (R&D), and completing complex and challenging projects for public and private entities worldwide.

SSP&A critically evaluates available data, guides focused data acquisition efforts, and develops quantitative analyses to deliver practical solutions to complex problems. SSP&A tailors project-specific combinations of the following disciplines and skills – often in collaboration with other consultants and contractors – to address the needs of each client:

- Environmental Modeling and Hydrogeology
- Geochemistry
- Engineering and Remediation
- Software Development
- Geophysical Investigations and Analysis
- Data Management and Analysis
- Field Services
- Expert Witness and Litigation Support

To meet the Chino Basin Watermaster's goals for the peer review, **S.S. Papadopulos & Associates, Inc. (SSP&A)** has assembled a highly qualified and collaborative team comprising **Paradigm Environmental, an Ulteig Company (Paradigm)** and **Wood Rodgers**. This team combines deep technical expertise in groundwater and watershed modeling, regulatory and planning experience, and local knowledge essential for effective stakeholder engagement. This team also includes nationally-recognized experts in hydrologic and groundwater modeling to support the peer review effort. We have a strong track record of collaborative work and relevant project experience, particularly in the California context, with expertise in groundwater modeling, model calibration, and uncertainty analysis to deliver the right combination of senior professionals with decades of experience in applying and reviewing complex hydrologic models used for water resources management, basin planning, and regulatory compliance.

SSP&A is currently engaged in evaluating the safe yield estimates for two confidential groundwater basins in California, neither of which conflicts with the Chino basin.

Relevant Experience

S.S. Papadopulos & Associates, Inc.

SSP&A staff proposed for this project are currently supporting two active legal matters in California that center on safe yield estimation. We recognize the inherent challenges in estimating groundwater flow budgets and the importance of integrated modeling to characterize aquifer storage and inter-basin flow dynamics. Several key components of the groundwater budgets, such as inter-basin flows, vadose zone storage, and aquifer storage, cannot be measured directly and must therefore be estimated using a calibrated model. This underscores the critical importance of robust model calibration.

SSP&A has a long-standing reputation for developing and applying groundwater models to support practical resource management and policy needs. In our current projects, we are providing independent technical peer review of safe yield estimates presented in approved Groundwater Sustainability Plans. Our team is responsible for refining and recalibrating existing groundwater models to improve the accuracy of these estimates. This work includes recalculating and verifying individual groundwater budget terms, particularly those related to recharge and inter-basin flow, and updating the numerical flow models accordingly.

As with any modeling effort, and especially those involving safe yield estimation, ongoing stakeholder engagement is essential. We are currently supporting mediation proceedings by providing technical input and expert interpretation of model results to help build consensus and guide decision-making.

Paradigm Environmental, an Ulteig Company

Paradigm Environmental, an Ulteig Company, brings specialized expertise in surface water modeling, particularly in applying the Hydrological Simulation Program – FORTRAN (HSPF) model, its successor code Loading Simulation Module, in C++ (LSPC) that includes streamlined HSPF algorithms, and in developing and applying spreadsheet-based tools for estimating sustainable yields and evaluating water availability. Paradigm's role in the State Board contract complements SSP&A's groundwater modeling expertise, enabling a comprehensive and integrated evaluation of hydrologic systems.

In collaboration with Paradigm, SSP&A is currently engaged under a contract with the California State Water Resources Control Board (SWRCB) to develop and apply integrated surface water – groundwater models that assess supply and demand in multiple watersheds across the state. This collaborative effort leverages complementary expertise and demonstrates our ability to deliver technically robust, policy-relevant modeling analyses.

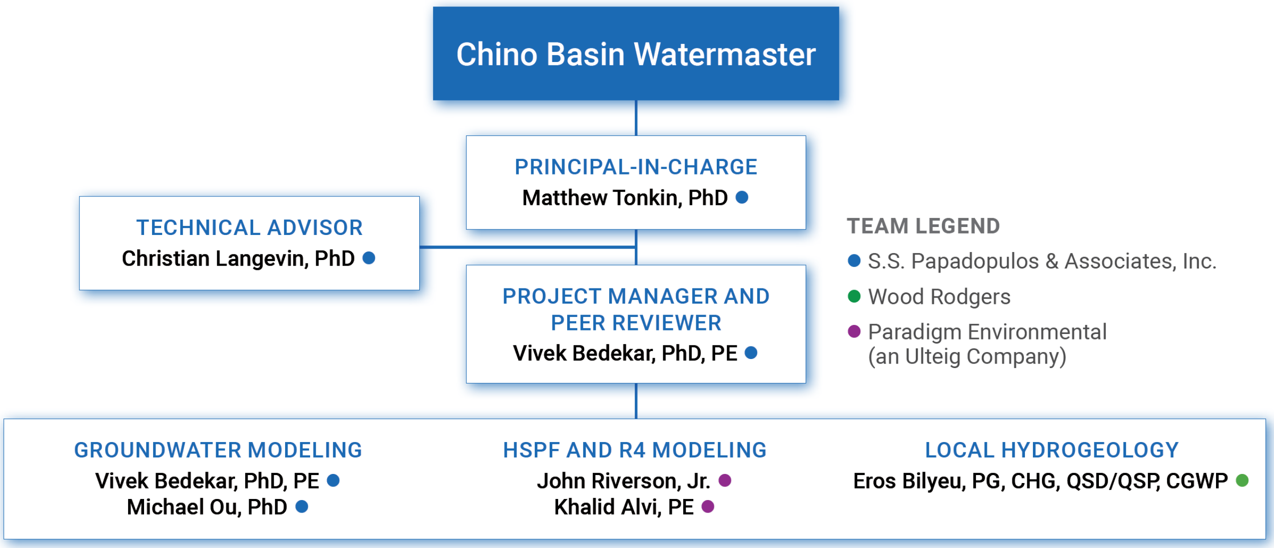
Wood Rodgers

Wood Rodgers contributes essential regional insight and stakeholder engagement experience, with a long-standing presence in the region and direct involvement in local groundwater sustainability planning. Their knowledge of basin-specific conditions, regulatory frameworks, and agency needs strengthens the team's ability to provide relevant and actionable peer review support.

With Wood Rodgers, SSP&A is currently involved in groundwater modeling for the San Bernardino Basin. While this project is still underway and results are not expected before the peer review work is completed, our involvement provides us with a strong understanding and knowledge of local hydrogeologic conditions and basin management challenges that will inform our approach.

Team Roles and Qualifications

SSP&A's streamlined team will perform an efficient, effective review of the draft 2025 Safe Yield Evaluation Process and Results (SYEPR). Brief introductions of our team members and their roles are provided below. Resumes for each team member are included in Appendix B.



Matthew Tonkin, PhD

Principal-in-Charge

EDUCATION: PhD, Civil Engineering; MSc, Hydrogeology; BSc, Applied Geology; YEARS OF EXPERIENCE: 30

Dr. Tonkin is Principal Hydrogeologist and President of SSP&A. He will provide principal oversight and confirm appropriate company resources are dedicated to this project. His areas of expertise include water resource evaluations, environmental data analysis and interpretation, and modeling to guide groundwater, surface water, and soil and contamination studies for public, private, and legal clients. He has more than 30 years of experience planning sampling and monitoring programs; developing and applying models of hydrologic and hydrogeologic systems; presenting to stakeholders; and collaborating with other experts. For this project, Dr. Tonkin will serve as Principal-in-Charge to review project deliverables and work products.

Christian Langevin, PhD

Technical Advisor

EDUCATION: PhD, Geology; MS, Geology; BS, Geology; YEARS OF EXPERIENCE: 25+

Dr. Langevin is an internationally recognized authority in the field of hydrologic modeling, Dr. Langevin specializes in the development and application of advanced simulation software for complex groundwater resource evaluations and contaminant transport analyses. Prior to joining SSP&A, Dr. Langevin served as the lead developer and primary caretaker of the U.S. Geological Survey (USGS) MODFLOW program, the world's most widely used groundwater simulator. In this pivotal role, he helped shape modern groundwater simulation tools. He has developed and codeveloped key hydrologic modeling software, including MODFLOW 6, MODFLOW-USG, MT3D-USGS, SEAWAT, and FloPy, and authored or coauthored numerous peer-reviewed publications and technical reports on hydrologic modeling. His expertise in translating physical hydrologic systems into numerical representations comes from over two decades of practical application together with teaching and advising on the application of numerical models in diverse hydrologic settings.

Vivek Bedekar, PhD, PE

Project Manager and Peer Reviewer

EDUCATION: PhD, Civil Engineering; MS, Environmental Engineering; BS, Civil Engineering; REGISTRATION: Professional Civil Engineer, DC #PE904565; YEARS OF EXPERIENCE: 25+

Dr. Bedekar has more than 25 years of experience working on a variety of modeling and software development projects. He has developed numerous local and regional models, surface-water/groundwater interaction models, flow-and-transport models, and variable density models. Dr. Bedekar's experience includes development of various modeling codes, serving as the lead author of MT3D-USGS, and co-developer of Texture2Par, and has contributed to MODFLOW and the Integrated Water Flow Model (IWFM) for California Department of Water Resources. For this project, Dr. Bedekar will serve as the primary point-of-contact for the Watermaster, manage the SSP&A team in reviewing the Safe Yield report and methodology, assist with the modeling efforts, attend the October 9, 16, and 23, 2025 meetings, and present the final peer-review report in September 2025 in person.

Gengxin (Michael) Ou, PhD

Modeling and Tool Development

EDUCATION: PhD, Civil Engineering (minor in Natural Resource Sciences); MS, Hydrology and Water Resources; BE, Hydrology and Water Resources Engineering; YEARS OF EXPERIENCE: 10+

Dr. Ou is a hydrologic and groundwater modeler with extensive experience in model implementation and development, water resources planning and assessments, development of graphical user interfaces, and statistical and spatial analysis. He brings strong computational and advanced mathematics skills and experience programming with Python, Fortran, R, and VBA. He has developed many software applications including several MODFLOW packages to enhance model capability. Dr. Ou analyzes and customizes modeling software architecture, performs model simulations, and provides data analysis and data integration. For this project, Dr. Ou will provide support for modeling tasks and develop tools for pre- and post-processing modeling results.

John Riverson, Jr.

HSPF Modeling Lead (Paradigm Environmental, an Ulteig Company)

EDUCATION: MS, Civil & Environmental Engineering; BS, Civil & Environmental Engineering; YEARS OF EXPERIENCE: 20

Mr. Riverson specializes in developing and applying hydrologic models and conducting supporting data analyses services, with a focus on public-domain models typically used to support water resources management and regulations and subject to peer review (e.g., HSPF, LSPC, SWMM, SWAT, TR-55, CE-QUAL-W2, QUAL2E/2K, SUSTAIN). He has an in-depth understanding of meteorological and hydrological processes and interactions, climate change assessment, watershed and stormwater management, water quality, and pollutant source characterization. John led the development of USEPA's LSPC from 2003 and was responsible for designing system architecture and developing algorithms for most of the core LSPC modules including: (1) high-resolution meteorological data (2) crop-associated irrigation, (3) hydraulic withdrawals and diversions, and (4) the time-variable land use module. John is regularly sought by different agencies to provide third-party review and QA/QC of modeling applications. For this project, Mr. Riverson will provide peer review for the HSPF model.

Khalid Alvi, PE

LSPC Lead Developer (Paradigm Environmental, an Ulteig Company)

EDUCATION: MS, Civil & Environmental Engineering; BS, Civil Engineering; REGISTRATION: Professional Engineer, VA #0402046509; YEARS OF EXPERIENCE: 24+

Mr. Alvi is a professional engineer and an experienced stormwater, watershed, water quality modeler, and data and GIS application developer with more than 24 years of experience in the development of watershed and BMP modeling systems. Mr. Alvi served as project manager and technical lead for the development of Opti-Tool, a spreadsheet-based stormwater best management practices optimization tool designed for use by municipal SW managers and their consultants to assist in developing technically sound and optimized cost-effective SW management plans. He co-led the development of EPA's Loading Simulation Program C++ (LSPC) to modernize the watershed model HSPF and EPA's SUSTAIN - a decision support system for the EPA's Office of Research and Development to develop, evaluate, optimize, select, and place BMPs based on cost and effectiveness. For this project, he will provide peer review for the R4 model.

Eros Bilyeu, PG, CHG, QSD/QSP, CGWP

Local Engagement, Yield and Storage Data, (Wood Rodgers)

EDUCATION: BS, Geology; REGISTRATION: Professional Geologist, CA #9351; Certified Hydrogeologist, CA #1061; Qualified Stormwater Pollution Prevention Plan Developer and Practitioner #27447; YEARS OF EXPERIENCE: 17+

Mr. Bilyeu is a California Certified Hydrogeologist with experience in high-resolution hydrogeologic characterization and 3D conceptual and numerical modeling of groundwater basins, karst terrains, and fractured bedrock aquifer systems. Mr. Bilyeu has extensive experience in groundwater management and planning, including implementation of key components of Groundwater Sustainability Plans (GSPs) under California's Sustainable Groundwater Management Act (SGMA) in high-priority basins. He has managed and executed a wide range of groundwater and well-related projects, including managed aquifer recharge (MAR), recharge basins, well siting, well design, and construction management for municipal supply wells. His technical expertise also includes the design and installation of multi-level and nested monitoring wells, remedial extraction wells, and Aquifer Storage and Recovery (ASR) wells, as well as horizontal wells. For this project, Mr. Bilyeu will provide his local hydrogeologic expertise when reviewing aquifer properties.

Relevant Project Descriptions

Detailed summaries of relevant projects completed by SSP&A, Paradigm, and Wood Rodgers are included in Appendix A.

Section 2.
Technical Approach

Project Understanding

Chino Basin Watermaster (Watermaster) is undertaking a critical reassessment of the Safe Yield of the Chino Basin through the 2025 Safe Yield Evaluation Process and Results (SYEPR). Preliminary findings based on the recalibrated Chino Valley Model (CVM) indicate a potential reduction in Safe Yield on the order of 14,000 acre-feet per year (AFY), which is about 10% less than prior estimates made in 2020. Given the significance of this outcome, Watermaster has requested an independent, technical peer review to evaluate the underlying methodology, assumptions, and results.

SSP&A has conducted a preliminary review of the available technical memoranda and presentations to develop a comprehensive, objective approach to this peer review. Our methodology is grounded in technical rigor, transparency, and collaboration. We believe that effective peer review is not only about verification, but also about enhancing trust and clarity in decision-making through constructive, data-driven engagement with Watermaster staff, their consultants, and the stakeholders.

Our proposed approach addresses each element of the Scope of Work outlined in the RFP. The following sections describe our planned technical review activities, organized by Task, and highlight how we will bring our groundwater modeling and evaluation expertise to ensure a robust and credible outcome for the 2025 SYEPR.

Scope of Work

Task 1 – Evaluate Watermaster's implementation of the court-approved 2022 Safe Yield Reset Methodology

SSP&A will conduct a thorough review of the Court Order approving the 2022 Safe Yield Reset Methodology and assess the consistency of Watermaster's implementation with the Court's directives. This evaluation will specifically focus on the estimation of Net Recharge and the broader methodology, including:

- **Assessment of future water demands and cultural conditions:** We will review whether these assumptions align with the Court Order and accepted practices for predictive simulations.
- **Evaluation of Ensemble Modeling and Uncertainty Analysis:** Our team will examine the selection process for the multiple calibrated realizations used in the uncertainty analysis, focusing on:
  - Whether uncertainty analysis was required and its value to model calibration and decision-making.
  - The use of an ensemble modeling approach, specifically, the Iterative Ensemble Smoother (IES), and whether realization #157 (or the final selection) is appropriately representative of the ensemble. Review whether the use of a 'base model' is more appropriate for predictive purposes rather than one specific realization from the ensemble.

   - Opportunities for further calibration using traditional gradient-based techniques, and whether parameter values and boundary conditions are within reasonable and plausible ranges.
- **Review of estimated Net Recharge ranges:** We will assess the assumptions and compare estimated Net Recharge to historical precipitation (P), applied water (AW) data, and review Net Recharge as a percentage of P and AW, and compare that against other relevant studies. Special attention will be paid to whether multipliers were used in changing the recharge generated by models like HSPF and R4, and if such use may compromise the integration of surface water and groundwater systems by under/over-estimating other water balance components such as evapotranspiration (ET).

The findings from Task 1 will be included in the peer-review report (final deliverable) outlining the methodology's fidelity to the Court Order, technical soundness, and transparency.

Task 2 – Review Assumptions and Calculations Used to Estimate Net Recharge

Our team recognizes the advantages and potential challenges associated with using a suite of integrated models – HSPF, R4, HYDRUS-2D, and MODFLOW-NWT. We will:

- **Review model assumptions and calibration changes**, particularly parameters and boundary conditions that were adjusted during history matching, to ensure consistency and physical plausibility.
- **Develop a comprehensive water budget** across all tools and physical domains and ensure all components are accounted for without duplication or omission, recognizing the risk of disconnects when linking models. With a complex assemblage of models, it is critical to evaluate the combined water budget to ensure that inconsistencies in linkage terms do not go undetected. For example, surface water model outputs used as recharge inputs to the groundwater model must align precisely, particularly during model calibration, to avoid discrepancies in groundwater recharge estimates.
- **Evaluate flow components holistically**, including deep infiltration of precipitation and applied water (DIPAW), managed aquifer recharge, mountain-front recharge, streambed infiltration, basin boundary flows, and ET. We will correlate the changes in groundwater storage with precipitation, applied water, and groundwater pumping to understand the system. Change in vadose zone storage will be similarly assessed to understand lag times associated with flow through vadose zone. Aquifer properties (horizontal and vertical conductivity, and storage) will also be reviewed.
- **Compare 2025 model outputs with prior evaluations,** and investigate reasons for the ~14,000 AFY decrease in Safe Yield estimates, assessing their technical defensibility. Spatial and temporal patterns of changes will be evaluated including, but not limited to, DIPAW, vadose and groundwater storage changes, stream-aquifer interactions, basin boundary inflows/outflows, and ET.

We assume access to all model files and documentation, including R4, and will request developer support for the R4 model where necessary. To meet the project schedule, our team members will coordinate to perform Task 2 in parallel.

Task 3 – Review elements relating to the CVM model calibration and determination of storage levels in the basin

We will evaluate the model calibration methodology to determine whether a range of calibration targets was appropriately considered during history matching. Specifically, we will assess model performance in simulating groundwater heads and streamflows and how the calibration process was used to constrain the water budgets. The vadose zone may not have observed values to constrain water budgets and therefore a qualitative assessment will be performed for changes in saturation with depth and through time. Equally important is to assess whether aquifer properties and vadose zone parameters remained within physically meaningful ranges throughout the calibration process. Ensuring that model parameters reflect actual hydrogeologic conditions, not simply numerical artifacts to accommodate model error, is essential to support reliable predictive use.

A key part of this task will involve reviewing the calibrated model's ability to simulate changes in groundwater levels, which in turn indicates whether storage properties have been appropriately parameterized. Special emphasis will be placed on storage-related parameters, as one of the stated purposes of the model is to confirm the total storage capacity of the Chino Basin.

We will evaluate whether model calibration minimizes the risk of compensating for structural or data limitations through overfitting. Overfitted parameters may improve history matching but lack physical meaning and can result in misleading predictions. Our review will emphasize the importance of multiple lines of evidence during calibration, ensuring that the model can produce credible water budget estimates and serve as a reliable tool for future decision-making.

We will analyze the spatial and temporal distribution of groundwater head residuals to determine whether there is any bias in the model. Special attention will be given to model performance near the basin boundaries, where boundary conditions often exert disproportionate influence and may introduce error. A series of reality checks will be conducted to evaluate how well the model performs in these edge regions.

Our team will also assess the use of the Iterative Ensemble Smoother (IES) in the uncertainty analysis. We will review how uncertainty analysis was incorporated into the calibration framework; whether the selected realization (e.g., one close to the ensemble mean) exhibits both strong calibration and reasonable parameter and boundary condition values; and, whether traditional gradient-based calibration techniques could further improve model performance.

Given the connected nature of the Chino Basin, careful model calibration is critical for reasonably estimating Safe Yield. This task will ensure that the CVM has been calibrated in a scientifically sound and defensible manner that supports both current evaluation needs and future planning.

Task 4 – Other Issues Relevant to the Calculation of Net Recharge

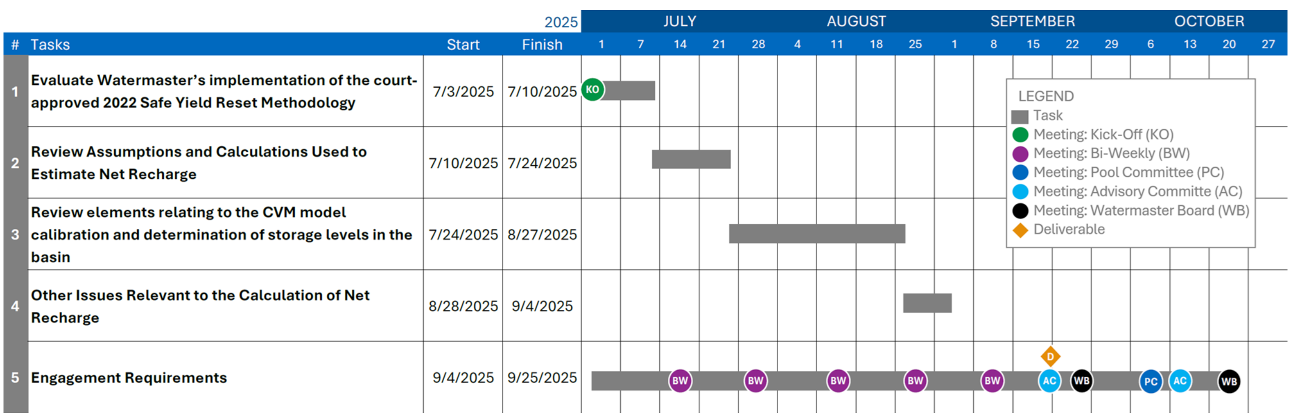
We recognize that relevant technical issues may fall outside the predefined tasks. As we review model assumptions, methodologies, and calibration outputs, we will identify and document any additional factors with potential to impact Net Recharge estimates, such as limitations or assumptions in coupling model components, use of model multipliers that may compromise internal consistency, and opportunities to strengthen the predictive use of CVM by refining how uncertainty is applied.

We aim to collaborate with Watermaster staff and their consultants throughout the review, potentially integrating improvements as they are identified to ensure an efficient and iterative process.

The deliverable for Tasks 1- 4 will be a comprehensive report summarizing findings, limitations, and recommendations.

Task 5 – Engagement Requirements

The schedule below reflects the anticipated project schedule by task, including meetings and deliverables.



SSP&A will maintain an active and transparent line of communication with Watermaster staff and other consultants:

- We will participate in **biweekly meetings** to provide progress updates and discuss technical issues.
- A **presentation of findings** will be delivered to the Advisory Committee on September 18, 2025.
- The **final Peer Review report** will be submitted and presented to the Watermaster Board on September 25, 2025.
- We will also participate in all October Pool Committee, Advisory Committee, and Board meetings, either in person or virtually.

Our team is committed to making this engagement collaborative, data-driven, and solution-oriented. The peer review process will be framed by professional rigor and built on our experience with similar large-scale groundwater model evaluations across the country.

Section 3.
Cost Estimate

The total cost estimate for the project, including materials, labor, software, and travel is $95,628. Details of the cost breakdown are provided below.

Task	Description	Matthew Tonkin		Christian Langevin		Vivek Bedekar		Michael Ou		John Riverson, Jr.		Khalid Alvi		Eros Bilyeu		Total Cost
	Billing Classification	Principal Hydrogeologist		Principal Hydrologist		Associate Engineer		Senior Project Scientist		Principal Engineer		Senior Project Engineer		Senior Hydrogeologist		
	Hourly Rate	$376		$376		$269		$216		$345		$325		$270		
		Hours	Total	Hours	Total	Hours	Total	Hours	Total	Hours	Total	Hours	Total	Hours	Total	
1	Evaluate Watermaster's implementation of the court-approved 2022 Safe Yield Reset Methodology	0	$0	8	$3,008	24	$6,456	0	$0	0	$0	0	$0	0	$0	**$9,464**
2	Review Assumptions and Calculations Used to Estimate Net Recharge	8	$3,008	16	$6,016	24	$6,456	16	$3,456	16	$5,520	16	$5,200	0	$0	**$29,656**
3	Review elements relating to the CVM model calibration and determination of storage levels in the basin	8	$3,008	24	$9,024	56	$15,064	40	$8,640	0	$0	0	$0	16	$4,320	**$40,056**
4	Other Issues Relevant to the Calculation of Net Recharge	0	$0	8	$3,008	16	$4,304	0	$0	0	$0	0	$0	0	$0	**$7,312**
5	Engagement Requirements	0	$0	10	$3,760	20	$5,380	0	$0	0	$0	0	$0	0	$0	**$9,140**
		16	$6,016	66	$24,816	140	$37,660	56	$12,096	16	$5,520	16	$5,200	16	$4,320	**$95,628**

Appendix A. Relevant Project Descriptions

Third-party Review of GULF and GMA 14 Models

Lone Star Groundwater Conservation District, Conroe, Texas

REFERENCE: Sarah Kouba, General Manager, Lone Star Groundwater Conservation District, (936) 494-3436, skouba@lonestargcd.org; TEAM: Vivek Bedekar, Michael Ou (SSP&A)

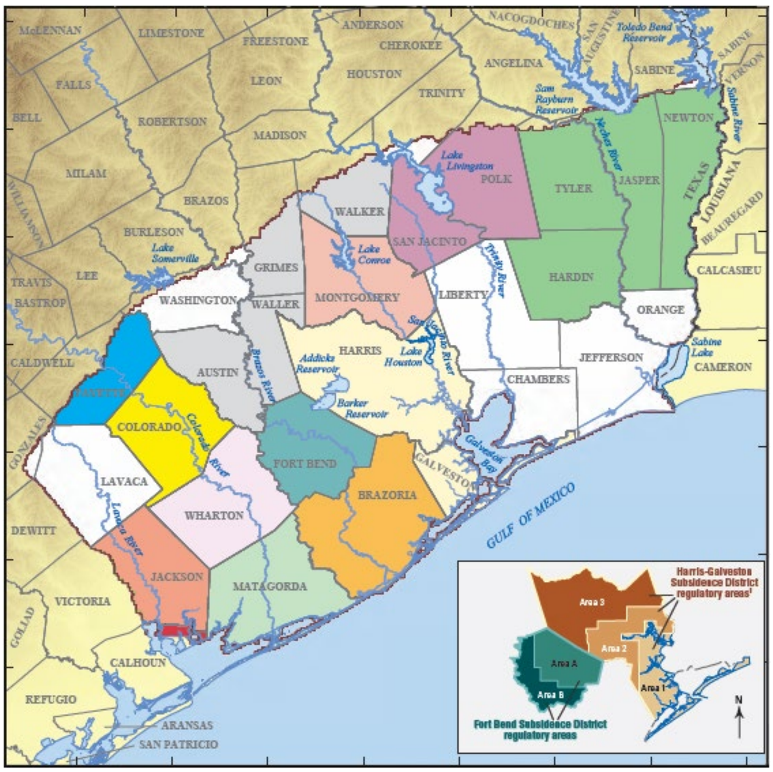


Figure shows land subsidence and groundwater conservation districts within the Gulf Coast aquifer system study area in southeast Texas. SOURCE: Ellis et al, 2023

SSP&A was selected by the Lone Star Groundwater Conservation District (GCD) of Texas to provide a third-party review of a groundwater model that is being developed for the Groundwater Management Area (GMA) 14 for joint planning purposes. GMA 14 partially or fully includes five GCDs and two subsidence districts.

A groundwater model (GULF Model) was developed by the U.S. Geological Survey (USGS) to simulate groundwater conditions and subsidence in the Gulf Coast Aquifer System. Subsidence has been recorded due to increased groundwater pumping, predominantly in Montgomery, Harris, Fort Bend, and other neighboring counties. The USGS model is being revised by a consultant team comprised of Advanced Groundwater Solutions, LLC (AGS) and KT Groundwater (GMA14 Model), who were retained by the Lone Star GCD.

SSP&A's role is to review the GULF Model and subsequently review the GMA14 Model to evaluate the changes made in the GMA 14 Model, and identify limitations in both models, if any. SSP&A staff have summarized their findings related to the groundwater model calibration, and particularly the compaction and subsidence aspects of the model in a report. The report was submitted to Lone Star GCD and to the Texas Water Development Board (TWBD) at the end of March 2025.

Goleta Groundwater Basin – Water Resources Modeling and Expert Testimony

Confidential Client, Goleta, California

REFERENCE: Carl L. Blumenstein, Attorney at Law, NOSSAMAN LLP, (415) 438-7219; TEAM: Matthew Tonkin, Vivek Bedekar, Michael Ou (SSP&A)

SSP&A was retained to provide subject matter expert services for the second phase of a bifurcated case to evaluate and revise a previously-developed conceptual flow model (CSM). Initially, Dr. Matthew Tonkin acted as a Phase 2 responsive expert to review, execute, modify, and opine on Defendant's models.

Documents received, reviewed, and opined upon included groundwater models constructed using MODFLOW-2000/SURFACT; integrated hydrologic models constructed using ParFlow-CLM; and land surface models constructed using DPWM. Dr. Tonkin reviewed, executed, and re-calibrated various versions of these models and provided opinion on the CSM and hydrogeologic structure, including the coastal alluvial basin and underlying / surrounding consolidated tertiary sedimentary rocks subject to vertical and lateral fault displacement. He reviewed groundwater level and streamflow data and undertook streamflow separation to understand groundwater/surface-water interaction.

As the project progressed, Dr. Tonkin reviewed and responded to new groundwater level, streamflow, pumping, climate, aquifer test, and rock core data; and reviewed, executed, and re-calibrated new versions of the MODFLOW-SURFACT, ParFlow-CLM, and DPWM models in addition to other LSMs constructed using the USDA HYDRUS code, USGS SWB code, USGS INFIL3.0 simulation code, and USGS PRMS code.

Subsequently, all Phase 1 work (which Dr. Tonkin had not previously been engaged in) and Phase 2 work was revisited to prepare for a new judge and new Phase 1 and Phase 2 deposition and trial testimony.

Dr. Tonkin was retained as an affirmative and responsive expert, along with Dr. Vivek Bedekar to as a responsive expert to complete assessments that included: (a) re-calibration and application of the various groundwater and LSMs; (b) independent evaluation of the sources and rates of recharge via aerial infiltration and also from three primary mountain-front recharge processes – stream leakage, alluvial canyon flows, and bedrock underflow; and (c) use of these assessments to evaluate the resiliency of the alluvial basin to changes in recharge.

At the completion of the Phase 2 work, Dr. Tonkin authored a comprehensive affirmative Phase 1 expert report that detailed the regional and local hydrogeology, sources and rates of recharge, and long-term sustainability of groundwater resources with particular emphasis on the consolidated bedrock units. Estimation of transient net groundwater recharge in response to climate conditions was a major component of this work, which included:

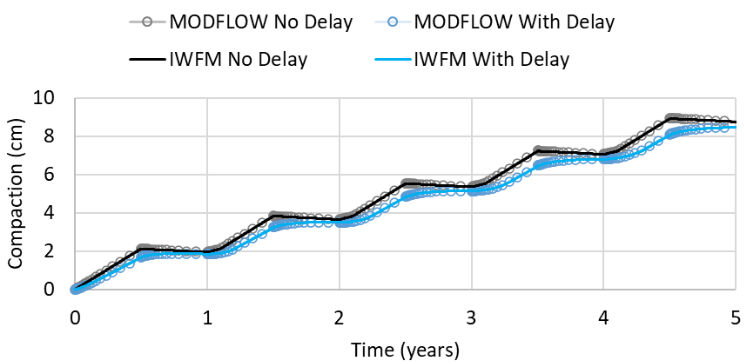
- Evaluation and revisions to CSM and multiple models built on that CSM.
- Evaluation of multiple data types critical to estimation of groundwater recharge.
- Preparation of detailed expert reports.
- Testimony at deposition and preparation for trial testimony.

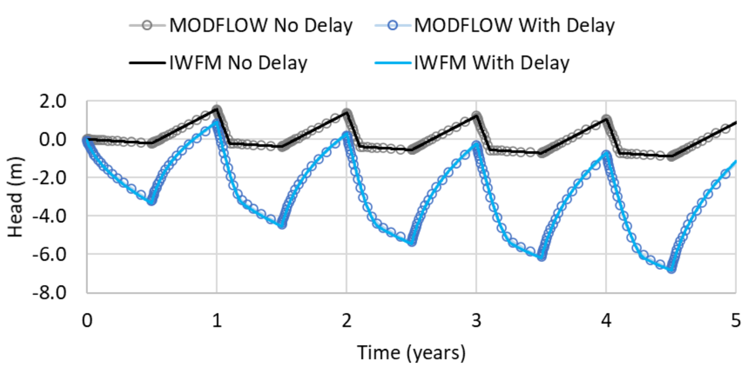
Central Valley Integrated Water Flow Model Modification, Calibration, and Finite Element Modeling Services

California Department of Water Resources, Sacramento

REFERENCE: Christopher Bonds, PG, CHg, Senior Engineering Geologist (Specialist), SVSim Project Manager, California Department of Water Resources, (916) 586-5428, chris.bonds@water.ca.gov; TEAM: Vivek Bedekar, Matthew Tonkin (SSP&A)

SSP&A has worked on several Central Valley modeling projects for more than 12 years using coarse- and fine-gridded Central Valley models, and the Sacramento Valley Model.





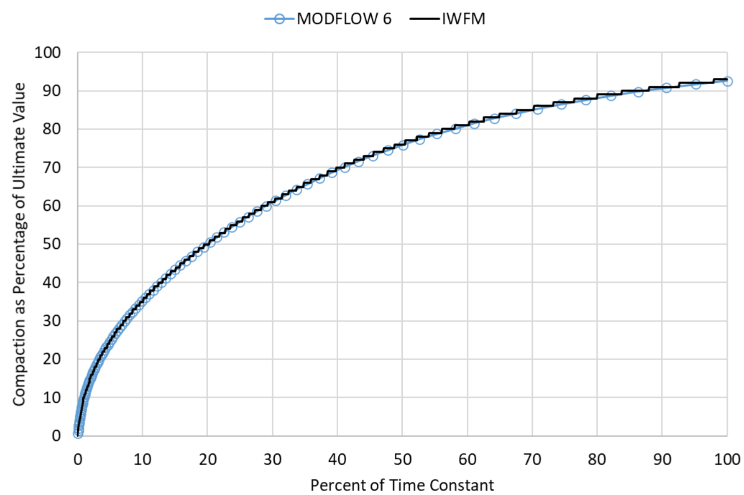
MODFLOW and IWFM models simulated using with-delay formulation. Compaction is not impacted as much as head change, and head change is much pronounced with delayed subsidence.

SSP&A has completed several projects in collaboration with the California Department of Water Resources (DWR) simulating groundwater conditions within the Central Valley. Initially, SSP&A acted as a technical consultant to the Sacramento Office of the DWR from 2005 to 2008 implementing the modification, calibration and development of a finite-element model of the Central Valley, that was developed using the Integrated Groundwater and Surface-water Model (IGSM2) simulation platform. The work was completed together with CH2M Hill, Oakland Office. In this role, SSP&A completed a range of tasks including the development of calibration tools to calibrate the Central Valley IGSM2 (CVGSM2) and later with the finite element Integrated Water Flow Model (IWFM - formerly IGSM/IGSM2) codes, review of USGS and DWR models and reports, tool development for PEST support, and co-production of a report to the DWR outlining a stepwise calibration strategy for the CVGSM2 application.

This project laid an initial foundation for the linkage of PEST with the IWFM simulator for calibration, sensitivity, and uncertainty analysis purposes. SSP&A subsequently teamed with Woodard and Curran under contract to DWR to continue the calibration of the coarse-grid (CG) version of the updated CVGSM2 application referred to as the C2VSIM model; calibration of the fine-grid (C2VSim-FG) version of the model; and the development and calibration of the Sacramento Valley Simulation Model (SVSim).

SVSim was developed and calibrated to simulate the surface water – groundwater conditions and interaction within the Sacramento Valley in California. The calibration used a holistic approach, taking into account basin-wide integrated water budgets and then calibrating individual components of flow in the integrated system including root zone, groundwater, and streamflow. SVSim was developed using DWR's IWFM flow simulator with the primary objective of estimating stream depletion associated with groundwater pumping.

In addition to traditional calibration methods evaluating model-wide and subregional water budgets, groundwater levels, and streamflow, SSP&A developed and implemented several innovative methods. Groundwater data were synthesized identifying temporal trends in groundwater head data using cluster analysis. The identified long-term and seasonal water level trends were utilized to effectively calibrate the central valley models. Sediment texture-based groundwater parameters were calculated by developing a textural analysis code called Texture2Par. SSP&A leveraged their PEST.cloud computing platform by adopting it for use with DWR's cloud computing infrastructure. This enabled the use for DWR's computing resources together with a version of PEST, PESTPP, and PEST_HP, optimized for use in highly parallelized environments.



IWFM matches MODFLOW results. The analytical solution is not calculated but MODFLOW documentation shows the same results.

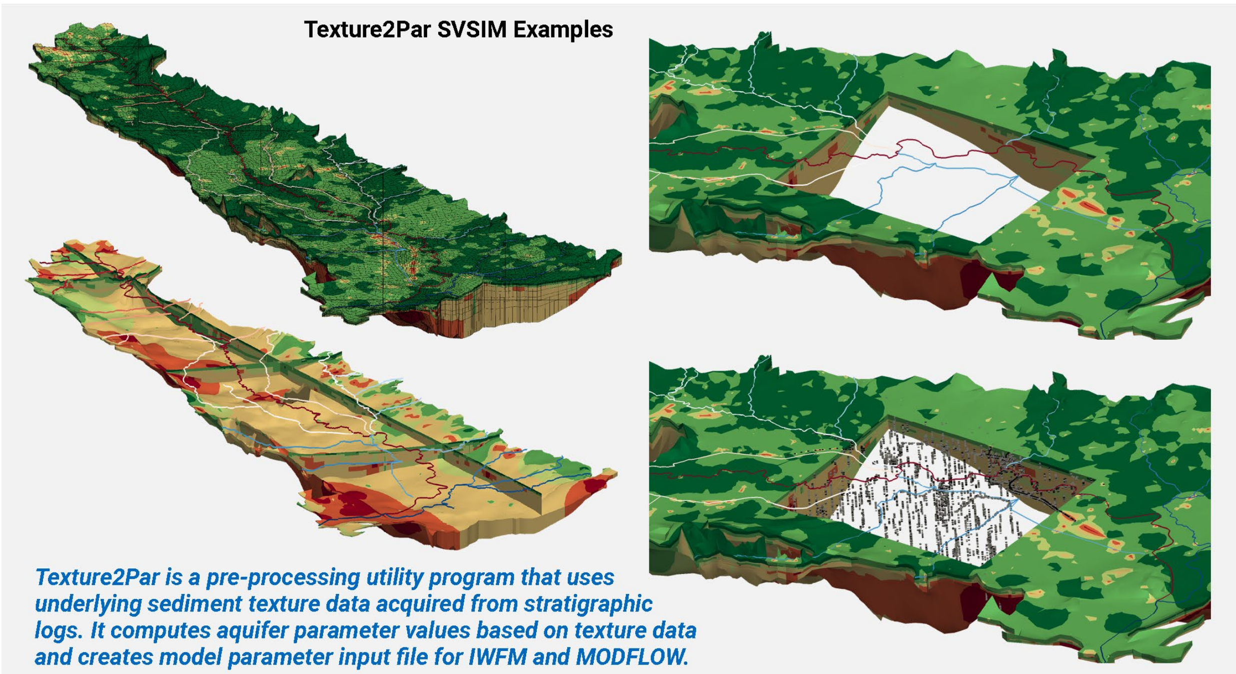
DWR's Bay Delta Office also retained SSP&A to develop numerical code to incorporate delayed subsidence effects within DWR's IWFM flow simulator. The code changes account for delayed effect of pumping on storage change within clay interbeds that results in land subsidence, an improvement from the previous version that assumed an instantaneous change in storage. Other contributions to the IWFM code by SSP&A include the incorporation of variable wetted perimeter and dynamic connection to groundwater (GW) over wide stream reaches such as flow bypasses that are wide section of streams connected to multiple groundwater nodes. These changes were released as part of the IWFM code.

To facilitate detailed review, post-processing and visualization of three-dimensional models developed in a range of simulation codes, SSP&A has developed and released GroundWater Desktop (GWD), a fully 3D interface to visualize groundwater models and their results. GWD can be used to visualize multiple models, and currently supports MODFLOW, MODPATH, MT3D, and the unstructured grid versions MODFLOW-USG and MODFLOW 6. GWD was also expanded to incorporate models developed using the finite-element IWFM simulation code, enabling IWFM-based models to be examined using cross-sectional, cut-away and layer "exploded" views.

Aquifer Parameter Tool (Texture2Par) Development

California Department of Water Resources, Central Valley

REFERENCE: Katherine Dlubac, Senior Engineering Geologist, (916) 902-7289, Katherine.Dlubac@water.ca.gov; TEAM: Matthew Tonkin, Vivek Bedekar, Michael Ou (SSP&A)



Texture2Par is a pre-processing utility program that uses underlying sediment texture data acquired from stratigraphic logs. It computes aquifer parameter values based on texture data and creates model parameter input file for IWFM and MODFLOW.

SSP&A collaborated with Woodard and Curran to develop the aquifer parameter tool, Texture2Par, for use with Integrated Water Flow Model (IWFM) and MODFLOW models in support of California Department of Water Resources' (DWR's) Central Valley and statewide modeling efforts.

Texture2Par facilitates the assignment of aquifer parameter values directly to IWFM and MODFLOW model input files on the basis of sediment texture data acquired from stratigraphic logs. Aquifer properties that can be ascribed using Texture2Par are:

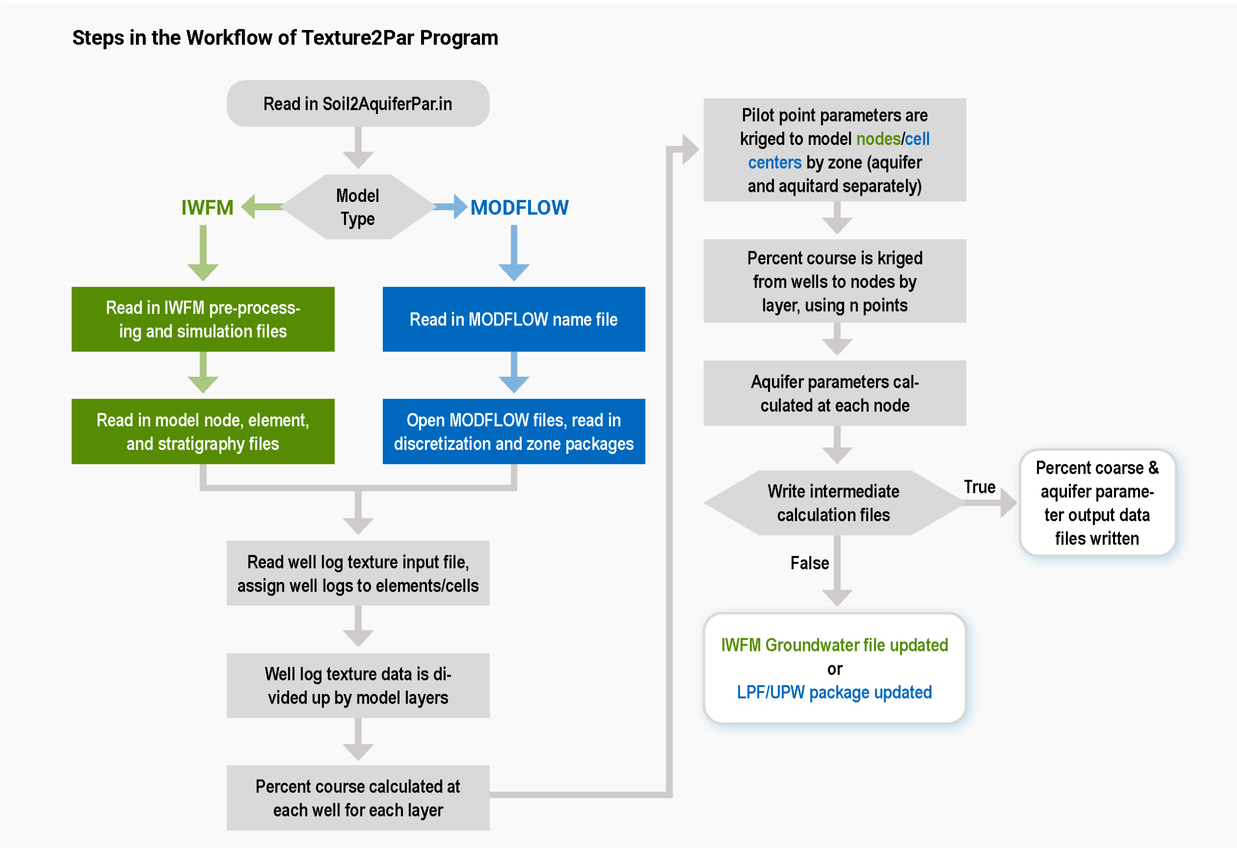
- Horizonal hydraulic conductivity
- Vertical hydraulic conductivity
- Specific yield
- Specific storage

Interbed clay thicknesses are also calculated for subsidence simulations.

Texture2Par uses estimates of soil coarseness derived from stratigraphic logs to infer values for aquifer properties using power-law averaging techniques. Decreases in hydraulic conductivity with increasing depth resulting from compaction can also be accommodated with Texture2Par.

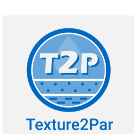
In the first release of Texture2Par, spatially distributed aquifer properties are computed based on the model discretization; values for each aquifer property corresponding to end-member coarse and fine material types; and values for the percentage of coarse material at boring locations.

Only a small number of inputs is required to generate spatially distributed, potentially heterogeneous, parameterization of the model based on texture data, enabling Texture2Par to be integrated into a parsimonious calibration (parameter estimation) workflow that uses sediment texture data. To accommodate areas of differing cementation, compaction, or sorting that leads to varying texture properties, Texture2Par incorporates pilot points enabling the values for aquifer parameters associated with purely coarse or fine textures (and fractions between) to vary in space.



Pilot points can be grouped with specific model nodes or cells to form distinct geological zones that exhibit different relationships between texture and aquifer properties. Example applications of Texture2Par include SVSim, C2VSim-FG developed using IWFM, and Arizona DWR's Phoenix AMA Model developed using MODFLOW-NWT.

Texture2Par Highlights



SSP&A and Woodard and Curran are currently working with DWR to develop methods, tools, documentation, and case studies for formally integrating Airborne Electro-Magnetic (AEM) data into both (a) development of hydrogeologic conceptual models (HCMs) and (b) parameterization and calibration of groundwater models.

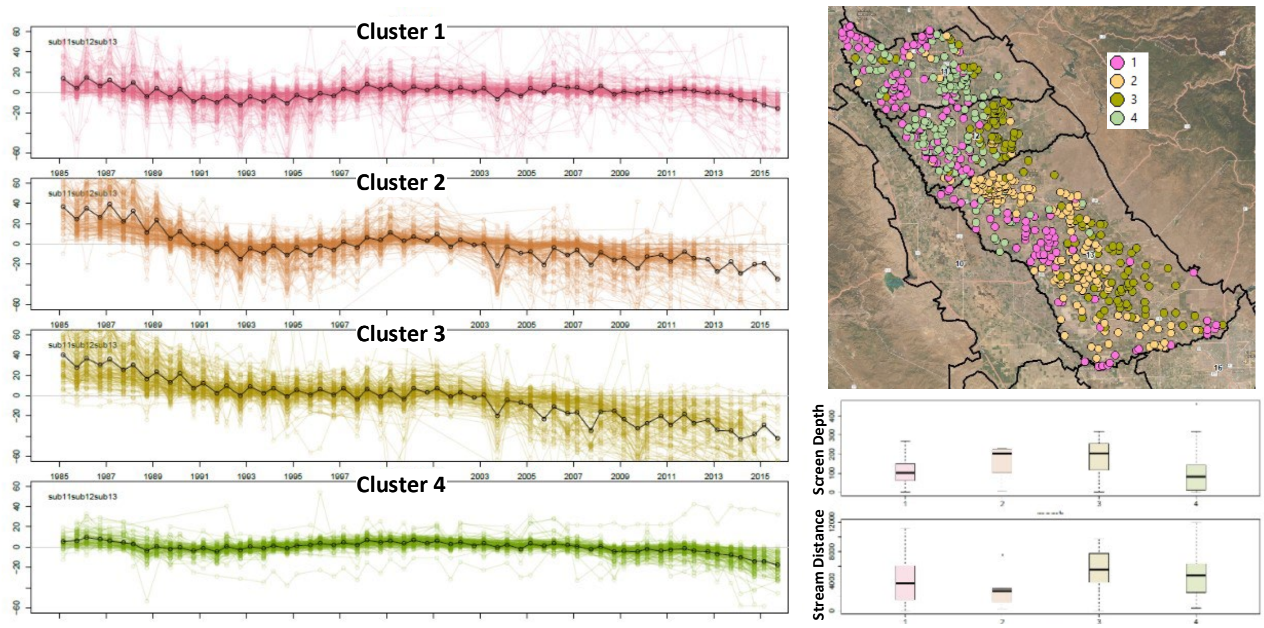
The development of HCMs and aquifer parameterization is instrumental in understanding the hydrogeologic systems that are being evaluated.

The first two phases of the project – literature review and method testing and development – were completed in December 2022. The project is anticipated to enhance the capabilities of Texture2Par and companion tools for HCM analysis by incorporating state-wide AEM data collected through recent geophysical surveys, thereby improving understanding of the geological and hydrogeologic structure of priority basins which are focus areas for water-resource modeling efforts.

Central Valley Hydrograph Cluster Analysis

California Department of Water Resources, Central Valley

LOCATION: Central Valley, California; REFERENCE: Chris Bonds, Senior Engineering Geologist, California Department of Water Resources, 916-376-9657, Chris.Bonds@water.ca.gov; TEAM: Matt O'Connell, Vivek Bedekar, Matthew Tonkin (SSP&A)



Cluster analysis of water level data to identify 'type-hydrographs' across a large basin. The figure shows four hydrograph clusters and the associated type-hydrographs. Physical characteristics of the wells were not used to calculate clusters, but statistical analysis shows that wells within clusters display similar spatial locations, well depth, and proximity to streams.

Large-scale regional groundwater models, such as the Sacramento Valley and the Central Valley Models in California (SVSim and C2VSimFG) encompass extensive datasets with thousands of hydrographs. Each hydrograph reflects both regional stresses and localized hydrological processes, making it challenging to discern dominant trends essential for accurate model calibration. Traditional calibration methods often struggle to isolate these trends due to the "noise" introduced by local variations and short-term perturbations.

SSP&A have developed a hydrograph pattern identification procedure utilizing fuzzy cluster analysis to address these challenges. This approach involves (1) Correlation Analysis to compute correlation coefficients between hydrographs to construct a comprehensive correlation matrix, (2) Clustering to apply unsupervised fuzzy c-means clustering (FCM) to group observation wells with similar functional responses into clusters based on similar temporal trends, (3) Type-Hydrograph Development to create representative 'type-hydrographs' for each cluster, which encapsulate the dominant observed temporal patterns, and (4) Calibration to use these type-hydrographs as calibration targets, thereby focusing on dominant hydrologic processes rather than individual hydrographs.

In the California Central Valley, this methodology effectively condensed data from 12,204 well hydrographs into 45 representative type-hydrographs, streamlining the calibration process for aquifer storage parameters and boundary conditions that affect temporal trends.

Monterey Peninsula Water Supply Project

California Marine Sanctuary Foundation, Monterey, California

REFERENCE: Bill McIlvride, Senior Project Hydrogeologist, Weiss Associates, (510) 450-6000, WAM@weiss.com; TEAM: Vivek Bedekar, Matthew Tonkin (SSP&A)

SSP&A was selected by Weiss Associates to conduct an independent hydrogeologic review of data, studies, and models related to the California American Water's (Cal-Am) proposed Monterey Peninsula Water Supply Project (MPWSP). The MPWSP was expected to capture predominantly seawater from a planned well field near the Monterey Bay shoreline in the City of Marina, California.

The primary objective of the project was to calculate ocean water percentage (OWP) captured by the well field of the MPWSP. The effects of potential and actual hydraulic gradients on OWP and the possible project modifications to mitigate and reduce potential effects of pumping were assessed. The project involved the calculation of freshwater captured by slant wells proposed for a desalination plant. The desalination plant would incur penalties for any freshwater captured by the withdrawal wells.

An existing flow model was utilized, and boundary conditions and parameters were modified to perform sensitivity analysis and meet the project objectives. The conceptual site model was also reassessed to more accurately represent the aquifer formations and its impact on groundwater flow and the resulting OWP captured by the slant wells. The methodology used in the previous versions of the models included particle tracking to assess flow paths from the ocean boundary to calculate OWP, which was an approximate calculation. The methodology was improved by incorporating a solute transport code MT3D to identify the source of water and to quantify the amount of saltwater captured by the pumping wells.

Produced Water Analysis

Confidential Client, California

TEAM: Matthew Tonkin, Vivek Bedekar (SSP&A)

SSP&A was retained by a national drilling and energy development company to provide an expert-level assessment of the actual historical, and potential future, impacts from the disposal of produced water to both surface impoundments and to subsurface injection wells.

Initially, SSP&A developed detailed water budgets for the historical period of operation, and also documented the quality of the produced water from various well fields and following mixing in surface impoundments prior to disposal. Next, SSP&A developed a detailed 3D groundwater flow and constituent transport (F&T) model to simulate the historic and future transport, extent, mixing, and fate of produced water in the subsurface. The analyses completed using this subregional-scale model – which was calibrated to 60 years of groundwater elevation and multi-constituent groundwater quality data – were supplemented by hydrogeologic conceptual model (HCM) development and documentation, evaluations of aquifer and gas producing horizons, review of available gas well information (including electric logs, mud logs, well completion reports, chemical analysis results, etc.), geochemical evaluation of laboratory results from multiple groundwater and gas phase sampling events, critical review of analytical laboratory methods and QA/QC procedures, and review of the field methods. In the modeling simulations, it was assumed that – consistent with available field data – any oil and gas present in the upper producing zones through to the unconfined upper aquifer were at residual levels and therefore need not be explicitly simulated.

As the project evolved it became clear that three important aspects of the analyses required particular attention – first, the role of long-screen cross-connecting wells on communication between different aquifer and producing zones, and the role of well integrity and compromise on this vertical connectivity; second, the role of the disposed water (brine) density and its changes over the development history of the producing zone; and third, the heterogeneity of the aquifer and producing zones as represented by sediment texture (“net-to-gross”) data obtained at very high vertical frequency from hundreds of borings. To incorporate these characteristics, SSP&A (a) implanted the MODFLOW/MT3D Multi-Node-Well (MNW) and MODFLOW-6 Multi-Aquifer-Well (MAW) packages to represent wells as continuous connected sinks/sources; (b) explicitly modeled the density of the various fluids using SEAWAT and the Variable Density formulation of MODFLOW-6; and (c) incorporated use of the Texture-to-Parameter (Texture2Par or “T2P”) program developed separately by SSP&A for the California Department of Water Resources (DWR). T2P provides the ability to incorporate fine-scale texture data in the definition of aquifer conductivity, storage, and compressibility parameters as part of the non-linear model calibration process.

To further analyze the combined relative effects of density, well design, and heterogeneity on pressure development, well integrity, and lateral versus vertical migration, SSP&A developed very detailed but computationally efficient radially-symmetric simulations for a number of high-priority wells. Deliverables from the project were used to understand the relative importance of a wide range of factors on historical migration patterns leading to the present-day extents; project potential future impacts; and, to evaluate the feasibility of a wide range of potential mitigating actions.

Software Development: Contributions to MODFLOW and IWFM

S.S. Papadopulos & Associates in collaboration with U.S. Geological Survey, California Department of Water Resources, and GSI Environmental

TEAM: Matthew Tonkin, Christian Langevin, Vivek Bedekar (SSP&A)

SSP&A has made important contributions to the MODFLOW family of simulators over the past 45 years. Our founders helped shape the precursor to MODFLOW, laying foundational concepts in groundwater modeling.

Before MODFLOW-NWT, SSP&A implemented Newton-Raphson capabilities in MODFLOW for solution stability. We collaborate with Dr. Sorab Panday by contributing to the development of MODFLOW-USG, and continue our leadership as part of the core development team for MODFLOW 6. SSP&A also collaborated with Dr. Can Dogrul (DWR) in the development of delayed subsidence in IWFM.

Calibration and Uncertainty Analysis

SSP&A performs model calibration and uncertainty analysis on models developed internally and by others, offering clients enhanced confidence in model predictions and decision-making.

We have collaborated with Dr. John Doherty (developer of PEST), the USGS, U.S. Nuclear Regulatory Commission (NRC), Pacific Northwest National Laboratory (PNNL), and others in the development of novel methods. These collaborations include development of course materials and co-instructing professional courses.

PEST.cloud

In collaboration with Dr. Doherty, SSP&A developed a web-based cloud tool for model calibration using PEST on Microsoft Azure to streamline compute node setup, file distribution, and run monitoring, with easy result packaging and downloads.

Contributions to PEST/PEST++ and Associated Capabilities

Under a USGS contract, SSP&A served as the prime contractor and co-developer of PEST++ and related tools for inverse modeling on distributed computer networks. SSP&A developed two key components: GENIE, a model-independent parallel run manager to manage model runs across networks using multithreaded message-passing; and PESTCommander, a graphical user interface (GUI) to simplify model file management across diverse computing environments including Cloud-based systems.

Linear Predictive Analysis of Models (OPR-PPR)

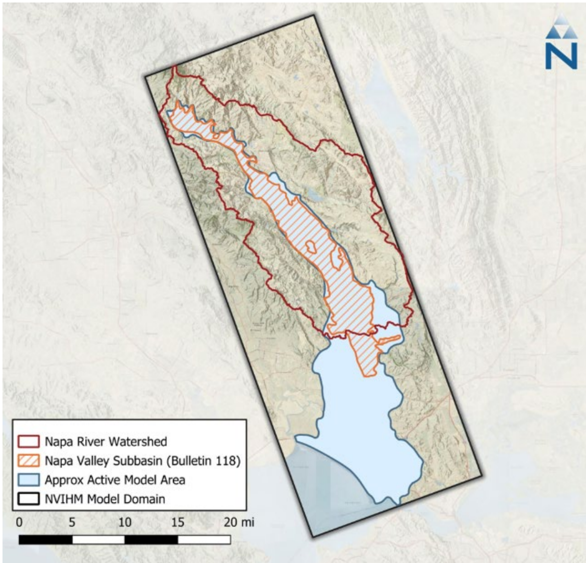
SSP&A developed the OPR-PPR program for the USGS to evaluate how different data types influence predictive uncertainty. OPR-PPR helps prioritize data collection by assessing the value of observations and other independent information. The program was published in a 2007 USGS report, and SSP&A has provided training on its use alongside Dr. Mary Hill.

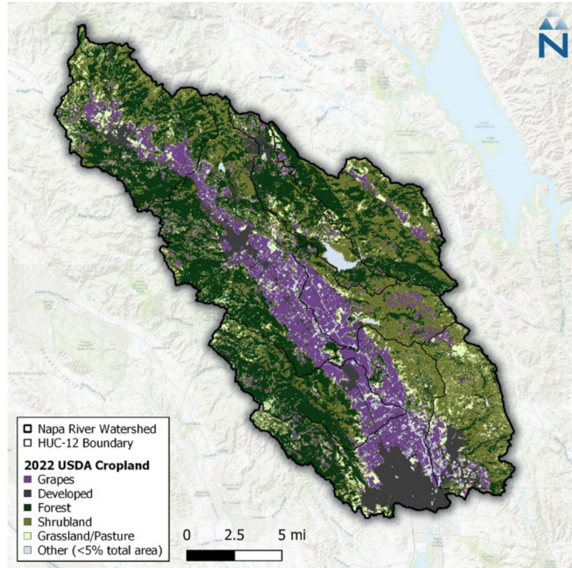
Supply and Demand Assessment Hydrology Modeling,

State Water Resources Control Board

TEAM: Khalid Alvi, John Riverson, Jr. (Paradigm), Vivek Bedekar, Annette Hein, Jack Wang, Michael Ou (SSP&A)

In April 2021, Governor Gavin Newsom issued a state of emergency proclamation for specific watersheds across California in response to exceptionally dry conditions throughout the state. This proclamation, as well as subsequent proclamations, directed the Board to address these emergency conditions to ensure adequate, minimal water supplies for critical purposes. To support the Water Board's actions in addressing emergency conditions, hydrologic modeling and analysis tools are being developed to contribute to a comprehensive decision support system that assesses water supply and demand, as well as the flow needs for watersheds throughout California.





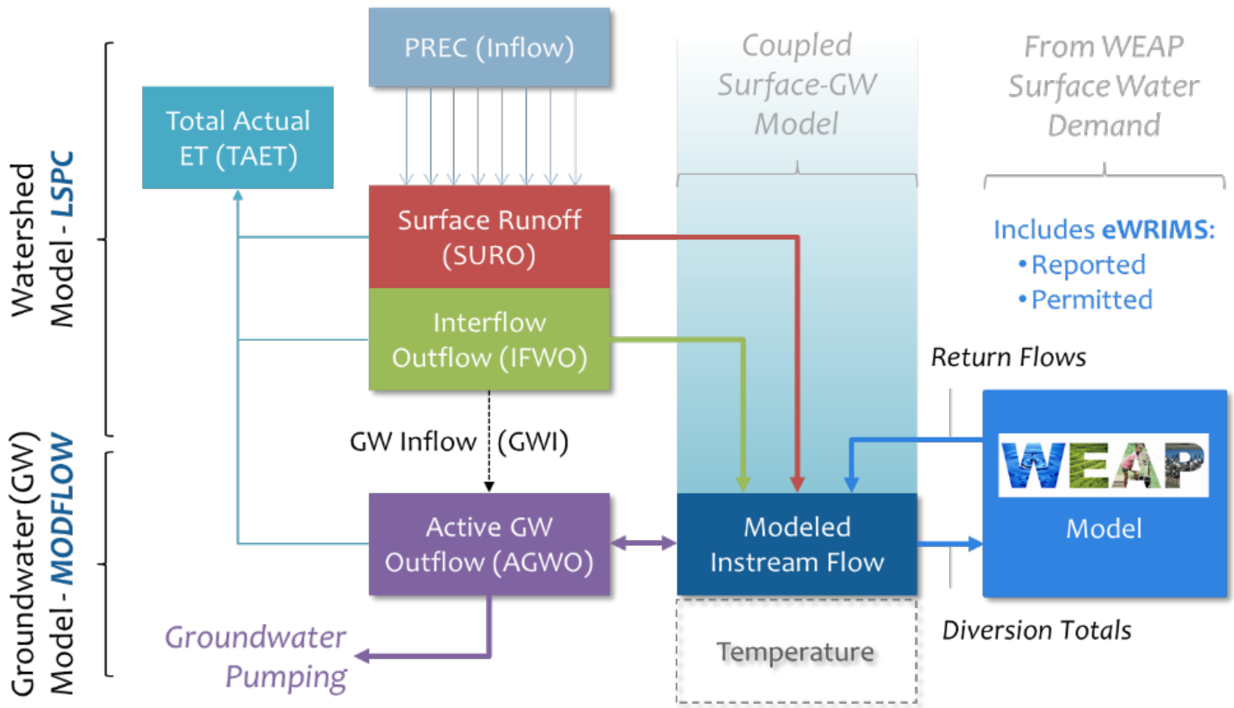
In conjunction with SSP&A, Paradigm is supporting the SWRCB with hydrologic modeling of multiple watersheds across the state, incorporating representation of surface water and groundwater withdrawals. The model development process is data-intensive, sourcing geospatial data sets from various local, state, and national sources. The team is currently developing work plans, calibrated models, and modeling reports for 18 different watersheds across the state using the Loading Simulation Program C++ (LSPC) watershed model, which is linked to MODFLOW models in specific watersheds when necessary to represent more complex groundwater interactions.

The watershed models leverage the foundation of the underlying Hydrologic Simulation Program FORTRAN model, combined with a modernized relational database framework within LSPC, which enables the construction of large-scale systems within a single model. The data frameworks are built using the latest national and local data sets to develop climate forcing inputs for precipitation and evapotranspiration. Hydrologic response units are constructed using the National Land Cover Database (NLCD), soil survey, and digital elevation models published by federal agencies. The United States Department of Agriculture's (USDA) Crop Data Layer (CDL) is used to override national land cover categories to represent crop types better. In some cases, locally available data is even used to represent crop distributions. This is especially important in heavily managed watersheds like the Napa River, where irrigation withdrawals can have a significant impact on low flows in both the mainstem and smaller tributaries. The LSPC processes for irrigation leverage the fundamental hydrology modules and inputs from HSPF but have been designed and coded by the Paradigm team to support the scale of the LSPC model applications and offer added flexibility to support future scenario development.

Hydrology Modeling Services for Instream Flow Assessment

State Water Resources Control Board

TEAM: Khalid Alvi, John Riverson, Jr. (Paradigm), Vivek Bedekar, Michael Ou, Kathy Mihm (SSP&A)



Paradigm is supporting the State Board, through collaboration with the California Department of Fish and Wildlife and the North Coast Regional Board, in developing hydrologic and temperature characterization models for the South Fork Eel River and Shasta River watersheds.

The purpose of these models is to support the implementation of the California Water Action Plan and perform hydrologic studies to fully understand the linkages of water use, surface and groundwater, and instream flows and temperatures that vary spatially and temporally throughout the watersheds. The hydrology models provide a basis for assessments of benefits and impacts of potential watershed management actions on fish habitat, existing water users, and other beneficial uses.

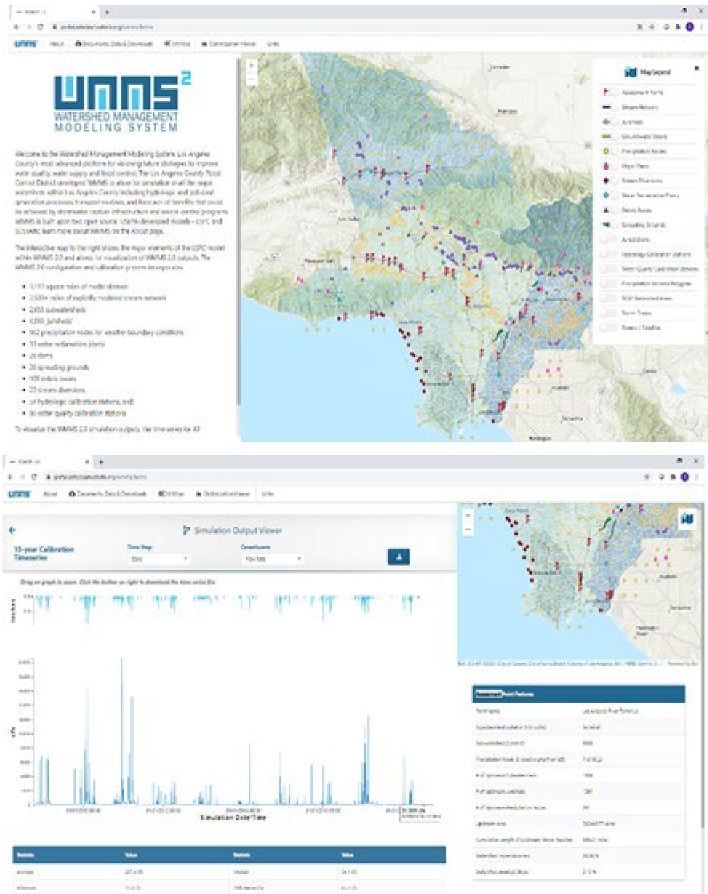
Working with SSP&A, Paradigm has developed integrated surface-groundwater interaction models, based on linked LSPC and MODFLOW models, for both the South Fork Eel River and Shasta River watersheds. The models incorporate several high-resolution spatial and temporal datasets and are being configured to facilitate evaluations of complex water management scenarios. The models are being calibrated against long-term USGS streamflow data and, when available, recently collected critical low-flow measurements from key small tributaries. The South Fork Eel LSPC model development effort has successfully coupled outputs from a MODFLOW model, more explicitly representing groundwater processes unique to the watershed, with boundary conditions developed through SEI's WEAP modeling efforts to define water use demands. Paradigm is currently planning for a similar linkage of the Shasta River LSPC model to a groundwater model under development by a key stakeholder, Siskiyou County. Paradigm is also developing techniques for utilizing flow predictions from the hydrologic models to link to methods and models for estimating stream temperatures in each watershed.

Watershed Management Modeling System (WMMS) 2.0

Los Angeles County

TEAM: Khalid Alvi, John Riverson, Jr. (Paradigm)

In 2009, the Los Angeles County Flood Control District (LACFCD) partnered with USEPA Region 9 to compile the various TMDL models (described above) into a countywide modeling system to support watershed planning and TMDL implementation.



WMMS 2.0 Web-Based Interface and Tools to View the Model and Output.

Led by Steve Carter and John Riverson, this Watershed Management Modeling System (WMMS) converted all existing HSPF/LSPC models to a consistent version of LSPC, and included a wealth of new or improved methods for representing hydrologic controls (e.g., diversions), meteorological inputs, subwatershed delineations, land characteristics, and irrigation practices within each watershed. WMMS resulted in the modeling of all coastal watersheds in Los Angeles County, representing 12,000 km^2, 2,655 subwatersheds, and 941 streams/rivers. In 2012, LACFCD released WMMS to the public for use in watershed planning and hydrologic analyses for all of Los Angeles County.

In 2020, Paradigm supported the LACFCD in the update of WMMS 2.0 to provide a next-generation version of the modeling system that incorporates recent and best-available data, improves model performance, promotes transparency through comprehensive documentation and peer review, engages stakeholders, and provides a user-interface and tools that will allow agencies to more-readily access and leverage WMMS for hydrologic and water quality analyses and visualize model results. As the original developers of LSPC for the USEPA, Paradigm staff were able to leverage the latest version of LSPC and perform strategic code modifications and tailor the model to address the needs of WMMS 2.0 (this latest LSPC version is also being used to support State Board hydrologic modeling services)

Paradigm first performed an extensive review and analysis of spatial data representing various land characteristics within each watershed, and developed Hydrologic Responses Units (HRUs) that form the building blocks for hydrologic and water quality model parameterization. Paradigm also pioneered new techniques for incorporating and processing meteorological data from multiple sources, including rainfall gages and other publicly available datasets (i.e., PRISM and NLDAS), to provide a comprehensive understanding of the spatial and temporal variation of historic rainfall and evapotranspiration that serve as model boundary conditions. The resulting LSPC model simulates hydrologic runoff, subsurface flows, and water quality for sediment, nutrients, and metals. Paradigm performed a comprehensive assessment of all available flow and water quality data, analysis of hydrologic and spatial trends, and processing of data for comparison with model-predicted flows and water quality to support model calibration. Paradigm provided all services for model documentation, engagement with stakeholders, and model training. Currently, Paradigm is supporting upgrades to WMMS 2.0 to provide simulation of future climate change scenarios, which includes hourly simulation of flows (present to 2100) for all watersheds using synthetic meteorological inputs based on downscaled global climate model projections.

To support WMMS 2.0 release, Paradigm developed a web-based viewer, model interface, and repository (https://portal.safecleanwaterla.org/wmms/home), which includes multiple tools to provide access to hydrologic model predictions, manage model workflow, and visualize model results. The viewer provides mapping tools that illustrate key features of the model and watersheds (e.g., streams, groundwater basins, diversions, dams), and allows users and non-modelers to click and access model-simulated hourly flows at numerous assessment points. The website also provides access to all model documentation, model files and data inputs, recordings of training sessions, and model user guides.

Agua Mansa Commerce Park (Former Riverside Cement Plant) Jurupa Valley, California Riverside Cement Plant

Varidian Partners

TEAM: Eros Bilyeu (Wood Rodgers)

Mr. Bilyeu served as Project Hydrogeologist for the redevelopment of the former Riverside Cement Plant property, a 277-acre site located at the boundary between the Chino Basin and Rialto-Colton Basin, an area known for complex hydrostratigraphy and significant modeling uncertainty in regional groundwater flow.

Under a California Land Reuse and Revitalization Act (CLRRA) agreement with DTSC, Mr. Bilyeu led hydrogeologic investigations and soil/groundwater characterization in support of grading design and remedial planning. He developed and implemented multiple site-wide sampling work plans, including detailed assessment of hexavalent chromium impacts in perched and semi-confined aquifers.

Fieldwork included trenching, deep borings, and a multi-depth well network across historically disturbed geologic units. Mr. Bilyeu characterized the Sky Blue and Chino Limestone formations, evaluated structural and stratigraphic controls on groundwater flow, and mapped the interface between cement kiln dust (CKD) deposits and native alluvium to support risk-based remedial design.

Findings informed grading and cut/fill operations exceeding 2 million cubic yards. Chromium exceedances in groundwater were evaluated in the context of aquifer recharge, oxidation conditions, and regional flow vectors. The project offered direct insight into boundary condition uncertainty, recharge underrepresentation, and lithologic heterogeneity, which are key issues relevant to the Chino Valley Groundwater Model.

Mr. Bilyeu also supported coordination with DTSC, SCAQMD, the EPA, and the Regional Water Quality Control Board, contributing to effective regulatory engagement and site closure strategy development.

Rialto Groundwater Investigation at the Kinder Morgan Facility

Kinder Morgan

TEAM: Eros Bilyeu (while with CH2M Hill, prior to joining Wood Rodgers)

This project is directly relevant to the Chino Basin Model Peer Review, particularly for tasks related to aquifer parameter assumptions, boundary condition sensitivity, and calibration challenges near the Chino-Rialto interface.

Mr. Bilyeu served as a field and project hydrogeologist for groundwater investigations at the Kinder Morgan Rialto Terminal, located along the Rialto-Colton fault boundary in the Upper Santa Ana Valley Groundwater Basin, adjacent to the Chino Basin. The project focused on evaluating aquifer behavior, vertical and lateral hydraulic gradients, and LNAPL presence in a historically industrial area with complex subsurface conditions.

Mr. Bilyeu supervised drilling, well construction, and hydrogeologic logging during the installation of multiple monitoring wells across perched, unconfined, and semi-confined alluvial aquifers. His work included detailed stratigraphic interpretation to distinguish between aquitards and water-bearing zones. He developed and applied qualitative lithologic mapping protocols based on USCS classifications and integrated them with geophysical resistivity logging to characterize lateral heterogeneity and porosity trends.

The project improved the conceptual understanding of subsurface conditions, specifically the shallow and regional groundwater aquifer interface, in a region where groundwater flow direction and aquifer connectivity have challenging to model. Mr. Bilyeu's work supported contaminant transport evaluation, plume stability assessment, and informed groundwater flow dynamics in the area.

Appendix B.
Resumes

- Matthew Tonkin, PhD
- Christian Langevin, PhD
- Vivek Bedekar, PhD, PE
- Michael Ou, PhD
- Eros Bilyeu, PG, CHG, QSD/QSP, CGWP (Wood Rodgers)
- John Riverson, Jr.
- Kalid Alvi, PE

Matthew J. Tonkin, Ph.D.

President and Principal Hydrogeologist

As President, Dr. Tonkin manages and provides technical review for many projects. He specializes in data synthesis and modeling to guide groundwater, surface water, soil and contamination studies, for public, private and legal clients. This includes planning sampling and monitoring programs; collaborating with other experts; developing and applying models; and presenting to stakeholders. He received his PhD on the topic of model calibration and uncertainty analysis under Dr. John Doherty and has instructed on these and other topics.

YEARS OF EXPERIENCE

25+

EDUCATION

» **PhD**, Civil Engineering, University of Queensland, Australia, 2009

» **MSc**, Hydrogeology, University of Birmingham, UK, 1994

» **BSc**, Applied Geology, University of Birmingham, UK, 1993

EXAMPLE AREAS OF EXPERTISE

» Groundwater Remedy Design

» Groundwater Flow and Contaminant Transport Simulation

» Environmental Data Analysis and Interpretation

» Modeling Project Design and Management

» Water Resource Evaluations

» Model Calibration and Uncertainty Analysis

AWARDS AND HONORS

» Co-Inventor of U.S. Patent No. 10,371,860 (issued Aug. 6, 2019), entitled "*Simultaneous Multi-Event Universal Kriging Methods for Spatio-Temporal Data Analysis and Mapping*": 2019

» ITRC Industry Recognition Award (co-recipient) – MTBE and other Fuel Oxygenates Team: 2005

» NGWA Outstanding Groundwater Remediation Project Award (co-recipient): 2004

» ENTEC Award for MS Program and Thesis: 1994

» British National Environmental Research Council (NERC) MS scholarship: 1993

REPRESENTATIVE EXPERIENCE

S.S. Papadopulos & Associates, Inc.

WATER RESOURCE EVALUATIONS

California Department of Water Resources (CA-DWR): In collaboration with CH2M-Hill, created and modified programs to calibrate the IGSM2 code Central Valley application (CVGSM2) during its transition to the IWFM platform. Reviewed existing USGS and CA-DWR models and reports to support model re-structuring and re-parameterization. Re-defined aquifer parameters using pilot points; completed sensitivity analyses with the revised model to guide calibration; co-authored reports outlining a stepwise model development and calibration strategy.

California Department of Water Resources (CA-DWR): In collaboration with Woodward & Curran, developed conceptual and numerical modeling bases, calibration approach, and stream-depletion analysis methods, for three Central Valley models – the Sacramento Valley (SVSIM), and the coarse- and fine-grid full Central Valley applications (C2VSIM-CG and C2VSIM-FG). This included developing methods and tools to integrate sediment texture into model development and parameterization (Texture2Par); implementing time-series and correlative analysis for groundwater elevation and streamflow targets; leading calibration of the three models; and preparing methods of historical and predictive streamflow depletion analysis.

Confidential Client, California: Evaluated groundwater budgets, and the transport, extent, and mixing of produced water in the subsurface using a variety of time-series and geochemical analysis, geo-statistics, and deterministic modeling techniques.

Saline Incursion Management, Washington State: To evaluate the sustainability of a water resources that is subject to salinity incursion and upconing, participated in the development of a variable-density model, and led the design and implementation of a transient calibration strategy that included water levels and salinities. Used the calibrated model to estimate optimal pumping rates to meet drinking water criterion for chloride at existing and proposed production-well locations.

Spring-water Bottling Company Water Supply Study, Michigan: Evaluated possible impacts of groundwater pumping on surface water bodies including wetlands. Following calibration of a groundwater model to baseflow data, and steady state and transient water levels, designed a series of non-linear predictive error analyses to assess uncertainties in predicted depletions. Conducted similar analysis at several potential spring sources over several years.

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Water Resource Assessment, Minnesota: Retained by MDNR to evaluate groundwater and surface water conditions, including modeling and statistical studies conducted by the USGS and others, and opine on the impact of groundwater extraction on surface water. Evaluated the relative impact of groundwater pumping and climate change on groundwater and surface water in the vicinity of White Bear Lake, MN, and other lakes. SSP&A developed a transient 3D modeling framework to guide mitigating strategies, which entailed calibration and predictive management scenario development. Modeling comprised linking the Soil Water Balance (SWB) Land Surface Model (LSM) with a MODFLOW-NWT groundwater model constructed. At the conclusion of the project, SSP&A transferred all pre- and post-processing tools, numerical modeling files, associated data, calibration files, and predictive modeling, to MN DNR and provided training to staff to execute the model, advance the calibration, and run predictive management scenarios. SSP&A presented findings at a public meeting. MN DWR staff continue to use the model and provide updates to the public (North & East Metro Groundwater Management Area | Minnesota DNR [state.mn.us]).

Republican River Basin Interstate Compact: Provided technical evaluation of the nature, magnitude and timing of streamflow accretions and depletions through the development of a calibrated model. Calibration data included transient water-level and stream-flow calibration targets. Implemented pilot points with regularization for aquifer parameters, and evaluated a mixed-model ANOVA applied to power conversion coefficients (PCCs) as a surrogate for metered pumping. Supported testimony before a River Master and in Supreme Court.

EXAMPLE DATA ANALYSIS PROJECTS

Confidential Client, San Francisco, California: To support soil removal actions, wrote programs to process numerous look-up tables, using varying assumptions for censored data, to calculate, summarize, and compare 95% UCLs for the mean for over 30 analytes.

Marion Thompson Site, Indiana: Completed Monte-Carlo analyses of contaminant transport in groundwater combining bootstrap re-sampling, published PDFs, and re-parameterization techniques to represent variables for this probabilistic evaluation of fate-and-transport.

PCB-Contaminated Site: For a confidential private client, reviewed 1,100 chromatographs to characterize source area, receptor stream and sediment signatures. Wrote programs to plot, scale, and align chromatographs based on curve area, height and lab spikes. Developed cumulative-area method to identify contributions at receptors as part of an allocation process.

Big South Fork National Park, Kentucky: Assessed contaminant load to a river from 80 mines. Coordinated field sampling tasks. Completed data QA/QC, analyses and interpretation. Simulated mine water mixing using Phreeqe. Prepared STORET database for the National Park Service.

REMEDIATION PROJECTS

Goleta Groundwater Basin, California: Retained to provide hydrogeological and modeling services in legal proceedings as an affirmative and responsive expert establishing quantities of water available for allocation / adjudication as via a Physical Solution. Developed a detailed understanding of the hydrogeology of the Goleta Groundwater Basin (GGWB) and surrounding and underlying consolidated bedrock units, and conducted simulations using groundwater flow, integrated hydrologic, and land-surface process models constructed with

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- Individual Structural Geological Mapping Award: 1993
- Royal Air Force Flight Training Scholarship: 1988

APPOINTMENTS AND COMMITTEES

- 2021–present: Groundwater Resources Association of California (GRAC) GRACast Subcommittee
- 2013–2024: MODFLOW-and-More Conference Organizing Committee: Colorado School of Mines, Princeton
- 2018, 2019: Groundwater Journal, Guest Editor
- 2005–2010: Interagency Steering Committee on Multimedia Environmental Models (ISCMEM)
- 2002–2006: Interstate Technology and Regulatory Council (ITRC) MTBE Team

PROFESSIONAL SOCIETIES

- National Ground Water Association (NGWA)
- Geological Society of America (GSA)
- Groundwater Resources Association of California (GRAC)
- American Geophysical Union (AGU)

PROFESSIONAL HISTORY

- S.S. Papadopulos & Associates, Inc.: 1995–present
- Birmingham University, UK, Geology Department: 1993–1994

EMAIL

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Modflow, Modflow-Surfact, ParFlow-CLM, Hydrus, the Soil Water Balance (SWB), INFIL, PRMS, and the Distributed Parameter Watershed Model (DPWM). A major component of the work comprised distinguishing and estimating potential and actual groundwater recharge.

Private Client, San Francisco, California: Led evaluation of risk posed to two high-capacity supply wells by fuel released from a storage facility. Simulated multi-component vadose- and saturated-zone transport of the BTEX compounds, MTBE, TBA, and less soluble components. Implemented kinetic transport capabilities developed by SSP&A under contract to USEPA as released in the MT3D-USGS transport simulation code.

Confidential Client, California: Assessed the fate and transport of several contaminants including chlorinated solvents, chromium, and 1,4-dioxane in groundwater from numerous sources, as part of a multi-party allocation at a large Superfund site within a mixed residential-/commercial-use area. Provided technical support to ultimately conclusive mediation proceedings.

U.S. Navy Red Hill Fuel Storage Facility, Hawaii: In accordance with an Administrative Order on Consent (AOC), assisted EPA and Hawaii DOH in evaluating the conceptual site model (CSM); interpreting soil, soil vapor, fuel product, and groundwater data; and the development by the Navy and its contractors of saturated and vadose zone flow and transport models for the complex fractured basalt aquifer overlain and intruded by volcanics. Led forensic evaluations of environmental data including analyses of gas chromatograms, and evaluations of PFAS/PFOA compounds associated with AFFF facilities. Undertook spatial and temporal statistical analyses. Developed model review criteria; presented at multiple in-person and remotely hosted stakeholder meetings; provided written technical comment on Navy deliverables. Provided additional technical support in response to documented releases to the environment that occurred in 2021, and more recently provided technical support in developing monitoring and response strategies for defueling of the facility.

Confidential Client, Maryland: Retained to evaluate the fate of Cr[VI] arising from historical plating at this RCRA corrective action facility, and interpret the effectiveness of various remedies. Delineation comprised vertical delineation borings (VDBs) and nested wells, and Cr[VI] remedies included enhanced fluid recovery (EFR) and in-situ chemical reduction (ISCR). SSP&A evaluated the EFR and ISCR using multi-variate trend analysis, data mapping, and reactive transport modeling. Provided guidance in the delineation and mobility-assessment of light non-aqueous phase liquid (LNAPL) and its soluble fractions; and evaluated the sources, transport and fate of chlorinated volatile organic compounds (cVOCs). Evaluated the potential for PFAS/PFOA compounds to be presented based on facility manufacturing and material use information. Participated in numerous remotely hosted and in-person meetings with the EPA, including application of the RCRA FIRST (Facilities Investigation Remedy Selection Track) toolbox for site evaluation and remedy selection, culminating in SSP&A leading the development of a long-term monitoring (LTM) plan to support a Statement of Basis. The LTM work guided data collection to support MNA as the final groundwater remedy with source removal, natural source zone depletion (NSZD), and a restrictive land use covenant.

U.S. EPA Region 5: Provided multi-year technical support to Region 5 EPA Superfund group evaluating remedy decisions and actions under CERCLA. Scope includes evaluating conceptual site models (CSMs); interpreting regulatory documents focused on remedy decisions; reviewing or developing analyses of groundwater flow, contaminant transport, and the sources, disposition, and remediation of primary and secondary sources; with the overarching objective of evaluating and improving the performance of remedies at >30 Superfund sites. Authored / co-authored reports to support Five-Year Reviews, with recommendations on remedy and monitoring optimization. Remedial technologies evaluated included pump-and-treat (P&T), monitored natural attenuation (MNA), slurry/barrier walls, in-situ reduction/oxidation, and soil vapor extraction (SVE), among others. Oversaw sampling and characterization activities for PFAS/PFOA compounds at two selected sites based on past manufacturing and reporting chemical use histories. Led a rigorous comparative monitoring network evaluation and optimization study using Summit Optimizer, MAROS, VSP, indicator cross-validation, and maximum likelihood methods.

U.S. DOE Hanford Site, Washington State: Over 15 years as part of a multi-firm team addressing radionuclide, organic and inorganic contamination under CERCLA, RCRA, and AEA programs. Developed fate-and-transport models for remedy design and optimization of Central Plateau and River Corridor OUs. Developed and documented methods and guidelines to assess remedy performance and conducted a “needs assessment” for model-based decision support. Developed methods to assess remedy performance and simulated Uranium, Iodine, Sr90, Tc-99, CrVI, TCE, NO3, CCl4 and other constituents, as part of CERCLA and RCRA actions. Developed and published multi-variate trend analyses for MNA remedies. Oversaw sitewide RCRA facility and monitoring network evaluations and the development of monitoring and data analysis strategies during the transition of dozens of RCRA facilities from interim to final monitoring status. Presented findings at numerous multi-stakeholder meetings.

New York Department of Environmental Conservation: Provided hydrogeologic oversight and groundwater flow and fuel-component transport and fate analyses to design and optimize soil and groundwater remedies to protect sole-source municipal supplies from single and multiple UST releases at over 15 facilities. Designed and implemented sentinel monitoring network programs for municipal supplies. Presented results at public/civic meetings, ITRC events, and a remediation charette throughout New York State. Co-recipient of NGWA groundwater remediation award for work at the Hampton Bays site.

Delta Consultants (on behalf of BP), Deer Park, New York: Analyzed the distribution and transport of multiple contaminants arising from a fuel-spill migrating toward a large freshwater body to support investigation efforts and a comparative evaluation of remedial alternatives. Presented results to New York State Department of Environmental Conservation.

Otis Air Force Base, Massachusetts: Retained to design performance monitoring plans for several pump-and-treat systems under CERCLA including evaluation of the location, migration, and impacts of CVOCs and other constituents discharging to freshwater kettle ponds. Contributed to treatment plant design assessments, recommended O&M improvements, and co-authored quarterly and annual reports. Designed and oversaw data collection activities including impeller and heat-pulse flow profiling of long-screened extraction wells to identify contaminant inflow locations and estimate aquifer parameters. Developed novel data mapping techniques as a supplement to numerical groundwater flow and contaminant transport modeling. Presented technical findings to AFCEE and at multi-stakeholder meetings. To undertake this work efficiently, made primary residence in Barnstable County from 1999 through 2004.

West Lake Superfund Site, Missouri: Led an assessment of the lateral and vertical extent, disposition, and potential transport and fate of radionuclides within and from solid landfill water materials. Implemented 3D multiple-indicator geo-statistics using a variety of data types to assess radionuclide extent and partial excavation strategies, and managed a project team participating in field work, lab studies and geochemical fate and transport modeling.

PROGRAMMING & SOFTWARE DEVELOPMENT

Release of MT3D-USGS: Contributing developer to MT3D-USGS, incorporating multi-component transport capabilities developed for EPA plus other features (Documented in Bedekar *et al*, 2016).

Expansion of HSSM and MT3DMS to Simulate Multi-Species Reactive Transport: Contracted by USEPA-ORD to expand HSSM and MT3DMS to simulate kinetic reactive transport of multiple fuel constituents with application to fuels. Capability ultimately released in MT3D-USGS.

Linkage of HSSM with MT3DMS: Contracted by the USEPA-ORD, with Dr. Chunmiao Zheng, to link vadose simulation capabilities of HSSM to MT3DMS and provide calibration support with PEST. Developed software released in 2010 (Documented in Zheng *et al*., 2010).

Data Worth Evaluation Using Models: Contracted by the U.S. Geological Survey to program OPR-PPR, which uses FOSM methods and the JUPITER API to evaluate the relative importance of observations and information on model parameters to predictions (Detailed in Tonkin *et al*., 2007).

Predictive Analysis with MODFLOW: Contracted by the USGS to program MOD-PREDICT, which executes MODFLOW-2000 forward, performs sensitivity and calibration runs, and calculates summary statistics focused on predictive error analysis. (Documented in Tonkin *et al*., 2003).

Hydraulic Capture Analysis: Co-developer of KT3D_H2O programs that combine kriging, analytic elements and particle tracking to map groundwater levels and evaluate hydraulic capture. (Documented in Karanovic *et al*., 2009; Tonkin et al., 2009; Tonkin and Larson, 2002.)

TRAINING & SOFTWARE SUPPORT

MODFLOW and More Conferences: Member of organizing committee, Integrated Groundwater Modeling Center (IGWMC), Colorado School of Mines (2013, 2015, 2017, 2019, 2022).

The PEST Conference: Principal organizer and editor of electronic proceedings for model calibration and uncertainty analysis. Published on-line at LULU.com (November 2009).

Collection and Mapping of Water Levels to Assist in Remedy Performance Evaluation: Organizer, co-instructor. Presented to USDOE and contractors at the Hanford Site (August 2009).

PEST Software Support: Provided technical support for the software PEST through a list-serve hosted by S.S. Papadopulos & Associates, Inc. (2002–2012). Organizer and Instructor (with Dr. John Doherty) of model parameterization and uncertainty analysis courses using PEST in the USA and overseas (2002–present).

Instructor (with Dr. Mary Hill) of "UCODE_2005 and Pest: Universal Inversion Codes for Automated Calibration" (2006, 2007, 2009, 2011); "Programming with the JUPITER-API" (2008).

ITRC Workshop Instructor: "MTBE & TBA Comprehensive Site Assessment and Successful Groundwater Remediation". New York (2003), Denver (2004), San Francisco (2005).

Structural Mapping Supervisor: Birmingham University, United Kingdom. Assisted professors in developing mapping training for introduction to curriculum (1994).

Publications & Presentations

Scantlebury, L., Bedekar, V., Tonkin, M.J., Karanovic, M., and Harter, T., 2025. *Texture2Par: A Texture-Driven Tool for Estimating Subsurface Hydraulic Properties*. Environmental Modelling & Software. doi: 10.1016/j.envsoft.2025.106372

DiFilippo, E., M. Tonkin and W. Huber, 2023. *Use of Censored Multiple Regression to Interpret Temporal Environmental Data and Assess Remedy Progress*. Groundwater, vol 61, no. 6: 846-864. doi: 10.1111/gwat.13315

Wyatt, K., M. Beck, and M. Tonkin, 2022. *Advanced Geostatistics to Optimize the Sampling Approach for Contaminated Soil Investigations and Remediations*. Platform presentation at Battelle's Twelfth International Conference on Remediation of Chlorinated and Recalcitrant Compounds. May.

Muffels, C., S. Panday, C. Andrews, M.J. Tonkin, and A. Spiliotopoulos, 2022. *Simulating Groundwater Interaction within a Surface Water Network using Connected Linear Networks (CLNs)*. Ground Water. doi: 10.1111/gwat.13202. Online release April.

Tonkin, M.J., and M. Chowdhury, 2022. *Groundwater Modeling to Support Site Characterization and Remediation in Field Sampling Methods for Remedial Investigations*. 3rd Edition.

Tonkin, M.J., and Chowdhury, M., 2021. *Monitoring Network Analysis for Integrated Central Plateau Decision Making (at the DOE Hanford Site)*. Invited Presentation at REMPLEX, the 2021 Global Summit on Environmental Remediation, November.

Tonkin, M.J., M. Hill, R.M. Maxwell, and C. Zheng, 2020. *Groundwater Modeling and Beyond: MODFLOW-and-More*. 2019 Special Issue. Ground Water, v. 58, no. 3, pp. 325-326, doi: 10.1111/gwat.12999.

Spiliotopoulos A., E.L. DiFilippo, P. Khambhammettu, D. Hayes, M.J. Tonkin, M. Hartman, K. Ivarson, and J. Hulstrom, 2019. *Web-Assisted Methods and Tools for Efficient Remedy Design and System Performance Evaluation at Hanford*. Presentation at the Waste Management Conference, Phoenix, AZ, March 7, 2019. Received "Superior" paper and "WM2019 Papers of Note Winner" awards. OSTI #23003084

DiFilippo E.L., M.J. Tonkin, A. Spiliotopoulos, W. Huber, and V. Rohay, 2019. *Evaluating Environmental Remediation Performance at Radwaste Sites Using Multiple, Censored Regression Analysis*. Presentation at the Waste Management Conference, Phoenix, AZ, March 7, 2019. IAEA #52043413

Maxwell, R.M., A. Navarre – Sitchler, and M. Tonkin, 2018. *Forward: Modeling for Sustainability and Adaptation*. Ground Water, v. 56, no. 4, pp. 515-516, doi: 10.1111/gwat.12795.

Bedekar, V., E.D. Morway, C.D. Langevin, and M. Tonkin, 2016. *MT3D-USGS Version 1: A U.S. Geological Survey Release of MT3DMS Updated with New and Expanded Transport Capabilities for Use with MODFLOW*. U.S. Geological Survey Techniques and Methods Report #6-A53, Reston, VA. 69 p.

Tonkin, M.J., J. Kennel, W. Huber, and J. Lambie, 2015. *Multi-Event Universal Kriging (MEUK)*, Advances in Water Resources, v. 87, pp. 92–105, January. doi: 10.1016/j.advwatres.2015.11.001

Royer, P. D., M.J. Tonkin, and T. Hammond, 2014. *Conjunctive Water Use in Confined Basalt Aquifers: An Evaluation Using Geochemistry, a Numerical Model, and Historical Water Levels*. Journal of the American Water Resources Association (JAWRA), v. 50, No. 4, pp. 963–976, August. doi: 10.1111/jawr.12151

Tonkin, M.J., J. Kennel, W. Huber, and J.A. Lambie, 2013. *Hybrid Analytic Element Universal Kriging Interpolation Technique Built in the Open Source R Environment*. Presentation at the American Geophysical Union, Fall Meeting 2013, Abstract #H52E-03.

Tonkin, M. and Z. Tajani, 2012. *Piecewise-Continuous Boundaries Using the MODFLOW FHB and MT3DMS HSS Packages*. Ground Water, v. 50, no. 2, pp. 296-300. doi: 10.1111/j.1745-6584.2011.00811.x

Bedekar, V., C. Neville, and M. Tonkin, 2012. *Source Screening Module for Contaminant Transport Analysis Through Vadose and Saturated Zones*. Ground Water, v. 50, pp. 954–958. doi:10.1111/j.1745-6584.2012.00954.x

Ma, R., C. Zheng, J. Zachara, and M. Tonkin, 2012. *Utility of Bromide and Heat Tracers for Aquifer Characterization Affected by Highly Transient Flow Conditions*. Water Resources Research, v. 48, #8. doi: 10.1029/2011WR011281

Bedekar, V., R.G. Niswonger, K. Kipp, S. Panday, and M. Tonkin, 2011. *Approaches to the Simulation of Unconfined Flow and Perched Groundwater Flow in MODFLOW*. Ground Water, v. 50, no. 2, pp. 187-198. doi: 10.1111/j.1745-6584.2012.00811.x

Ma, R., C. Zheng, M. Tonkin, and J. Zachara, 2011. *Importance of Considering Intraborehole Flow in Solute Transport Modeling under Highly Dynamic Flow Conditions*.

Journal of Contaminant Hydrology, v. 123, Issues 1-2, April 1, 2011, pp. 11-19.

Hunt, R., J. Luchette, W. Schreuder, J. Rumbaugh, J. Doherty, M. Tonkin, and D. Rumbaugh, 2010. *Using a Cloud to Replenish Parched Groundwater Modeling Efforts*. Ground Water, v. 48, no. 3, pp. 360-365.

Shannon, R., M. Karanovic, and M. Tonkin, 2010. *Hydraulic Capture Estimated using Universal Kriging with Hydrologic Drift Terms*. Presentation at the19th Annual Maryland Groundwater Symposium, Baltimore, MD, 47.

Tonkin, M.J. (Editor), 2010. *PEST Conference Proceedings*. Potomac, MD, November 2009. Available at www.LULU.com.

Zheng, C., J. Weaver, and M. Tonkin, 2010. MT3DMS, *A Modular Three-dimensional Multispecies Transport Model: User Guide to the Hydrocarbon Spill Source (HSS) Package*. Prepared for U.S. Environmental Protection Agency, Athens, GA.

Tonkin, M., and J. Doherty, 2010. *Citation and Acceptance of the 2009 M. King Hubbert Award*. Ground Water (published online). January 2010.

Tonkin, M., S. Dadi, and R. Shannon, 2009. *Collection and Mapping of Water Levels to Assist in the Evaluation of Groundwater Pump-and-Treat Remedy Performance*. SGW-42305 (Rev. 0). Prepared for the US Department of Energy, Richland, WA, September 2009.

Karanovic, M., M. Tonkin, and D. Wilson, 2009. *KT3D_H20: A Program for Kriging Water-Level Data Using Hydrologic Drift Terms*. Ground Water, v. 45, no. 4, pp. 580-586, July/August. doi: 10.1111/j.1745-6584.2009.00565.x

Tonkin, M. J., 2009. *Efficient Calibration and Predictive Error Analysis for Highly-Parameterized Models Combining Tikhonov and Subspace Regularization Techniques*. Doctoral Thesis, University of Queensland, Australia.

Weaver, J., J. Zhang, M. Tonkin, and R.J. Charbeneau, 2009. *Modeling the Transport of Ethanol Fuel Blends with the Combined HSSM and MT3D Models*. Presentation at the 21st Annual National Tanks Conference and Expo, Sacramento, CA, March 30 – April 01, 2009.

Tonkin, M., and J. Doherty, 2009. *Calibration-Constrained Monte Carlo Analysis of Highly-Parameterized Models Using Subspace Techniques*. Water Resources Research, v. 45. W00B10. doi: 10.1029/2007WR006678

Tonkin, M., C. Arola, and D. Miller, 2007. *Decision-Level Modeling within a Feasibility-Study Process: An Application at the Hanford Site*. Presentation at the Association of Engineering and Environmental Geologists 50th Anniversary, Los Angeles, CA, September 26-28, 2007.

Tonkin, M., and J. Doherty, 2007. *An Efficient Calibration-Constrained Monte Carlo Technique for Evaluating Model Predictive Uncertainty*. in Proceedings of an International Conference on Calibration and Reliability in Groundwater Modeling: Credibility of Modeling (ModelCARE2007), Copenhagen, Denmark, September 2007. IAHS Publication 320.

Hunt, R., J. Doherty, and M. Tonkin, 2007. *Are Models Too Simple? Arguments for Increased Parameterization*. Ground Water, v. 45, no. 3, pp. 254-262.

Tonkin, M., J. Doherty, and C. Moore, 2007. *Efficient Non-Linear Predictive Error Variance for Highly Parameterized Models*: Water Resources Research, v. 43. W07429. doi: 10.1029/2006WR005348

Tonkin, M., C. Tiedeman, D. Ely, and M. Hill, 2007. *OPR-PPR, a Computer Program for Assessing Data Importance to Model Predictions Using Linear Statistics, Constructed Using the JUPITER API*. Prepared in Cooperation with the U.S. Department of Energy. Techniques and Methods 6-E2. U.S. Geological Survey.

Muffels, C., H. Zhang, J. Doherty, R. Hunt, M. Anderson, and M. Tonkin, 2006. *Incorporating PROPACK into PEST to Estimate the Model Resolution Matrix for Large Groundwater Flow Models*. Presentation at the American Geophysical Union (AGU) Fall Meeting, Moscone Center, San Francisco, CA, December 2006.

Muffels, C., J. Doherty, M. Anderson, R. Hunt, T. Clemo, and M. Tonkin, 2006. *LSQR and Tikhonov Regularization in the Calibration of a Complex MODFLOW Model*. Presentation at the Geological Society of America Annual Meeting, Philadelphia, PA, October 2006.

Muffels, C., M. Tonkin, H. Zhang, M. Anderson, and T. Clemo, 2006. *Application of LSQR to Calibration of a MODFLOW Model: A Synthetic Study*. in Proceedings of MODFLOW and More 2006, Managing Ground-Water Systems, International Ground Water Modeling Center, Colorado School of Mines Golden, CO, May 2006, v. 1, pp. 283-287.

Tonkin, M., M. Karanovic, A. Hughes, and C. Jackson, 2006. *New and Contrasting Approaches to Local Grid Refinement*. in Proceedings of MODFLOW and More 2006, Managing Ground-Water Systems, International Ground Water Modeling Center, Colorado School of Mines Golden, CO, May 2006, v. 2, pp. 601-605.

Tonkin, M., and J. Doherty, 2005. *A Hybrid Regularized Inversion Methodology for Highly Parameterized Environmental Models*. Water Resources Research, v. 41, no. 10, October. W10412. doi: 10.1029/2005WR003995

Tonkin, M., and M. Becker, 2005. Environmental Insite: *A Software Package for Ground Water Data Visualization*. Ground Water, v. 43, no. 4, pp. 466-470. Software Spotlight.

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Tonkin, M., J. Weaver, C. Zheng, C. Muffels, and J. Rumbaugh, 2005. *Coupled Free and Dissolved Phase Transport: New Simulation Capabilities and Parameter Inversion*. in Proceedings of the 2005 National Ground Water Association (NGWA) Conference on MTBE and Perchlorate, Assessment, Remediation, and Public Policy, San Francisco, CA, May 2005.

Muffels, C., M. Tonkin, J. Haas, and D. Trego, 2005. Predictive and Post-Audit Mass Flux Estimates. in Proceedings of the National Ground Water Association (NGWA) Ground Water Summit, San Antonio, TX, April 2005.

Tonkin, M. (as Contributing author to Interstate Technology & Regulatory Council (ITRC)). MTBE and Other Fuel Oxygenates Team, 2005. *Overview of Groundwater Remediation Technologies for MTBE and TBA*. February 2005.

Neville, C. and M. Tonkin, 2004. *Modeling Multi-Aquifer Wells with MODFLOW*. Ground Water, v. 42, no. 6, pp. 910-919.

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Cohen, H., M. Tonkin, and C. Neville, 2000. *Determination of Hydraulic Conductivity Distribution in a Heterogeneous Glacial Sand Aquifer: Correlation between Estimates Based on Impeller Flow Meter Data and Grain Size Distributions*. Society for Sedimentary Geology/International Association of Sedimentologists Research Conference: Environmental Sedimentology: Hydrogeology of Sedimentary Aquifers, Santa Fe, NM, September 24-27, 2000.

Deposition & Testimony-at-Trial Experience

DEPOSITIONS

- 2023 – *Jed and Alisa Behar v. Northrop Grumman Corporation and Northrop Grumman Systems Corp*., United States District Court for the District of California, Civil Action No. 21-cv-03946-HDV-SK. December 6.
- 2022 – *Goleta Water District v. Slippery Rock Ranch, LLC*. Superior Court of the State of California. No. 1487005. March 18.
- 2022 – *Goleta Water District v. Slippery Rock Ranch, LLC*. Superior Court of the State of California. No. 1487005. March 12.
- 2021 – *Goleta Water District v. Slippery Rock Ranch, LLC*. Superior Court of the State of California. No. 1487005. August 31 - September 1.
- 2021 – *Goleta Water District v. Slippery Rock Ranch, LLC*. Superior Court of the State of California. No. 1487005. April 28.
- 2019 – *Goleta Water District v. Slippery Rock Ranch, LLC*. Superior Court of the State of California. No. 1487005. September 16 - 17.
- 2018 – *State of New York v. United Gas Corp., et al*. December 11 - 12.
- 2016 – *Waverley View Investors, LLC. vs. United States of America*. United States Court of Federal Claims. No. 15-371L. December 15.

- 2016 – *Samantha Hall vs. Conoco, Inc. et al*. United States District Court for the Western District of Oklahoma. No. 14-CV-670-HE. March 3.
- 2014 – *Jerilyn K. Allen et al. vs. ExxonMobil Corporation*. Circuit Court of the State of Maryland, County of Baltimore No. C-11-8536. April 4.
- 2011 – *State of New York vs. 913 Portion Road Realty Corp, et al*. Supreme Court of the State of New York. No. 26495-M. July 29.
- 2008 – *Jeff Alban et al. vs. ExxonMobil Corporation et al*. Circuit Court of the State of Maryland, County of Baltimore. No. 03-C-06-010932. February 6.

TESTIMONY-AT-TRIAL

- 2017 – *Waverley View Investors, LLC. vs. United States of America*. United States Court of Federal Claims. Case No. 15-371L. May 15.
- 2017 – *White Bear Lake Restoration Association, ex rel, State of Minnesota vs. Minnesota Department of Natural Resources and Thomas J. Landwehr in his Capacity as Commissioner of the Minnesota Department of Natural Resources*. State of Minnesota Second Judicial District Court, County of Ramsey. Case No. 62-CV-13-2414. March 23.
- 2017 – *Waverley View Investors, LLC. vs. United States of America*. United States Court of Federal Claims. Case No. 15-371L. January 18.

Christian D. Langevin, Ph.D.

Principal Hydrologist

Dr. Langevin is an internationally recognized authority in the field of hydrologic modeling. He specializes in the development and application of advanced simulation software for complex groundwater resource evaluations and contaminant transport analyses. Prior to joining SSP&A, Dr. Langevin served as the lead developer and primary caretaker of the U.S. Geological Survey (USGS) MODFLOW program, the world's most widely used groundwater simulator. In this pivotal role, he helped shape modern groundwater simulation tools. He has developed and codeveloped key hydrologic modeling software, including MODFLOW 6, MODFLOW-USG, MT3D-USGS, SEAWAT, and FloPy, and authored or coauthored numerous peer-reviewed publications and technical reports on hydrologic modeling. His expertise in translating physical hydrologic systems into numerical representations comes from over two decades of practical application together with teaching and advising on the application of numerical models in diverse hydrologic settings. His specialized knowledge includes constant- and variable-density groundwater flow – emphasizing saltwater intrusion – solute and heat transport, efficient unstructured grid applications, and automated workflows for model construction, calibration, and predictive analysis. His project experience includes modeling integrated surface and groundwater systems, aquifer storage and recovery, deep-well injection, and coastal hydrology including seawater intrusion.

REPRESENTATIVE EXPERIENCE

S.S. Papadopulos & Associates, Inc. *– Saint Paul, Minnesota*

Dr. Langevin recently joined SSP&A and will be working on a variety of projects to be added here in the near future.

U.S. Geological Survey *– Mounds View, Minnesota*

MODFLOW Development and Support: Led development and support of the USGS hydrologic simulation program called MODFLOW. Provided leadership throughout the development of new capabilities through the initial needs identification, background work to understand what had previously been done, prototyping of multiple alternatives to examine the most promising avenues, implementation of methods within one or more programming languages, rigorous testing of the new capability against a suite of benchmark problems, publication of the new capability in the appropriate outlet, and supporting, teaching, and promoting the capability to existing and new users. Extensions to MODFLOW during this period included solute transport, heat transport, variable-density flow, particle tracking, an Application Programming Interface (API), and parallel simulation capabilities for laptops, desktops, and supercomputers. Promoted technology transfer of new simulation capabilities through USGS and customized workshops and training classes, conference presentations, and publications in peer-reviewed journals.

U.S. Geological Survey *– Reston, Virginia*

MODFLOW Development and Support: Led development of the next generation of MODFLOW, culminating in the release of MODFLOW 6. Collaborated on the development, publication, and USGS release of the MODFLOW-USG groundwater flow model. Developed the USGS Gridgen software for construction of quadtree unstructured grids. Contributed to development, publication, and release of the MT3D-USGS program.

YEARS OF EXPERIENCE

25+

EDUCATION

- **PhD**, Geology, University of South Florida, 1998
- **MS**, Geology, University of South Florida, 1993
- **BS**, Geology, University of Wisconsin-Madison, 1991

EXAMPLE AREAS OF EXPERTISE

- Quantitative Hydrogeology
- Numerical Modeling of Groundwater Flow
- Variable-Density Groundwater Flow
- Solute Transport
- Saltwater Intrusion
- Development of Customized Hydrologic Modeling Software
- Automated and Reproducible Modeling Workflows

AWARDS & HONORS

- Alumni Award, University of South Florida Geology Department: 2010
- John Hem Award for Excellence in Science & Engineering, National Ground Water Association: 2008

ACADEMIC APPOINTMENTS

- Courtesy faculty appointment, Florida International University, Department of Earth Sciences, Miami, FL: September 2007 – May 2010
- Courtesy faculty appointment, University of Alabama, Graduate School, Tuscaloosa, AL: October 2004 – May 2010

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Special Assignments: Participated in the Water Science Center Technical Reviews, conducted jointly by the Office of Groundwater and Office of Water Quality. As part of the review team, met with Water Science Center staff, reviewed data collection activities and interpretive projects, and prepared a written report of findings. Assignments included:

- Technical Reviewer, Ohio Water Science Center: Columbus, OH, May 24-28, 2010
- Technical Review Leader, Maryland-District of Columbia-Delaware Water Science Center: Baltimore, MD, April 4-8, 2011.
- Technical Reviewer, California Water Science Center: San Diego, CA, June 12-17, 2011.
- Technical Reviewer, South Carolina Water Science Center: Columbia, SC, January 8-13, 2012.
- Technical Review Leader, Louisiana Water Science Center: Baton Rouge, LA, May 21-25, 2012.
- Technical Reviewer, Caribbean Water Science Center: San Juan, PR, February 3-8, 2013.
- Technical Review Leader, North Carolina Water Science Center: Raleigh, NC, April 8-12, 2013.
- Technical Reviewer, Arizona Water Science Center: Tucson, AZ, February 10-14, 2014.
- Technical Review Leader, Pacific Islands Water Science Center: Honolulu, HI, May 4-8, 2015.
- Technical Reviewer, Colorado Water Science Center: Lakewood, CO, July 20-24, 2015.
- Technical Reviewer, Oregon Water Science Center: Portland, OR, April 25-29, 2016.
- Technical Review Leader, New Mexico Water Science Center: Albuquerque, NM, February 13-17, 2017.
- Technical Reviewer, New Jersey Water Science Center: Trenton, NJ, May 1-5, 2017.

U.S. Geological Survey – Fort Lauderdale, Florida

SEAWAT Development and Support: Led the development, publication, and USGS release of the popular SEAWAT code for simulation of variable-density groundwater flow coupled with solute and heat transport.

Effect of Sea Level Rise on Saltwater Intrusion Near a Coastal Wellfield: Quantified the effect of sea level rise, well field withdrawals, variations in precipitation, and surface water management practices on movement of the saltwater interface in the surficial aquifer system in Broward County, Florida. Applied highly parameterized calibration strategies for history matching of a variable-density numerical model. Predicted future movement of the saltwater interface in response to a range of anticipated stresses.

Integrated Surface and Groundwater Modeling for Everglades Restoration: To support Federal and state restoration efforts, developed and applied coupled numerical surface and groundwater models to the Everglades and coastal wetlands. Simulated alternative restoration scenarios to evaluate the response of surface and groundwater flows and salinities to a range of water management scenarios.

Continued from previous page

» Courtesy faculty appointment, University of Florida, Tropical Research and Education Center, Homestead, FL: August 2004 – 2010

» Visiting Professor, University of Puerto Rico-Rio Piedras, Department of Environmental Studies: 2003 Summer Semester

» Instructor, University of South Florida, Geology Department, Tampa, FL: 1994, 1995, 1996 Fall Semesters

COMMITTEES

» 2024-Present: Steering Group Member, Groundwater Network of the Global Energy and Water Exchanges (GEWEX) Program

» 2016: Team Leader and Lead Author, Office of Groundwater Technical Memorandum 2016.02— *Policy for documenting, archiving, and public release of numerical groundwater flow and transport models*

» 2015: International Committee Participant, Danish International Network Programme

» 2014: Team Member and Coauthor, Office of Groundwater Technical Memorandum 2015.02 – *Policy and guidelines for archival of surface-water, groundwater, and water-quality model applications*

» 2006 – Present: Associate Editor, Groundwater Journal

» 2000 – 2005: Technical Advisor, Aquifer Storage and Recovery Project Development Team of the Comprehensive Everglades Restoration Plan

» 2002: Expert Consultant, Bureau of Indian Affairs for SEAWAT modeling study, Lummi Indian Reservation, Washington

» 2002: International Expert Consultant, United Nations Food and Agricultural Organization, Rabat, Morocco

PROFESSIONAL SOCIETIES

» National Ground Water Association (NGWA)

» Geological Society of America (GSA)

» American Geophysical Union (AGU)

Effect of Turkey Point Hypersaline Cooling Canals on the Biscayne Aquifer: Quantified the effect of hypersaline cooling canals on groundwater flow patterns and salinity distributions in the Biscayne aquifer. Applied the heat and solute transport capabilities of the SEAWAT model to quantify the effect of hypersaline cooling canals on the Biscayne aquifer.

Estimation of Capture Zones and Drawdown at Two Public Supply Well Fields: Evaluated the effects of quarry lakes on simulated well field capture zones. Quantified the uncertainty in captures zones using a stochastic Monte Carlo analysis and particle tracking. Predicted the effects of proposed quarry lake expansion.

Deep-Well Injection at the South District Wastewater Treatment Plant: Evaluated the fate and transport of deep-well injectate. Simulated the buoyancy effects due to temperature and dissolved solid concentrations on movement of injectate.

Quantification of Submarine Groundwater to Biscayne Bay: Conducted field studies and numerical analyses to estimate the rate of fresh groundwater discharge into Biscayne Bay, Florida. Fresh groundwater discharge rates were used to inform and improve hydrodynamic simulations of salinity patterns in Biscayne Bay.

Environmental Resources Management, Inc. – *Tampa, Florida*

Nutrient Loading to Shallow Aquifers: Identified and mapped areas of increased risk for nutrient loading using novel geographic information scripting. Developed automated routines and graphical user interfaces for project managers.

Savannah River Site, Department of Energy – *Aiken, South Carolina*

Groundwater Model Database Development: Developed a geographic information system to store temporal and spatial data useful for constructing and calibrating groundwater flow and transport models.

Software Releases

MODFLOW 6

MODFLOW 6 releases are listed below and also available on GitHub at: https://github.com/MODFLOW-ORG/modflow6/releases

Langevin, C.D., Hughes, J.D., Provost, A.M., Russcher, M.J., Niswonger, R.G., Panday, Sorab, Merrick, Damian, Morway, E.D., Reno, M.J., Bonelli, W.P., Boyce, S.E., and Banta, E.R., 2025. *MODFLOW 6 Modular Hydrologic Model version 6.6.1*: U.S. Geological Survey Software Release, 10 February 2025. doi: 10.5066/P9FL1JCC

Langevin, C.D., Hughes, J.D., Provost, A.M., Russcher, M.J., Niswonger, R.G., Panday, Sorab, Merrick, Damian, Morway, E.D., Reno, M.J., Bonelli, W.P., Boyce, S.E., and Banta, E.R., 2024. *MODFLOW 6 Modular Hydrologic Model version 6.6.0*: U.S. Geological Survey Software Release, 19 December. doi: 10.5066/P1DXFBUR

Langevin, C.D., Langevin, C.D., Hughes, J.D., Provost, A.M., Russcher, M.J., Morway, E.D., Reno, M.J., Bonelli, W.P., Panday, Sorab, Merrick, Damian, Niswonger, R.G., Boyce, S.E., and Banta, E.R., 2024. *MODFLOW 6 Modular Hydrologic Model version 6.5.0*: U.S. Geological Survey Software Release, 23 May. doi: 10.5066/P13COJJM

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ONLINE PROFILES

- ORCID: https://orcid.org/0000-0001-5610-9759
- Google Scholar: https://scholar.google.com/citations?user=5oaktdAAAAAJ&hl=en

PROFESSIONAL HISTORY

- S.S. Papadopulos & Associates, Inc.: 2025–present
- USGS Water Mission Area, Integrated Modeling and Prediction Division, Chief Scientist for Groundwater Modeling: 2017–2025
- USGS Office of Groundwater, Chief Scientist for Groundwater Modeling: 2010-2017
- USGS Florida Water Science Center, Research Hydrologist: 1998–2010

EMAIL

langevin@sspa.com

Langevin, C.D., Hughes, J.D., Provost, A.M., Russcher, M.J., Niswonger, R.G., Panday, Sorab, Merrick, Damian, Banta, E.R., Morway, E.D., Reno, M.J., and Bonelli, W.P., 2022. *MODFLOW 6 Modular Hydrologic Model version 6.4.0*: U.S. Geological Survey Software Release, 30 November. doi: 10.5066/P9FL1JCC

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2021. *MODFLOW 6 Modular Hydrologic Model version 6.3.0 release candidate*: U.S. Geological Survey Software Release, 4 March. doi: 10.5066/F76Q1VQV

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2021. *MODFLOW 6 Modular Hydrologic Model version 6.2.2 release candidate*: U.S. Geological Survey Software Release, 6 August. doi: 10.5066/F76Q1VQV

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2021. *MODFLOW 6 Modular Hydrologic Model version 6.2.1*: U.S. Geological Survey Software Release, 17 February. doi: 10.5066/F76Q1VQV

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2020. *MODFLOW 6 Modular Hydrologic Model version 6.2.0*: U.S. Geological Survey Software Release, 22 October. doi: 10.5066/F76Q1VQV

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2020. *MODFLOW 6 Modular Hydrologic Model version 6.1.1*: U.S. Geological Survey Software Release, 12 June. doi: 10.5066/F76Q1VQV

Langevin, C.D., Hughes, J.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2018. *MODFLOW 6 Modular Hydrologic Model version 6.1.0*: U.S. Geological Survey Software Release. doi: 10.5066/F76Q1VQV

OTHER SOFTWARE RELEASES

Mccreight, James L., Langevin, C.D., Hughes, J. D., Bonelli, W. P., 2024. *pywatershed v2.0.0*, U.S. Geological Survey Software Release. doi: 10.5066/P13EWPEV

Fienen M.N., Hughes, J.D., Langevin, C.D., Larsen, J.D., and Leaf, A.T. 2024. *python-for-hydrology*, U.S. Geological Survey software release. Reston, VA. doi: 10.5066/P1QTRYJY

Mccreight, James L., Langevin, C.D., Hughes, J. D., Bonelli, W. P., 2023. *pywatershed v1.0.0*, U.S. Geological Survey Software Release, 1 December. doi: 10.5066/P9AVWA7Z

Bedekar, Vivek, Morway, E.D., Langevin, C.D., and Tonkin, Matt, 2016. *MT3D-USGS version 1: A U.S. Geological Survey release of MT3DMS updated with new and expanded transport capabilities for use with MODFLOW*: U.S. Geological Survey Techniques and Methods 6-A53, 69 p. doi: 10.3133/tm6A53

Lien, Jyh-Ming, Liu, Guilin, and Langevin, C.D., 2015. *GRIDGEN version 1.0—A computer program for generating unstructured finite-volume grids*: U.S. Geological Survey Open-File Report 2014–1109, 26 p. doi: 10.3133/ofr20141109

Panday, Sorab, Langevin, C.D., Niswonger, R.G., Ibaraki, Motomu, and Hughes, J.D., 2013. *MODFLOW-USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation*: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p. doi: 10.3133/tm6A45

Langevin, C.D., Thorne, D., Dausman, A.M., Sukop, M.C., and Guo, W., 2007. *SEAWAT Version 4: A computer program for simulation of multi-species solute and heat transport*. U.S. Geological Survey Techniques and Methods Book 6, Chapter A22, 39 p.

Publications & Presentations

PEER-REVIEWED PUBLICATIONS

Morway, E.D., Provost, A.M., Langevin, C.D., Hughes, J.D., Russcher, M.J., Chen, C.Y., Lin, Y.F.F., 2025. *A New Groundwater Energy Transport Model for the MODFLOW Hydrologic Simulator*. Groundwater. doi: 10.1111/gwat.13470

Provost, A.M., Bardot, K., Langevin, C.D., McCallum, J.L., 2025. *Accurate Simulation of Flow through Dipping Aquifers with MODFLOW 6 Using Enhanced Cell Connectivity*. Groundwater. doi: 10.1111/gwat.13459

Langevin, C.D., Hughes, J.D., Provost, A.M., Russcher, M.J. and Panday, S. 2024. *MODFLOW as a Configurable Multi-Model Hydrologic Simulator*. Groundwater, 62: 111-123. doi: 10.1111/gwat.13351

Larsen, J.D., Langevin, C.D., Hughes, J.D. and Niswonger, R.G., 2024. *An Agricultural Package for MODFLOW 6 Using the Application Programming Interface*. Groundwater, 62: 157-166. doi: 10.1111/gwat.13367

Hughes, J.D., Langevin, C.D., Paulinski, S.R., Larsen, J.D. and Brakenhoff, D., 2024. *FloPy Workflows for Creating Structured and Unstructured MODFLOW Models*. Groundwater, 62: 124-139. doi: 10.1111/gwat.13327

Mancewicz, L.K., Mayer, A., Langevin, C.D., and Gulley, J., 2023. *Improved Method for Simulating Groundwater Inundation Using the MODFLOW 6 Lake Transport Package*. Groundwater, 61: 421-430. doi: 10.1111/gwat.13254

Herrera, P.A., Langevin, C.D. and Hammond, G., 2023. *Estimation of the Water Table Position in Unconfined Aquifers with MODFLOW 6*. Groundwater, 61: 648-662. doi: 10.1111/gwat.13270

Hughes, J.D., Russcher, M.J., Langevin, C.D., Morway, E.D., and McDonald, R.R., 2022. *The MODFLOW Application Programming Interface for simulation control and software interoperability*: Environmental Modelling & Software, v. 148, 105257. doi: 10.1016/j.envsoft.2021.105257

Morway, E.D., Langevin, C.D., and Hughes, J.D., 2021. *Use of the MODFLOW 6 water mover package to represent natural and managed hydrologic connections*: Groundwater, v. 59, no. 6, p. 913-924. doi: 10.1111/gwat.13117

Langevin, C.D., Panday, S. and Provost, A.M. 2020. *Hydraulic-Head Formulation for Density-Dependent Flow and Transport*. Groundwater, 58: 349-362. doi: 10.1111/gwat.12967

Provost, A.M., Werner, A.D., Post, V.E.A., Michael, H.A., and Langevin, C.D., 2018. *Rebuttal to "The case of the Biscayne Bay and aquifer near Miami, Florida: density-driven flow of seawater or gravitationally driven discharge of deep saline groundwater?" by Weyer* (Environ Earth Sci 2018, 77:1–16). Environ Earth Sci 77, 710. doi: 10.1007/s12665-018-7832-5

Panday, Sorab, Bedekar, Vivek, and Langevin, C.D., 2018. *Impact of Local Groundwater Flow Model Errors on Transport and a Practical Solution for the Issue*. Groundwater, 56: 667-672. doi: 10.1111/gwat.12627

Bakker, M., Post, V., Langevin, C. D., Hughes, J. D., White, J. T., Starn, J. J. and Fienen, M. N., 2016. *Scripting MODFLOW model development using Python and FloPy*. Groundwater 54 p. 733-739. doi: 10.1111/gwat.12413

Feinstein, D.T., Fienen, M.N., Reeves, H.W., and Langevin, C.D., 2016. *A semi-structured MODFLOW-USG model to evaluate local water sources to wells for decision support*. Groundwater 54 p. 532-544. doi: 10.1111/gwat.12389

Hughes, J.D., Langevin, C.D., and White, J.T., 2014. *MODFLOW-based coupled surface water routing and groundwater-flow simulation*. Groundwater 53 p. 452-463. doi: 10.1111/gwat.12216

Konikow, L.F., Akhavan, M., Langevin, C.D., Michael, H.A., and Sawyer, A.H., 2013. *Seawater circulation in sediments driven by interactions between seabed topography and fluid density*. Water Resources Research, Volume 49, Issue 3 p. 1386-1399. doi: 10.1002/wrcr.20121

Morway, E.D., Niswonger, R.G., Langevin, C.D., Bailey, R.T., and Healy, R.W., 2013. *Modeling variably saturated subsurface solute transport with MODFLOW-UZF and MT3DMS*. Ground Water 51 p. 237-251 doi: 10.1111/j.1745-6584.2012.00971.x

Langevin, C.D., and Zygnerski, M., 2013. *Effect of sea-level rise on salt water intrusion near a coastal well field in southeastern Florida*. Ground Water 51, p. 781-803. doi: 10.1111/j.17456584.2012.01008.x

La Licata, I., Langevin, C.D., Dausman, A.M., and Alberti, L., 2013. *Effect of tidal fluctuations on transient dispersion of simulated contaminant concentrations in a coastal aquifer*. Hydrogeology Journal, Vol. 18, no. 1: 25-38. doi: 10.1007/s10040-011-0763-9

Langevin, C.D., and Panday, S., 2012. *Future of groundwater modeling*. Ground Water 50 no. 3: 334-339. doi: 10.1111/j.1745-6584.2012.00937.x

Panday, S., and Langevin, C.D., 2012. *Improving sub-grid scale accuracy of boundary features in regional finite-difference models*. Advances in Water Resources 41: 65-75.

Hughes, J.D., Decker, J.D., and Langevin, C.D., 2011. *Use of upscaled elevation and surface roughness data in two-dimensional surface water models*. Advances in Water Resources, Vol. 34, no. 9: 1151-1164. doi: 10.1016/j.advwatres.2011.02.004

Herckenrath, D. Langevin, C.D., and Doherty, J., 2011. *Predictive uncertainty analysis of a saltwater intrusion model using null-space Monte Carlo*. Water Resources Research, Vol. 47, W05504. doi: 10.1029/2010WR009342

Mulligan, A.E., Langevin, C.D., and Post, V., 2011. *Tidal boundary conditions in SEAWAT*, Ground Water 49: 866-879. doi: 10.1111/j.1745-6584.2010.00788.x

Obeysekera, J., Kuebler, L., Ahmed, S., Chang, Miao-LI, Engel, V., Langevin, C., Swain, E., and Wan, Y., 2011. *Use of Hydrologic and Hydrodynamic Modeling for Ecosystem Restoration*. Critical Reviews in Environmental Science and Technology, 41: 6, 447-488.

Dausman, A. M., Doherty, J., Langevin, C. D. and Sukop, M. C., 2010. *Quantifying data worth toward reducing predictive uncertainty*. Ground Water, 48: 729–740. doi: 10.1111/j.1745-6584.2010.00679.x

Langevin, C. D., Dausman, A. M. and Sukop, M. C., 2010. *Solute and heat transport model of the Henry and Hilleke laboratory experiment*: Ground Water, 48: 757–770. doi: 10.1111/j.17456584.2009.00596.x

Dausman, A.M., Doherty, J., Langevin, C.D., and Dixon, J., 2010. *Hypothesis testing of buoyant plume migration using a highly parameterized variable-density groundwater model at a site in Florida, USA*. Hydrogeology Journal vol. 18, no. 1: 147-160. doi: 10.1007/s10040-009-0511-6

Hughes, J.D., Langevin, C.D., and Brakefield-Goswami, L., 2010. *Effect of hypersaline cooling canals on aquifer* *salinization*: Hydrogeology Journal vol. 18, no. 1: 25-38. doi: 10.1007/s10040009-0502-7

Langevin, C.D., 2008. *Modeling axisymmetric flow and transport*: Ground Water vol. 46, no. 4:579-590.

Swain, E.D., Langevin, C.D., and Wang, J.D., 2008. *Utilizing spectral analysis of coastal discharge computed by a numerical model to determine boundary influence*. Journal of Coastal Research, vol. 24, no. 6: 1418-1429.

Thorne, D., Langevin, C.D., and Sukop, M.C., 2006. *Addition of simultaneous heat and solute transport and variable fluid viscosity to SEAWAT*: Computer and Geosciences vol. 32, 1758-1768.

Langevin, C.D. and Guo, W., 2006. *MODFLOW/MT3DMS-based simulation of variable density ground water flow and transport*: Ground Water vol. 44, no. 3:339-351.

Mao, X., Prommer, H., Barry, D.A., Langevin, C.D., Panteleit, B., and Li, L., 2006. Three-*dimensional model for multi-component reactive transport with variable density groundwater flow*: Environmental Modelling & Software vol. 21, no. 5:615-628.

Langevin, C.D., Swain, E.D., and Wolfert, M.A. 2005. *Simulation of integrated surface-water/groundwater flow and salinity for a coastal wetland and adjacent estuary*: Journal of Hydrology 314, 212234.

Bakker, M., Oude Essink, G.H.P., and Langevin, C.D. 2004. *The rotating movement of three immiscible fluids a benchmark problem*. Journal of Hydrology 287, 270-278.

Langevin, C.D. 2003b. *Simulation of submarine ground water discharge to a marine estuary: Biscayne Bay, Florida*. Ground Water 41, no. 6: 758-771.

Langevin, C.D. 2003a. *Stochastic ground water flow simulation with a fracture zone continuum model*. Ground Water 41, no. 5: 587-601.

Stewart, M.T., and Langevin, C.D. 1999. *Post Audit of a numerical prediction of wellfield drawdown in a semiconfined aquifer system*. Ground Water 37, no. 2:245-252.

Langevin, C.D., Stewart, M.T., and Beaudoin, C.M. 1998. *Effects of dredge and fill canals on freshwater resources of small oceanic islands. An example from Big Pine Key, Florida*. Ground Water 36, no. 3: 503-513.

PUBLISHED REPORTS, CONFERENCE PAPERS, AND DATA RELEASES

Morway, E., Provost, A., and Langevin, C.D., 2025. *Two 2-Dimensional models patterned after the Barends analytical solution for verifying the accuracy of the new Groundwater Energy (GWE) Transport model built for the MODFLOW 6 hydrologic simulator*: U.S. Geological Survey data release. doi: 10.5066/P13KJF3C

Provost, A.M., Bardot, K., Langevin, C.D., and McCallum, J.L., 2025. *MODFLOW 6 models used to evaluate the accuracy of enhanced cell connectivity for simulation of flow through dipping aquifers*: U.S. Geological Survey data release. doi: 10.5066/P13BNARA

Langevin, C.D., Provost, A.M., Panday, Sorab, and Hughes, J.D., 2022. *Documentation for the MODFLOW 6 Groundwater Transport (GWT) Model*: U.S. Geological Survey Techniques and Methods, book 6, chap. A61, 56 p. doi: 10.3133/tm6A61

Morway, E.D., Langevin, C.D., Hughes, J.D., 2021. *MODFLOW 6 model of two hypothetical stream-aquifer systems to demonstrate the utility of the new Water Mover Package (MVR) available only with MODFLOW 6*: U.S. Geological Survey data release. doi: 10.5066/P9GQETP9

Provost, A.M., Langevin, C.D., and Hughes, J.D., 2017. *Documentation for the "XT3D" option in the Node Property Flow (NPF) Package of MODFLOW 6*: U.S. Geological Survey Techniques and Methods 6–A56, 40 p. doi: 10.3133/tm6A56

Langevin, C.D., Hughes, J.D., Banta, E.R., Niswonger, R.G., Panday, Sorab, and Provost, A.M., 2017. *Documentation for the MODFLOW 6 Groundwater Flow Model*: U.S. Geological Survey Techniques and Methods 6–A55, 197 p. doi: 10.3133/tm6A55

Hughes, J.D., Langevin, C.D., and Banta, E.R., 2017. *Documentation for the MODFLOW 6 framework*: U.S. Geological Survey Techniques and Methods 6–A57, 42 p. doi: 10.3133/tm6A57

Bakker, M., Schaars, F., Hughes, J.D., and Langevin, C.D., 2013. *The sea water intrusion (SWI2) Package for modeling vertically-integrated variable density groundwater flow in regional aquifers with the U.S. Geological Survey Modular Groundwater Model (MODFLOW-2005)*. U.S. Geological Survey Techniques and Methods, 6-A46, 47 p.

Ibaraki, M., Panday, S., Niswonger, R.G., Langevin, C.D., 2013. *Improvement of performance of MODFLOW xMD matrix solver package for heterogeneous computing environments*. MODFLOW and More 2013: Translating Science Into Practice, Golden, Colorado, June 2-5.

Bakker, M., Post, V., Hughes, J., Langevin, C., Frances, A., White, J., 2013. *Enhanced FloPy scripts for constructing and running MODFLOW-based models*. MODFLOW and More 2013: Translating Science Into Practice, Golden, Colorado, June 2-5.

Feinstein, D.T., M.N. Fienen, H.W. Reeves, and Langevin, C.D., 2013. *Application of a "semistructured" approach with MODFLOW-USG to simulate local groundwater/surface-water interactions at the regional scale as basis for a decision-support tool*. MODFLOW and More 2013: Translating Science Into Practice, Golden, Colorado, June 2-5.

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Langevin, C.D., Hughes, J.D., and Russcher, M. 2023. *Recent MODFLOW developments*. Presented at the Deltares Hydrology International User Days, Deltares, Delft, The Netherlands, November 30. INVITED, PRESENTED.

Hughes, J.D., Russcher, M., and Langevin, C.D. 2023. *Modeling without limits: Harnessing the power of the MODFLOW API*. Presented at the Civil Engineering seminar series at Delft University, Delft, The Netherlands, November 30. INVITED.

Langevin, C.D., Provost, A.M., Bardot, K., and McCallum, J. 2023. *Secrets to modeling groundwater flow through dipping hydrogeologic layers*. Civil Engineering seminar series at Delft University, Delft, The Netherlands, November 30. INVITED, PRESENTED.

Langevin, C.D. 2023. *Squeezing Water from a Rock: Unveiling recent groundwater modeling advances with MODFLOW 6*. Online presentation to the Pacific Northwest (PNW) Groundwater Modeling Group, September 21. INVITED, PRESENTED.

Langevin, C.D. 2023. *Recent MODFLOW developments*. Online presentation to the Japan Ground Water Technology Association, September 6. INVITED, PRESENTED. *NOTEWORTHY – This was a 3-hour seminar, translated real-time into Japanese, to a large group of scientists and engineers*.

Panday, S., and Langevin, C.D. 2023. *Capabilities and functionality of MODFLOW-USG, USGTRANSPORT, and MODFLOW 6*. Online presentation to Groundwater Resources Association (GRA) of California, GRA 101 Week, July 17-21. INVITED.

Langevin, C.D. 2023. *FloPy, a Python package for creating, running, and post-processing MODFLOW-based models*. Online presentation to the Pacific Northwest (PNW) Groundwater Modeling Group, April 20. INVITED, PRESENTED.

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Langevin, C.D., 2021. *Advances in modeling groundwater flow and transport with MODFLOW*. Online presentation to the U.S. Environmental Protection Agency Contaminated Site Clean-Up Information (CLU-IN) Webinar, February 3. INVITED, PRESENTED. https://www.clu-in.org/conf/tio/ModFlow_020321/

Langevin, C.D., 2019. *USGS groundwater modeling software development*. Online presentation to the federal Advisory Committee on Water Information (ACWI), Subcommittee on Ground Water, November 18. INVITED, PRESENTED.

Langevin, C.D., Hughes, J.D., Provost, A.P., Sorab, Panday, Niswonger, R.G., Paulinski, S., Verkaik, Jarno, Russcher, Martijn, Morway, E., Bedekar, Vivek, Larsen, J., Black, A., and Witterick, W., 2019. *Ongoing MODFLOW development by the USGS and external collaborators*: Delft Software Days, Delft, Netherlands, November 4-15. INVITED, KEYNOTE.

Langevin, C.D., Panday, S., Provost, A.M., and Mancewicz, L. 2019. *New tools and approaches for simulating the effects of sea level rise on coastal aquifers*. Geological Society of America, National Meeting, Phoenix, AZ, September 22-25. INVITED, PRESENTED.

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Langevin, C.D., and Hughes, J.D., 2019. *The MODFLOW 6 modular hydrologic model*. Presentation to the Deltares technical staff, Utrecht, The Netherlands, April 1. INVITED, PRESENTED.

Langevin, C.D., 2018. *MODFLOW 6 as a framework for integrated hydrologic modeling*. Internal USGS Planning Meeting, Austin, TX, November 24-29. INVITED, PRESENTED.

Langevin, C.D., Provost, A.M, Hughes, J.D., and Panday, S. 2018. *Variable-density flow and transport in MODFLOW 6*. 2018 Salt Water Intrusion Meeting, Gdansk, Poland, June 18-22. INVITED, PRESENTED, KEYNOTE.

Langevin, C.D. 2018. *Lessons learned from over 30 years of MODFLOW software development*. EPANET Summit, Reston, VA, April 3. INVITED, PRESENTED. *Asked by the EPA to present on USGS MODFLOW development at a public meeting to discuss the future of the EPANET software for modeling water distribution systems.*

Langevin, C.D. 2017. *New groundwater modeling tools*: MODFLOW 6 and More. National Groundwater Association, Groundwater Summit, Nashville, TN, December 4-7. INVITED, KEYNOTE, PRESENTED.

Langevin, C.D., 2017. *Overview of the MODFLOW Model*. Joint meeting between the USGS and the National Weather Service, National Water Center, Tuscaloosa, AL, November 30. PRESENTED, INVITED.

Langevin, C.D., 2017. *New groundwater modeling tools*: MODFLOW 6 and More. USGS Office of Groundwater Webinar, August 16. INVITED, PRESENTED.

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Langevin, C.D. 2017. *MODFLOW 6 status*. USGS Regional Groundwater Availability Project Workshop, San Diego, CA, March 21-22. INVITED, PRESENTED.

Langevin, C.D., Hughes, J.D., Banta, E.R., Niswonger, R.G., and Panday, Sorab, 2017. *MODFLOW 6: An object-oriented version of the U.S. Geological Survey's MODFLOW model*.

MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24. INVITED, KEYNOTE, PRESENTED.

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., and Hughes, J.D., 2017. *Fundamentals and application of MODFLOW-USG, an unstructured grid version of MODFLOW*. Workshop Trinity College, Dublin, Ireland, February 28. INVITED.

Langevin, C.D., 2016. *Status and future directions of groundwater modeling in the USGS*, 2016 USGS National Groundwater Workshop, August 29-September 2, Reno, Nevada. INVITED, KEYNOTE, PRESENTED.

Langevin, C.D., 2016. *The role of numerical models in understanding and managing coastal aquifers*. Michigan Technological University, Houghton, MI, October 10. INVITED, PRESENTED.

Hughes, J.D., Langevin, C.D., Niswonger, R.G., Panday Sorab, Banta, E.R., Provost, A.M., 2016. *The new MODFLOW MODFLOW 6*: Groundwater Resources of California Annual Meeting, Concord, California, September 29. INVITED.

Langevin, C.D., Cunningham, W., Hughes, J.D., Provost, A.M., Dawson, C., Niswonger, R., Clark, B., Watt, M., White, J., and Banta, E., 2016. *A national framework for groundwater modeling in the USGS*. USGS National Groundwater Workshop, Reno, NV, August 28-September 2. INVITED, KEYNOTE, PRESENTED.

Langevin, C.D., Hughes, J.D., Panday, S., Provost, A., and Niswonger, R. 2016. *Past, present, and future directions for saltwater intrusion using SEAWAT*. SWIM-APCAMM 2016. 24th Salt Water Intrusion Meeting Proceedings Book, Cairns, Queensland, Australia, July 4-8. INVITED, KEYNOTE, PRESENTED.

Langevin, C.D., 2016. *Navigating the new open data requirements: A plan for groundwater models*, USGS Office of Groundwater Webinar, USGS Headquarters, Reston, VA, May 12. INVITED, PRESENTED.

Langevin, C.D., 2015. *The next generation of MODFLOW, Workshop 2 for "Network on bridging the state of practice with the state of science of groundwater modeling,"* Arhus, Denmark, September 14. INVITED, PRESENTED.

Langevin, C.D., 2015. *A new MODFLOW framework for simulating multiple hydrologic processes*, USGS Office of Groundwater Webinar, USGS Headquarters, Reston, VA, August 13. INVITED, PRESENTED.

Langevin, C.D. 2015. *Modern software development, Workshop 1 for "Network on bridging the state of practice with the state of science of groundwater modeling,"* Colorado School of Mines, Golden, CO, May 28. INVITED, PRESENTED.

Panday, Sorab, Langevin, C.D., Hughes, J.D., Niswonger, R.G., and Banta, E.R., 2015. *The LNF model for a new object-oriented version of MODFLOW*. MODFLOW and More 2015: Modeling a Complex World, Golden, Colorado, May 31-June 3. INVITED, KEYNOTE.

Langevin, C.D., Hughes, J.D., Panday, Sorab, Banta, E.R., and Niswonger, R.G., 2015. *A new object-oriented framework for the U.S. Geological Survey's MODFLOW model*. MODFLOW and More 2015: Modeling a Complex World, Golden, Colorado, May 31-June 3. INVITED, KEYNOTE, PRESENTED.

Langevin, C.D. 2015. *USGS groundwater modeling efforts*, Presentation to Egyptian delegates visiting USGS Headquarters in Reston, VA, February 26. INVITED, PRESENTED.

Langevin, C.D. 2014. *The MODFLOW family of programs*, Department of Energy, Nevada Test Site, Las Vegas, NV, May 22. INVITED, PRESENTED.

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., Hughes, J.D., 2013. *MODFLOW-USG and more*. MODFLOW and More 2013: Translating Science Into Practice, Golden, Colorado, June 2-5. INVITED.

Langevin, C.D., Panday, S., Hughes, J.D., Niswonger, R.G., Ibaraki, M., 2013. *Considerations for grid design with MODFLOW-USG*. MODFLOW and More 2013: Translating Science Into Practice, Golden, Colorado, June 2-5. INVITED, PRESENTED.

Langevin, C.D., Panday, S., Niswonger, R.G., Hughes, J.D., Ibaraki, M., 2011. *Local grid refinement with an unstructured grid version of MODFLOW*. In MODFLOW and More 2011: Integrated Hydrologic Modeling – Conference Proceedings, June 5 – 8, International Groundwater Modeling Center, Colorado School of Mines. INVITED, PRESENTED.

Panday, S., Niswonger, R.G., Langevin, C.D., Ibaraki, M., 2011. *An un-structured grid version of MODFLOW*. In MODFLOW and More 2011: Integrated Hydrologic Modeling – Conference Proceedings, June 5 – 8, International Groundwater Modeling Center, Colorado School of Mines. INVITED.

Langevin, C.D., Zygnerski, M.R., White, J.T., and Hughes, J.D. 2010. *Effect of sea-level rise on future coastal groundwater resources in southern Florida, USA*. SWIM21 – 21st Salt Water Intrusion Meeting Proceedings Book, Ponta Delgada, Azores, Portugal, June 21-26. INVITED, PRESENTED.

Langevin, C.D. 2009. *The groundwater modeling process*. Florida International University seminar series, Miami, FL, October 20. INVITED, PRESENTED.

Langevin, C.D., 2008. *An integrated model of surface and groundwater flow for evaluating the effects of competing water demands in Miami-Dade County*, South Florida Water Management District, West Palm Beach, Florida, November 21. INVITED, PRESENTED.

Langevin, C.D., 2008. *An integrated model of surface and groundwater flow for evaluating the effects of competing water demands in Miami-Dade County*, Miami-Dade County Water and Sewer Department, Miami, Florida, October 6. INVITED, PRESENTED.

Langevin, C.D. 2007. *Revisiting the "ASR Bubble in the Floridan Aquifer*." University of South Florida, October 19. Tampa, Florida. INVITED, PRESENTED.

Langevin, C.D., 2007. *Overview of South Florida: History and concerns*. Department of Interior Headquarters, Washington, D.C., October 10. INVITED, PRESENTED.

Langevin, C.D., 2007. *Overview of South Florida: History and concerns*. USGS National Headquarters, October 10, Reston, Virginia. INVITED, PRESENTED.

Langevin, C.D. 2007. *The confounding effects of fluid density variations on coastal groundwater flow*, University of Alabama seminar series. Tuscaloosa, AL, February 7. INVITED, PRESENTED.

Thorne, D., Langevin, C.D., and Sukop, M.C., 2006. *MODFLOW/MT3DMS-based simulation of variable-density groundwater flow with simultaneous heat and solute transport*: Presented at the 2006 Conference on Computational Methods in Water Resources XVI, Copenhagen, Denmark, June 19-22. INVITED.

Langevin, C.D., Swain, E.D., and Wolfert, M., 2003. *Flows, Stages, and Salinities: How Accurate is the SICS Integrated Surface-Water/Ground-Water Flow and Transport Model?* Presented to the Steering Committee of the U.S. Geological Survey's Place-Based Studies Program, Miami, Florida, August 27. INVITED, PRESENTED.

Langevin, C.D., Swain, E.D., and Wolfert, M.A., 2003. *Flows, stages, and salinities: How accurate is the SICS integrated surface-water/ground-water flow and transport model?* Presented at the Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem, Westin Innisbrook, Palm Harbor, Florida, April 13-18. INVITED, PRESENTED.

Swain, E.D., Langevin, C.D., and Wolfert, M.A., 2003. *Developing a computational technique for modeling flow and transport in a density dependent coastal wetland/aquifer system*. Presented at the Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem, Westin Innisbrook, Palm Harbor, Florida, April 13-18. INVITED.

Schaffranek, R.W., Jenter, H.L., A.L. Riscassi, Langevin, C.D., Swain, E.D., and Wolfert, M.A., 2003. *Applications of a Numerical Model for Simulation of Flow and Transport in Connected Freshwater-Wetland and Coastal-Marine Ecosystems of the Southern Everglades*. Presented at the Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem, Westin Innisbrook, Palm Harbor, Florida, April 13-18. INVITED.

Langevin, C.D., 2001. *Numerical simulation of submarine groundwater discharge to a marine estuary: An example from southern Florida, USA*. 1st International Conference on Saltwater Intrusion and Coastal Aquifers: Monitoring, Modeling, and Management SWICA-M3, April 22-25, Essaouira, Morocco. PRESENTED.

Langevin, C.D., 2000. *Ground-water discharge to Biscayne Bay*. U.S. Geological Survey Program on the South Florida Ecosystem: 2000 Proceedings, U.S. Geological Survey Open File Report 00449, p. 29. INVITED, PRESENTED.

Langevin, C.D., 2000. *Ground-water discharge to Biscayne Bay*. Greater Everglades Ecosystem Restoration (G.E.E.R.) Science Conference, December 11-15, Naples, Florida, INVITED, PRESENTED.

Langevin, C.D., and Guo, W., 1999. *Improvements to SEAWAT, a variable-density modeling code*. American Geophysical Union Fall meeting Abstracts Volume, December 13-17, San Francisco, CA. PRESENTED,

Langevin, C.D., 1999. *Ground-water flows to Biscayne Bay*. In U.S. Geological Survey Program on the South Florida Ecosystem. Proceedings of South Florida Restoration Science Forum, May 17-19, Boca Raton, Florida. U.S. Geological Survey Open File Report 99-181. p58-59. INVITED, PRESENTED.

Langevin, C.D., Vacher, H.L., and Stewart, M.T., 1994. *Numerical model of porewater fluxes in a hypothetical mud island*. Geological Society of America Abstracts with Programs, Southeastern Section Meeting, April 7-8, Blacksburg, VA. PRESENTED.

CONTRIBUTED PRESENTATIONS

Kollet, S., Condon, L., Houben, G., Gurmessa, S., Langevin, C.D., MacDonald, A., and Zheng, C. 2024. *Groundwater modeling in the Global Energy and Water Exchanges (GEWEX) project: Closing the terrestrial water cycle from the regional to the global scale*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Vazquez-Gasty, S., Panday, S., Roy, T., Russcher, M., Provost, A.M., Langevin, C.D., and Hughes, J.D. 2024. *Exploring variably saturated flow formulations for MODFLOW*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Reno, M., Langevin, C.D., Hughes, J.D., Paulinski, S., Russcher, M., and Bonelli, W.P. 2024. Integrated support for NetCDF in MODFLOW. MODFLOW and More Conference, Princeton, NJ, June 2-5, 2024.

Russcher, M.J., Hughes, J.D., Langevin, C.D., Provost, A.M., Verkaik, J., Bonelli, W.P., Larsen, J., Morway, E.D., and Reno, M. 2024. *Parallel computing with MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Morway, E.D., Provost, A.M., Langevin, C.D., Hughes, J.D., Russcher, M.J., Chen, C.Y., Bonelli, W., Reno, M., and Lin, Y.F. 2024. *Heat transport modeling with MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Provost, A.M., Bardot, K., Langevin, C.D., and McCallum, J. 2024. *Improving the accuracy of MODFLOW 6 flow simulations by ensuring adequate cell connectivity and accounting for flow refraction*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Chen, C.Y., Morway, E.D., Provost, A.M., Langevin, C.D., Hughes, J.D., and Lin, Y.F. 2024. *Demonstration of the new MODFLOW 6 heat-transport model in simulations of 1D vertical heat propagation through the unsaturated and saturated zones driven by transient surface temperature and precipitation*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Bonelli, W.P., Provost, A.M., Langevin, C.D., Hughes, J.D., and Russcher, M.J. 2024. *A fully integrated particle tracking (PRT) model for MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Bakker, M., Panday, S., Falta, R., Lemon, A., Langevin, C.D., Hughes, J.D., and Patterson, C.. 2024. *Towards a reduced-order formulation for seawater intrusion in MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 2-5.

Chen, C.Y., Morway, E.D., Provost, A.M., Langevin, C.D., Hughes, J.D., and Lin, Y.F. 2024. *Testing MODFLOW 6 GWE model on 1D vertical Stallman problem and 2D multi-Scale Tothian groundwater system for heat transport through unsaturated zone*. Online presentation to the Illinois State Water Survey (ISWS) Groundwater Section, January 25.

Morway, E.D., Provost, A.M., Langevin, C.D., Hughes, J.D., Russcher, M.J., Chen, C.Y., and Lin, Y.F. 2023. *A new Groundwater Energy (GWE) transport model for the MODFLOW 6 hydrologic simulator*. American Geophysical Union Fall Meeting, San Francisco, CA, December 11-15.

Hofer, J., Hughes, J.D., Langevin, C.D., and Russcher, M.J. 2022. *Exploring the PETSc Toolkit for solving hydrologic models with MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 5-8.

Russcher, M.J., Hughes, J.D., Langevin, C.D., Provost, A.M., and Verkaik, J. 2022. *Generalized model coupling in MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 5-8.

Provost, A.M., and Langevin, C.D. 2022. *The role and benefits of the XT3D capability in groundwater flow and transport modeling using MODFLOW 6*. MODFLOW and More Conference, Princeton, NJ, June 5-8.

Larsen, J.D., Langevin, C.D., Hughes, J.D., Niswonger, R.G. 2022. *Simulating irrigated agriculture in MODFLOW 6 through the MODFLOW Application Programming Interface*. MODFLOW and More Conference, Princeton, NJ, June 5-8.

Hughes, J.D., Russcher, M., Langevin, C.D., McDonald, R.M., and Hofer, J. 2022. *MODFLOW application programming interface for coupling MODFLOW 6 to other model components*. MODFLOW and More Conference, Princeton, NJ, June 5-8.

Mancewicz, L., Langevin, C.D., Mayer, A., and Gulley, J., 2019. *Methods for representing lake formation in an island setting with sea level rise: a comparison of alternative approaches*. Geological Society of America Annual Meeting, Phoenix, AZ, September 22-25.

Verkaik, J., Hughes, J.D., Langevin, C.S., and Russcher, M., 2019. *Parallel groundwater modeling using MODFLOW 6*. MODFLOW and More, Golden, CO, June 2-5.

Bedekar, V., Scantlebury, L., Panday, S., and Langevin, C.D. 2019. *Axisymmetric modeling with unstructured grids of MODFLOW*. MODFLOW and More, Golden, CO, June 2-5.

Provost, A.M., and Langevin, C.D. 2019. *Generalization of Pollock's particle-tracking method for unstructured MODFLOW 6 grids*. MODFLOW and More, Golden, CO, June 2-5.

Verkaik, Jarno, Hughes, J.D., Langevin, C.D., Russcher, Martijn, 2019. *Parallel Groundwater Modeling using MODFLOW 6*: MODFLOW and More 2019: Groundwater Modeling and Beyond, Golden, Colorado, June 2-5.

Provost, A.M., and Langevin, C.D., 2018. *A semi-analytical particle-tracking method for groundwater flows simulated on unstructured control-volume finite-difference grids*. 2018 AGU Fall Meeting, December 10-14, Washington, D.C.

Langevin, C.D., Hughes, J.D., Provost, A.M., Niswonger, R.G., and Panday, S., 2018. *The MODFLOW 6 hydrologic model*. National Groundwater Association, Groundwater Week Summit, Las Vegas, NV, December 3-6. PRESENTED.

Verkaik, Jarno, Hughes, J.D., and Langevin, C.D., 2018, *Parallel Groundwater Modeling using MODFLOW 6*. 2018 AGU Fall Meeting, December 10-14, Washington, D.C.

Hughes, J.D., and Langevin, C.D., 2018. *Aquifer compaction – a threat to coastal aquifers*. Proceedings of the 25th Salt Water Intrusion Meeting, Gdan´sk, Poland, June 17-22.

Hughes, J.D. and Langevin, C.D., 2017. *Hyper-Resolution Groundwater Modeling using MODFLOW 6*. 2017 AGU Fall Meeting, December 11-15, New Orleans, Louisiana.

Provost, A.M., Langevin, C.D., and Hughes, J.D., 2017. *The "XT3D" option for simulating fully three-dimensional anisotropy on regular and irregular MODFLOW 6 grids*. MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24.

Hughes, J.D., Langevin, C.D., Panday, Sorab, Banta, E.R., Provost, A.M., and Niswonger, R.G., 2017. *Use of the advanced packages and demand-based boundary flows in the MODFLOW 6 Groundwater Flow Model*. MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24.

Hughes, J.D., Langevin, C.D., Banta, E.R., Provost, A.M., Niswonger, R.G., and Panday, Sorab, 2017. *Use of MODFLOW 6 to Simulate Demand-Based Boundary Flows*. 2017 Groundwater Resources Association of California – Tools for developing SGMA Groundwater Sustainability Plans, Modesto, California, May 3-May 4.

Hughes, J.D., Bakker, M., Schaars, F., and Langevin, C.D. 2016. *Development of an unstructured sharp-interface model for MODFLOW*. SWIM-APCAMM 2016. 24th Salt Water Intrusion Meeting Proceedings Book, Cairns, Queensland, Australia, July 4-8.

Masterson, J.P., Walter, J.P., and Langevin, C.D., 2015. *Effects of sea-level rise on coastal aquifer systems – potential economic and ecological impacts*, Eastern U.S., Geological Society of America, Baltimore, MD, November 1-4.

Langevin, C.D., Hughes, J.D., Panday, Sorab, Banta, E.R., and Niswonger, R.G., 2015. *An object-oriented framework for consolidating MODFLOW functionality*: AQUA 2015 – 42nd IAH Congress – Hydrogeology: Back to the Future, Rome, Italy, September 13-18.

Hughes, J.D., Bakker, Mark, White, J.T., Langevin, C.D., Post, Vincent, Fienen, M.N., and Starn, J.J., 2015. *FloPy Version 3 – a Python package for MODFLOW-based models*: MODFLOW and More 2015: Modeling a Complex World, Golden, Colorado, May 31-June 3.

Hughes, J.D. and Langevin, C.D., 2015. *Simulating multi-aquifer wells using a new object-oriented version of MODFLOW*: MODFLOW and More 2015: Modeling a Complex World, Golden, Colorado, May 31-June 3.

Professional and Scientific Service

SCIENTIFIC REVIEW PANELS

Technical Advisor – Aquifer Storage and Recovery Project Development Team of the Comprehensive Everglades Restoration Plan, 2000-2005.

Expert consultant for the Bureau of Indian Affairs – SEAWAT modeling study, Lummi Indian Reservation, Washington State, November, 2002.

International expert consultant – United Nations Food and Agricultural Organization, Rabat, Morocco. Met in person with government ministry hydrologists and university professor from July 22-August 4, 2002. Served as an international expert on saltwater intrusion for the Moroccan government applying SEAWAT to examine water supply issues for two coastal aquifers in Morocco.

Participant – an international committee to "bridge the state of practice with the state of science of groundwater modeling." This projected was funded by the Danish International Network Programme for the 2015 calendar year. Attended two meetings (one in Golden CO, and one at Arhus University, Denmark) and prepared a written report with recommendations for improving the way research is translated into practice.

Team member and coauthor – Office of Groundwater *Technical Memorandum 2015.02 — Policy and guidelines for archival of surface-water, groundwater, and water-quality model applications*, December 5, 2014.

Team leader and lead author – Office of Groundwater *Technical Memorandum 2016.02— Policy for documenting, archiving, and public release of numerical groundwater flow and transport models*, September 30, 2016.

Team member – groundwater model archive policy. This resulted in all new USGS groundwater models being publicly available on the web. As of October 29, 2024, a total of 212 groundwater models have been released based on this policy. The list of models can be accessed by searching "usgsgroundwatermodels" on data.gov.

Steering group member – Groundwater Network of the Global Energy and Water Exchanges (GEWEX) program. January 2024 through present. Website: https://www.wcrp-climate.org/gewex

EDITORIAL

Associate Editor, Groundwater Journal. 2006–Present

CONFERENCES

Scientific Committee Member – 2025 Salt Water Intrusion Meeting, Barcelona, Spain, June 9-13, 2025.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More Conference, Princeton, NJ, June 2-5, 2024.

Scientific Committee Member – MODFLOW and More Conference, Princeton, NJ, June 5-8, 2022.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More, Golden, CO, June 2-5, 2019.

Scientific Committee Member and Session Chair for multiple sessions – 2018 Salt Water Intrusion Meeting, Gdansk, Poland, June 18-22, 2018.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24, 2017.

Session Chair – Groundwater Modeling to Support Water Management Decisions, USGS National Groundwater Workshop, August 29 – September 2, 2016, Reno, NV.

Scientific Committee Member and Session Chair for multiple sessions – 24th Salt Water Intrusion Meeting, Cairns, Queensland, Australia, July 4-8, 2016.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More Conference, May 31-June 3, 2015, Golden, CO.

Scientific Committee Member and Session Chair for multiple sessions – 2014 Salt Water Intrusion Meeting, Husum, Germany, June 16-20, 2014

Session Chair H062 – Open-Source Programming, Scripting, and Tools for the Hydrological Sciences, American Geophysical Union 2013 Fall Meeting, December 9-13, 2013, San Francisco, CA.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More 2013: Translating Science Into Practice, Golden, CO, June 2-5, 2013.

Session Co-chair, H51L – Measurement, Modeling, and Management of Coastal Aquifers, American Geophysical Union 2012 Fall Meeting, December 3-7, 2012, San Francisco, CA.

Scientific Committee – 2012 Salt Water Intrusion Meeting, Buzios, Brazil, June 17-22, 2012.

Scientific Committee Member and Session Chair for multiple sessions – MODFLOW and More Conference, Golden, Colorado, June 5-8, 2011.

Session Chair – MODFLOW: An Evolving Standard, 2011 Ground Water Summit and 2011 Ground Water Protection Council Spring Meeting, May 2-4, 2011, Baltimore, MD.

Co-chair – 21st Salt Water Intrusion Meeting, Azores, Portugal, June 21-26, 2010.

Chair and Lead conference organizer – 20th Salt Water Intrusion Meeting (SWIM), Naples, Florida, June 23-27, 2008. http://www.swim-site.nl/pdf/swim20.html

Co-chair – IAHS/IAPSO Symposium, A new focus on groundwater-seawater interactions, IUGG2007, the XXIV General Assembly of the international Union of Geodesy and Geophysics, Perugia, Italy, July 2-13, 2007.

Panel Member on saltwater intrusion discussion – 5th Washington Hydrogeologic Symposium, Tacoma, WA, April 12-14, 2005.

JOURNAL REFEREE

Frequent reviewer of journal articles for a wide variety of journals, mostly within the hydrology subject.

Academic Service

COURSES AND SEMINARS – TECHNICAL TRAININGS

Course coordinator and lead instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), San Diego, CA, January 4-8, 2025.

Instructor – Advanced Modeling of Groundwater Flow (GW3099), Boise, ID, September 16-20, 2024.

Lead instructor – MODFLOW Workshop, Offered as part of the Hydrogeology Field Camp, ESci4971W/5971, Earth and Environmental Sciences, University of Minnesota, August 13, 2024.

Course coordinator and lead instructor – MODFLOW 6 and FloPy: Take Your Modeling Skills to the Next Level, workshop offered as part of the 2024 MODFLOW and More Conference, Princeton, NJ, May 31-June 1, 2024.

Course coordinator and lead instructor – Python for Hydrogeology, workshop offered as part of the 14th Washington Hydrogeology Symposium, Auburn, WA, April 25, 2024.

Instructor – Python Programming Language and Groundwater Modeling (GW1774), Albuquerque, NM, January 29-February 2, 2024.

Instructor – Parallel MODFLOW, Delft, The Netherlands, November 27-December 1, 2023.

Course coordinator and lead instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), Memphis, TN, September 11-15, 2023

Instructor – Running Parallel MODFLOW on Denali, Lakewood, CO, July 13-14, 2023.

Course coordinator and lead instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), San Diego, CA, January 9-13, 2023

Instructor – Take your groundwater modeling skills to the next level with FloPy and Python, MODFLOW and More 2019: Modeling for Sustainability and Adaptation, Golden, Colorado, June 2-5, 2019.

Course coordinator and lead instructor – Introduction to groundwater flow modeling with MODFLOW 6, MODFLOW and More 2019: Modeling for Sustainability and Adaptation, Golden, Colorado, June 2-5, 2019.

Course coordinator and lead instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), San Diego, CA, May 20-24, 2019

Instructor – FloPy and MODFLOW 6 workshop, Delft, the Netherlands, March 25-29, 2019

Instructor – Advanced Modeling of Groundwater Flow (GW3099), Lincoln, NE, October 22-26, 2018.

Course coordinator and lead instructor – Groundwater flow and solute transport modeling, course requested by the U.S. Navy, Naval Facilities Engineering Systems Command (NAVFAC), Port Hueneme, CA, August 2018.

MODFLOW 6 Learning session – Workshop offered at the 2018 Chlorinated Conference, Palm Springs, CA, April 8-12, 2018.

Modeling saltwater intrusion – SWIM, Gdansk, Poland, June 12-16, 2018.

Instructor – Python Programming Language and Groundwater Modeling (GW1774), USGS National Training Center, Lakewood, CO, February 2018

Instructor – FloPy: Python Package for Creating, Running, and Post-Processing MODFLOW-based Models, National Groundwater Association, Groundwater Week, Nashville, TN, December 3-8, 2017.

Instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), Portland, OR, September 11-15, 2017.

Instructor – Take your groundwater modeling skills to the next level with FloPy and Python, MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24, 2017.

Course coordinator and lead instructor – Introduction to groundwater flow modeling with MODFLOW 6, MODFLOW and More 2017: Modeling for Sustainability and Adaptation, Golden, Colorado, May 21-24, 2017.

Instructor – MODFLOW 6: A hydrologic simulation framework for solving structured and unstructured groundwater flow problems, 2016 USGS National Groundwater Workshop, Reno, NV, August 29-September 2, 2016.

Instructor – Making sense of the new Open Data Policy Metadata and USGS Data Releases for the masses, 2016 USGS National Groundwater Workshop, Reno, NV, August 29-September 2, 2016.

Course coordinator and lead instructor – SEAWAT/SWI training course, Groundwater in coastal zones: modeling and measurement, offered at the 24th Salt Water Intrusion Meeting, Cairns, Queensland, Australia, June 28 – July 2, 2016.

Instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), Reston, VA, May 16 20, 2016.

Course coordinator and instructor – Python Programming Language and Groundwater Modeling (GW1774), San Diego, California, August 3-7, 2015.

Coordinator and instructor – Python Programming Language and Groundwater Modeling, Honolulu, Hawaii, April 30-May 1, 2015.

Instructor – Python Programming Language and Groundwater Modeling (GW1774), Portland, Oregon, February 2015.

Instructor – Advanced Modeling of Groundwater Flow (GW3099), led sessions on (1) Modeling Needs, (2) MODFLOW-USG, (3) GitHub, and (4) an overview of MODFLOW 6, Lakewood, Colorado, November 2014.

Instructor – Five-day training class titled "Introduction to Groundwater Modeling Using MODFLOW (GW2096)", Reston, VA, June 2-6, 2014. Co-instructors: Dave Pollock, Joseph Hughes, and Tom Reilly.

Course coordinator and instructor – Groundwater Modeling and Python (GW1774), Tucson, Arizona, May 5-9, 2014.

Instructor – Using Python to improve GW modeling effectiveness, Python Basics, USGS National Groundwater Workshop, Denver, CO. August 9, 2012.

Lead instructor – Workshop on recent MODFLOW developments, offered at the 2012 USGS National Groundwater Workshop, Denver, CO, August 6, 2012.

Instructor – Introduction to Groundwater Modeling Using MODFLOW (GW2096), Tucson, AZ, April 30May 4, 2012.

Instructor – Advanced Modeling of Groundwater Flow (GW3099), USGS National Training Center, Denver, CO, November 15-19, 2010.

Lead instructor – SEAWAT training course, Introduction to Three-Dimensional Variable-Density Groundwater Modeling Using SEAWAT, offered at the 21st Salt Water Intrusion Meeting, June 21-26, 2010, Ponta Delgada, Azores, Portugal.

Instructor – Half-day SEAWAT workshop at the U.S. Geological Survey, National Ground Water Meeting, August 2008.

Lead Instructor – 1-week USGS NTC Course ID1392, Introduction to Three-Dimensional VariableDensity Groundwater Modeling Using SEAWAT, February 26-March 2, 2007, Fort Lauderdale, FL.

Instructor – USGS NTC Course GW2099, Advanced Modeling of Ground Water, October 30 November 3, 2006, San Diego, CA.

Instructor – Saltwater intrusion modeling workshop, SWIM-SWICA Conference, Cagliari, Italy, September 24, 2006.

Field Trip Guide – Everglades National Park, May 2005. Presented the geology and hydrogeology of south Florida to undergraduate students from the University of South Florida.

Instructor – Half-day SEAWAT workshop at the 5th Washington Hydrogeologic Symposium, April 12-14, 2005, Tacoma, Washington.

Lead Instructor – 1-week USGS NTC Course ID1392, Introduction to Three-Dimensional VariableDensity Groundwater Modeling Using SEAWAT-2000, February 14-18, 2005, Fort Lauderdale Beach, FL.

Instructor – Half-day SEAWAT workshop at the U.S. Geological Survey, National Ground Water Meeting, June 24, 2004.

Field Trip Guide – Everglades National Park, May 2004. Presented the geology and hydrogeology of south Florida to undergraduate students from the University of South Florida.

Lead Instructor – 1-week SEAWAT Training Course, August 11-15, 2003, South Florida Water Management District, West Palm Beach, FL.

Instructor – SEAWAT training session, U.S. Geological Survey, Water Resources Division, Massachusetts District Office, Northborough, MA, February 21-23, 2001.

Instructor – Training session on Groundwater Vistas, U.S. Geological Survey, Water Resources Division, Texas District Office, Austin, TX. September 7-8, 2000.

Instructor – half-day SEAWAT workshop at the University of South Florida, August 25, 2000, Tampa, Florida.

Vivek Bedekar, Ph.D., P.E.

Associate, Engineer

Dr. Bedekar is a water resources and environmental consultant with experience working on a variety of modeling and software development projects. His experience includes the development of numerous local and regional models, surface-water/groundwater interaction models, flow-and-transport models, and variable density models. He has developed numerous modeling codes and is the lead author of MT3D-USGS. Dr. Bedekar publishes research papers, provides peer reviews, and instructs at modeling and software training courses.

REPRESENTATIVE EXPERIENCE

S.S. Papadopulos & Associates, Inc. *– Rockville, Maryland*

Airborne Electromagnetic (AEM) Survey Data Application, Department of Water Resources (DWR), California: In collaboration with Woodard & Curran, the project involves the development of methods, utility tools, documentation, and case studies with application of AEM data. The first phase of the project is currently underway.

Delayed-Subsidence in Integrated Water Flow Model (IWFM), California Department of Water Resources (DWR): Developed numerical code within DWR's IWFM flow simulator for DWR's Bay Delta Office. The code development accounted for delayed effect of pumping on storage change within clay interbeds that results in land subsidence. A technical memorandum provided to the DWR summarized mathematical formulation, numerical implementation, and examples.

Goleta Groundwater Basin, California: Assisted senior staff in support of a litigation matter. Reviewed models developed using several alternate groundwater and land surface models, including MODFLOW-SURFACT, Parflow-CLM, and DPWM. Supported evaluations of model development, recalibration, assessment of appropriate boundary conditions, and review of hydrogeology to develop a thorough understanding of the hydrogeologic system. Also performed water budget assessment, particle tracking, and solute transport simulations.

Monterey Peninsula Water Supply Project, California Marine Sanctuary Foundation: Teamed with Weiss Associates for a project that involved the calculation of freshwater captured by slant wells proposed for a desalination plant. The desalination plant would incur penalties for any freshwater captured by the withdrawal wells. An existing flow model was utilized, and boundary conditions and parameters were modified to perform sensitivity analysis and meet project objectives. In place of the original methodology of particle tracking used by the previous version of the model to assess flow paths, MT3D was used to identify the source of water and to quantify the amount of saltwater captured by the pumping wells.

South Fork Eel River Model, State Water Resources Control Board (SWRCB), California: Lead groundwater modeler for developing two integrated groundwater-surface water models for SWRCB in collaboration with Paradigm Environmental. LSPC was integrated with MODFLOW-USG to simulate the effects of pumping on instream flow. The calibrated model provided the basis for instream temperature modeling.

Shasta River Model, State Water Resources Control Board (SWRCB), California: Lead groundwater modeler for developing two integrated groundwater-surface water models for SWRCB in collaboration with Paradigm Environmental. LSPC was integrated with MODFLOW-NWT to simulate the effects of pumping on

YEARS OF EXPERIENCE

25+

EDUCATION

- **PhD**, Civil Engineering, Auburn University, 2019
- **MS**, Environmental Engineering, Indian Institute of Technology, 2001
- **BS**, Civil Engineering, University of Pune, India, 1998

REGISTRATION

- Professional Civil Engineer, Washington District of Columbia No. PE904565

EXAMPLE AREAS OF EXPERTISE

- Flow and Transport Modeling
- Numerical Software Development
- Surface Water-Groundwater Modeling
- MODFLOW, MT3D, and IWFM Development

AWARDS AND HONORS

- DAAD scholarship for master's project, Institute for Hydraulics and Water Resource Management, RWTH-Aachen, Germany: 2000–2001
- Gold Medal awarded for best academic performance in MS, Department of Civil Engineering, Indian Institute of Technology (IIT), Madras, India: 1999–2001

APPOINTMENTS

- 2023 – 2024: Co-convener, California Water and Environmental Modeling Forum (CWEMF), California
- 2023: Chair, GRACast subcommittee, Groundwater Resources Association (GRA), California

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instream flow. The model provides a scientific basis for making a variety of groundwater management decisions.

Sacramento Valley Model (SVSim), California Department of Water Resources (DWR): The Sacramento Valley model (SVSim) was calibrated in a stepwise systematic manner, by first targeting water budgets, then calibrating land use parameters, and finally calibrating aquifer parameters. This holistic approach helped obtain a reasonably calibrated model for estimating reliable water budgets, calibrating the model to streamflow and groundwater heads. Sensitivity analysis was also performed. Cluster analysis was performed to assess groundwater head trends and the identified trends called type-hydrographs were utilized as additional calibration targets. Aquifer parameters were developed utilizing sediment texture data with the use of the Texture2Par utility. Valley-wide water budgets were calculated using time-series analysis and reviewing CalSim reports. Issues in the IWFM code were identified and feedback on the IWFM code with respect to convergence and robustness was provided to DWR. Code changes in IWFM were made to accommodate variable wetted perimeter and dynamic connection to GW over wide stream reaches. Model comparisons with Femflow3D were performed. The model was applied to estimate stream depletion caused by pumping. Two technical memorandums were written at the conclusion of this project.

Fine-grid Central Valley Model (C2VSim-FG), California Department of Water Resources: Model calibration of the central valley model, C2VSim-FG, was performed using parameter estimation software, PEST. Groundwater head data was synthesized using cluster analysis to identify short- and long-term temporal trends from groundwater level data available for more than ten-thousand wells and the developed type-hydrographs were used as additional calibration targets. Texture2Par utility was used for developing aquifer parameters based on sediment-based texture data. A technical memorandum was produced at the conclusion of the project.

Texture2Par Utility Development: An open-source utility, Texture2Par, was developed to calculate aquifer parameters based on sediment-based texture data. Power-law averaging is used to compute bulk aquifer parameters based on percent coarse information available from well log texture data and relevant aquifer parameter model input files for MODFLOW or IWFM are written by the utility. Texture2Par incorporates capability to implement depth-decay of hydraulic conductivity. The standalone utility can also be incorporated seamlessly within the parameter estimation software, PEST. Sediment-based aquifer parameters can be varied and interpolated between pilot points.

Kings River Conservation District Model Conversion, California: Converted an existing surface-water/groundwater interaction model (originally developed using IGSM) to California Department of Water Resources' IWFM modeling code. The model was extended in time with new data, finer vertical discretization was added, and the model was recalibrated to root- zone water requirements and groundwater head and surface-water flow measurements. The model calculated regional budgets, stream flows, and groundwater hydrographs using irrigation data, crop distribution, and dynamically changing land-use. This model will be used as a scientifically based management tool to evaluate various Integrated Regional Water Management Plan projects.

Daly City, California: Developed a solute transport model for the assessment of fate and transport of methyl tertiary butyl ether (MTBE) and tert-butyl-alcohol (TBA) in the subsurface released at a gas station. The numerical model developed using MT3D-USGS simulated the production of TBA resulting from the degradation of MTBE and the movement of both plumes in groundwater;

Continued from previous page

- 2022: Co-chair, GRACast subcommittee, Groundwater Resources Association (GRA), California
- 2021 – 2023: External faculty in the Civil Engineering Department at the University of Memphis (three-year term)
- 2017: Member, Scientific Advisory Committee, Seventh International Groundwater Conference (IGWC-2017), Coimbatore, India, February.
- 2016: Judge for NASA's Special Award at 35th Annual Loudoun County Public Schools Regional Science & Engineering Fair (RSEF), Freedom High School, March.
- 2013 – 2015: Committee Member, Loudoun County Water Resources Technical Advisory Committee, Virginia.
- 2012: Panel Member, International Groundwater Conference (IGWC) panel on fracture flow modeling and issues related to local farmers, Aurangabad, India.

PROFESSIONAL HISTORY

- S.S. Papadopulos & Associates, Inc.: 2008–present
  - Associate: 2023–present
  - Senior Engineer: 2020–2023
  - Senior Project Engineer: 2008–2020
- University of Memphis, External Graduate Faculty: 2021–2023
- HydroGeoLogic, Inc., Senior Engineer: 2001–2008
- Shashi Prabhu and Associates, Civil Engineer: 1999

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and provided projections of long-term concentrations of both MTBE and TBA in the subsurface.

Livermore Valley Groundwater Basin Surface-Water Transport in MT3D, California: Added surface-water transport capability to MT3DMS to simulate contaminant transport in surface-water features, particularly to work with the lake (LAK) and the stream flow routing (SFR) packages of MODFLOW. Capability was also added to these packages to interact with the unsaturated zone transport in the case where the vadose zone is simulated using the unsaturated-zone flow (UZF) package of MODFLOW. A flexible numerical solution was implemented to easily select a spatial and temporal weighting scheme. Solutions were compared to analytical solutions and OTIS as part of the verification process. This development was performed to provide Zone 7 a tool to develop salt-management strategies so that Zone 7 could use the capability of transport of salt between groundwater and surface-water features in the Livermore Valley Groundwater Basin.

Data and Model Review for Litigation, Orange County, California: Provided data and model reviews in support of a litigation case for evaluating the fate and source of VOC plumes.

Confidential Client, California: Assisted senior staff in support of a litigation matter. Reviewed models developed using several alternate groundwater and land surface models. Supported evaluations of model development, calibration, and application.

Confidential Client, California: Provided expert opinion to a confidential client in support of a litigation matter. A Declaration was provided that demonstrated the connection between groundwater pumping wells and streamflow depletion, which formed the basis for judgement in the matter.

Confidential Client, California: Developed MODFLOW 6 models to evaluate the fate and transport of injectate from UIC wells. Benchmarked aspects of model against analytical solutions before implementing 3D models. Incorporated client's detailed 3D geologic model using sediment texture data to derive hydraulic conductivity using power law averaging.

Model Review, Gallup, New Mexico: Reviewed models to evaluate the accuracy of data, modeling results, and interpretations resulting from models that were created in support of pumping well permit applications by the City of Gallup. Impacts were evaluated on the water levels of wells in the vicinity of pumping wells owned by Tri-State Generation and Transmission Association, Inc.

Third-party Review of GULF and Groundwater Management Area 14 (GMA 14) Models, Lone Star Groundwater Conservation District, Conroe, Texas: Lead Reviewer for a groundwater model that is currently being developed for joint planning purposes for GMA 14, which partially or fully includes five GCDs and two subsidence districts.

Phoenix AMA Groundwater Model, Arizona: Calibrated the Phoenix AMA Groundwater Model for the Arizona Department of Water Resources. The model is used by AZ-DWR to assess groundwater conditions in the Phoenix AMA. The model is used by AZ-DWR to make basin-scale water availability projections into the future to achieve the objectives laid out in Arizona's Groundwater Management Act of 1980.

Confidential Client, Arizona: A third-party model review was performed for two different models in support of two litigation cases. The models were developed for source identification of pumped water. Expert reports and rebuttal comments were submitted; and appeared for depositions in both cases.

Texas Water Development Board: Teamed with WSP, created an online tool for TWDB for mapping statewide injectate migration in Class II injection wells. Literature review was performed for existing solution methodologies. Evaluated various numerical experiments to demonstrate the sensitivity of assumptions in the screening level analysis performed by the online mapping tool. Analytical solutions were implemented in the tool. The mapping tool was developed to work in coordination with other database processor tools developed by the teaming partner WSP that compiles well information from the Railroad Commission databases. Presented the methodology and tool at workgroup meetings comprised of close to 40 oil and gas, water resources, academic, and government professionals.

Texas Water Development Board – Aquifer Parameters: Managing an ongoing project for TWDB's groundwater modeling team to develop a statewide aquifer/well test data compilation. More than 150,000 PDF documents were evaluated, and relevant information was digitized and assembled in a database. A concerted stakeholder outreach effort was conducted by SSP&A and TWDB to obtain any aquifer or well pumping information available with organizations, agencies, GCDs, and other stakeholders. The TWDB documents and other data sources obtained from the stakeholder outreach were synthesized into usable, consistent, traceable and reproducible form.

MODFLOW-USG Development: Solute Transport in Lakes: Arcadis, Chile tasked SSP&A to add capability in MODFLOW-USG to simulate solute transport in lakes. The new capability added to the MODFLOW-USG code enables the simulation of solute transport within lakes, assuming instantaneous mixing within each lake, and their interaction with the underlying groundwater system.

The project was completed in collaboration with Dr. Sorab Panday.

MODFLOW-USG Development – Transient Domain and Transport Properties: In collaboration with Dr. Sorab Panday, added transient IBOUND capability; added transient transport properties capability; added an option to reorder matrix to solve only active nodes, reducing run-times proportional to number of active cells in the model.

Development of MT3D-USGS: In collaboration with U.S. Geological Survey (USGS), developed a new version of solute transport simulator, MT3D-USGS. This software is based on MT3DMS, developed by Dr. Chunmiao Zheng, but with new features in MT3D-USGS including simulation of transport in lakes and streams, a kinetic reaction module to simulate multiple electron-donors and acceptors, a contaminant treatment system package for simulating aboveground treatment and circulation of solutes, and unsaturated-zone transport. Other improvements include the handling transport in dry cells of MODFLOW-NWT and corrections to the storage formulation.

Red Hill Bulk Storage Facility, Hawaii: Provided technical guidance at the Facility regarding simulation of fuel components in the subsurface, and analyses of calculations made using MODFLOW-USG in particular, the main modeling code used at the Red Hill Facility by the Navy and its contractors.

Evaluation of Repetitive Sump Pump Failure at Private Residence, Maryland: The project involved the evaluation of the repetitive failure of a sump pump at a private residence. Analysis demonstrated that flow of water through alkaline fill material into the drains was causing the pump to fail. Tasks involved water level analysis in the vicinity of the residential property, model development to simulate groundwater flow to compute a drain elevation required to lower groundwater levels at the residential property to avoid the flow of water through the fill material.

Confidential Client, Atlanta: The project involved the release of organic compounds from a cleaning facility and the source identification associated with the contaminant release. The project involved reviewing data, expert reports, and depositions provided by subject matter experts. Tasks involved vadose zone modeling, developing analytical models for saturated zone transport, and linking the vadose and saturated zone models.

Confidential Client, North Dakota: Developed a flow and transport model to simulate the fate and transport of contaminants resulting from a pipeline leak. Sensitivity analyses were performed to evaluate parameter uncertainty and predicted results related to the percolation of contaminant at the site. Vadose zone modeling was also performed for additional analysis.

Confidential Client, Salisbury, Maryland: The project initially involved the evaluation of the reactive transport and fate of hexavalent chromium (Cr [VI]), which arose as the result of historical plating activities at a manufacturing facility, within an alluvial aquifer in Maryland. Tasks involved reactive transport analyses to assess short- and long-term remedial effectiveness and support long-term monitoring (LTM) design. Subsequently, the project also involved the delineation and mobility-assessment of light non-aqueous phase liquid (LNAPL); and evaluating the disposition, transport, and fate of chlorinated volatile organic compounds (CVOCs).

Nevada Energy: A 2D density-dependent flow and transport model was developed to assess the fate of a highly dense TDS plume. The objective of the model was to determine the timing and expected maximum concentration of TDS at the downstream end of the existing plume. The groundwater system in this case represented a 'theoretically' unstable system with a higher-density TDS plume overlying a relatively lower-density system in lower aquifer formations.

Analysis of Impact of Lakes on Subsurface Freshwater Resources of Low-lying Islands: Collaborative project with University of South Florida, Michigan Technological University, University of Florida, and SSP&A, exploring impacts of lake formation on low-lying islands resulting from inundation due to climate change. Research found that on low-lying islands with dry climates (evapotranspiration exceeds rainfall) freshwater storage can substantially decrease if sea level rise results in lake formation within interior topographic lows, splitting the freshwater lens and reducing available freshwater. Results were published in Geophysical Research Letters (Gulley *et al*, 2016). Follow up work included the evaluation of climate change impacts on small islands like the Abaco Island in The Bahamas.

Bannister Federal Complex Groundwater Model, Kansas City, Missouri: Developed a groundwater model as part of a comprehensive due diligence investigation of the Bannister Federal Complex (BFC) in Kansas City. The groundwater model assisted with the evaluation of redevelopment scenarios and evaluation of remedial alternatives and costs. Predictive results from the model were beneficial in identifying locations at the site that are prone to flooding during and post-demolition. Uncertainty analysis was performed using PEST to assess the range of possible groundwater levels in the anticipated flooding areas during the post-demolition phase. Predictive results were also used to design a well network to capture the plume. Analysis was also performed to assess the efficacy of slurry walls in maintaining inward head gradients.

New York State Department of Environmental Conservation, Elmont, New York: Co-developed capabilities in MT3DMS to simulate natural attenuation processes using multi-species kinetic reactions. A general form of reaction equation was implemented in MT3DMS to simulate the consumption of multiple electron donors by multiple electron acceptors.

U.S. Department of Energy (DOE), Hanford, Washington: As part of a multi-firm team, contributed to the evaluation and development of remedial alternatives and strategies for RI/FS and post-ROD activities. Developed and applied modeling approaches for remedy design and analysis. Evaluated remedy performance using multiple lines of evidence approach. Evaluated the capacity of an infiltration pond with an axisymmetric model developed using MODFLOW-SURFACT and MODFLOW-USG. Developed MODFLOW, MT3D, and MODPATH as part of the DOE software approval process.

Treated Water Discharge Impact Evaluation, Freeland, Washington: Evaluated the impacts of discharging treated water on groundwater and surface water in the vicinity of an infiltration site. Developed a groundwater model using MODFLOW.

Halliburton Energy Services, Inc., Duncan, Oklahoma: Assisted Halliburton Energy Services, Inc. in their effort to investigate and remediate perchlorate contamination. Seepage from evaporation ponds containing perchlorate impacted groundwater beneath the site. Evaluation of the spread of a perchlorate plume and the development of potential source terms contributing to the plume were analyzed using MODFLOW, MT3D, and analytical models.

Evaluation of Corrosion Inhibitor Spreading, Cushing, Oklahoma: Evaluated the distribution and spreading of a vapor-phase corrosion inhibitor upon application in porous and permeable materials beneath large aboveground storage tanks at a petroleum tank farm. Constructed a flow-and-transport model (using MODFLOW-SURFACT) to simulate the migration of the aqueous solution injected beneath the tanks and the subsequent transport of the vapor-phase inhibitor compound in the sand pack air beneath the tanks.

Water Resource Assessment, White Bear Lake, Minnesota: Developed a transient integrated surface water – groundwater model based on USGS' NMLG model. The transient model evaluated potential reasons for declining lake levels in White Bear Lake and other lakes in the region. The model is being used by MDNR for predictive assessment and development of mitigation strategies. MODFLOW-NWT was utilized for groundwater modeling and Soil Water Balance (SWB) was utilized for simulating land surface processes. At the conclusion of the project, technology transfer was conducted to pass the model to MDNR staff; attended a public meeting in Minnesota that shared modeling results with stakeholders.

Model Review and Contamination Calculations, Great Neck, New York: Reviewed a DYNFLOW model and provided calculations of the mass and volume of contamination.

Hardage-Criner Superfund Site, Oklahoma: Performed flow-and-transport modeling in 2011 to analyze the migration of contaminants across Criner Creek, safe shut-down duration of V-trench, and decreasing flow rates in the V-trench, and future scenarios were performed through 2025 to evaluate the fate and transport of the VOC plume. Post-audit simulations were performed in 2021, ten years subsequent to the original model to evaluate the robustness of the model calibrated in 2011.

Agrico MODFLOW Model Evaluation for Litigation, Florida: Evaluated a MODFLOW model in support of a litigation case to estimate the impact of historical activity at a fertilizer plant on the local groundwater system.

Model Review, St Croix, Virgin Islands: Reviewed ARMOS, BioTrans, and MODFLOW-SURFACT models.

Dry Cell Problem of MODFLOW and MT3D: Developed MODFLOW, MT3D and MODPATH codes to handle dry cells in a numerically stable, robust, and efficient manner. Work primarily involved reformulation of governing equations to incorporate Newton-Raphson numerical techniques and addition of solvers to the MODFLOW code and to handle mass flowing through unsaturated cells in the MT3D code. Other features were also added, including recirculation for pump-and-treat systems and simple reaction module.

Development of a Source Screening Module: Developed an Excel module to implement an analytical solution for tracking transport from a contaminant source to a receptor well through the vadose zone and saturated zone. Documentation was completed for the Excel module. The module was then applied to onsite data to compare against STOMP results.

Data Management and Analyses, New York, NY: Managed data and performed analysis for a 60-acre urban area underlain by petroleum hydrocarbons. Mapped apparent product thickness and evaluated product recovery. Evaluated gradients caused by pumping activities.

CTS Package for MT3D: Developed a contaminant treatment system (CTS) module in MT3D. The objective of this project was to enable simulation of a typical pump-and-treat system and to represent mixing and reinjection of treated contaminated groundwater. Tasks involved planning, conceptualization, programming, testing, and preparing the documentation for the module.

MODFLOW Developments: Several features were added to MODFLOW: injection/extraction well management in WEL and MNW2 packages; adaptive time-stepping; nodal mass balance for tracking local mass balance error; and general head boundary time series as part of the FHB package.

MT3D Developments and Related Research: Activities included:

- Adding chain decay and MONOD kinetics options; prescribed concentration boundary on the highest active node; separate Kd for mobile and immobile domains.
- Density-Dependent Reactive Transport Modeling Code Development: Ph.D. research at Auburn University, with Dr. Prabhakar Clement. Objective is to develop a simulation code to simulate density-dependent flow and reactive transport. These capabilities exist individually in separate codes, SEAWAT and RT3D. This project will combine these capabilities into one code to investigate the impact of density on reactive transport.
- Laboratory and Modeling Investigation of Saltwater Intrusion in Strip Islands: Ph.D. research at Auburn University, with Dr. Prabhakar Clement. Lab-scale sand-tank experiments were simulated using SEAWAT to study transient changes in freshwater lenses during dry and wet cycles were studied. The findings have been submitted to the journal Water Resources Research.

HydroGeoLogic, Inc. – Reston, Virginia

Upper Santa Clara River Chloride TMDL Collaborative Process, California: Developed a numerical model for the Upper Santa Clara River (USCR) watershed for the Santa Clarita Valley Sanitation District of Los Angeles County and the Los Angeles Regional Water Quality Control Board. The model evaluated the fate and transport of chloride in surface-water and groundwater basins of the USCR in accordance with the chloride total maximum daily load (TMDL) collaborative process. A water supply systems module was developed to deal with the complex water routing and resulting water quality between purveyors, groundwater, surface-water and water reclamation plants.

South Florida Ecosystem Office of the National Park Service (NPS), Florida: Developed a groundwater/surface-water interaction model simulating flow and transport to analyze the effectiveness of a Marsh Driven Operations Plan for three pumps and detention basins along the L-31N canal. Used the calibrated model to analyze the migration of total phosphorus (TP) and estimate TP budgets in detention ponds in the vicinity of the canal. Training was provided to NPS staff and students at Florida International University. The objective of the Marsh Driven Operations Plan was to manage surface-water flows to achieve flood protection and ecosystem protection by implementing operation strategies.

Groundwater Interactions in Western Orange and Seminole Counties, Florida: As Project Engineer of a project funded by the St. Johns River Water Management District, developed an integrated regional groundwater/surface-water model for western Orange and Seminole counties in east-central Florida. Responsible for data assimilation and processing, MODHMS model development and simulations, and post-processing of results and model calibration. The model developed assisted the water management district in more efficient management of the water resources in its jurisdiction, including balancing of surface-water and groundwater sources for water supply, and establishing a sound scientific and engineering basis for water use permitting.

St. John's River Water Management District, Florida: Assisted with litigation support to the Division of Water Use Regulation in reviewing three-dimensional groundwater flow, saltwater-intrusion models. Provided data analysis relating to a consumptive use permit application for a wellfield. Reviewed MODFLOW and SEAWAT models and prepared presentation material in assisting senior staff to support the District's attorneys in formulating questions and responding to questions from other parties. The judgment was in favor of the District.

Modeling in Support of a Well Permit Application, Florida: Performed numerical modeling in support of a well permit application for the county. The project involved performing sensitivity simulations for the pre-development ECF model, preparing, and simulating future conditions, compiling observations within the county, processing and analyzing results, and preparing the report.

Regional Saltwater Intrusion Modeling for Water Supply Planning, Okaloosa, Santa Rosa, and Coastal Walton Counties, Florida: As the Project Engineer, responsible for supporting the development of two regional, density-dependent saltwater intrusion models covering coastal Walton County in the northwest Florida panhandle. The DSTRAM-based model is designed to address concerns of upconing of deeper saline waters and of saltwater intrusion from the Gulf of Mexico and its impact on water supplies and existing wellfields. Responsibilities included pre-processing of input files, DSTRAM simulations, post-processing using TecPlot and other tools, sensitivity analysis and calibration.

Three-Dimensional Density-Dependent Flow and Transport Modeling of Saltwater Intrusion, Southern Water Use Caution Area, Florida: Supported the predictive simulations to assess the benefits and consequences of establishing a sub-surface trough or a pressure ridge along the Tampa Bay coast. Responsible for preliminary simulations assessing the effects of a sub-surface trough and pressure ridge, predictive simulations and post-processing using ArcView, ViewHMS and Tecplot.

Gilbert & Mosley Site, Wichita, Kansas: Developed a groundwater transport model for the Gilbert & Mosley Site. This project used a MODFLOW-SURFACT-based contaminant transport model to simulate a PCE-TCE-

DCE-VC plume. Tasks involved pre-processing of the field observation data, calibration of the model, remediation well simulations, post-processing of results using TECPLOT, and plotting and presentation of calibration results.

U.S. Army Corps of Engineers, Buffalo District, Niagara Falls Storage Site, Lewiston, New York: Developed groundwater models for the Niagara Falls Storage Site. This model simulated flow and transport of a variety of radionuclides and metals. One-dimensional flow was simulated using Hydrologic Evaluation of Landfill Performance (HELP) program for modeling unsaturated zone. Three-dimensional flow and transport were simulated using MODFLOW-SURFACT. Tasks involved data compilation, model development using MODFLOW-SURFACT and HELP, analyses of results, and post-processing.

Enhancement of Generic Soil Column Module (GSCM): The objective of the project was to enhance the existing module (GSCM) to include kinetic mass transfer between solid, aqueous, and gaseous phases. Tasks included code development in Fortran and C++ languages, performing test cases in MOFLOW-SURFACT and verification cases for GSCM, performing sensitivity runs, generating plots using MS Excel, and generating a static library (LIB) file compatible with C++ wrapper for GSCM. The proposed use of this module was for the dynamic simulation of fate and transport of chemical constituents in various types of waste management units.

Dyes and Pigment Industry Waste Listing Determination: Provided modeling services in support of human health risk modeling and sensitivity analysis corresponding to exposures from the disposal of dyes and pigment industry wastes. Tasks included data collection and the preparation, management, and execution of EPACMTP simulations.

Fossil Fuel Combustion Waste Listing Determination: Provided modeling services in support of human health and ecological groundwater risk modeling and sensitivity analysis corresponding to exposures from the disposal of fossil fuel combustion wastes. Tasks included data collection, preparation, management, and execution of EPACMTP simulations.

Development of a Probabilistic Screening Module for Industrial Waste Management Evaluation Model (IWEM) Software: Developed a model for the EPA's Office of Solid Waste for the management of non-hazardous industrial wastes. The probabilistic screening module used parameter generation techniques to ensure that only physically feasible scenarios were executed by the IWEM software.

U.S. Environmental Protection Agency Office of Radiation and Indoor Air, Probabilistic Risk Assessment Modeling of Low-Level Activity Waste: This project coupled EPACMTP with a source release model that tracked a radioactive parent and its daughter products. The project involved development of a Monte Carlo wrapper for a source release model, MCDUST (Monte Carlo - Disposal Unit Source Term), that produced results usable by EPACMTP. Tasks involved development of Monte Carlo wrapper capable of exchanging information with MS access database, understanding the structure of model input files, stochastic variables, and distributions from CMTP code, verification using MODFLOW-SURFACT, writing tools for pre- and post-processing using Visual-Fortran, data transfer from databases using Fortran, data assimilation, model simulations, testing and documentation.

Development of MODHMS/MODFLOW-SURFACT: Developed software as a part of the research and development program. Tasks involved formulation, code development, source control, and testing and documentation of MODHMS/MODFLOW-SURFACT. Tasks also included sales and technical software support. Specific modules/features added to the code included two additional numerical matrix equation solvers, a Land Use Parameterization (LUP) package and a Water Supply Systems (WSS) package, a Zone Budget (ZNB) package, enhancement of MODFLOW packages like the Flow and head boundary (FHB) package, a subsidence (SUB) package, and a Channel Package with two new channel structures. Related tools like MODPATH and PEST were enhanced to work seamlessly with MODHMS/MODFLOW-SURFACT.

Courses & Workshops

COURSES TAUGHT:

- 2024 – Training on PEST-facilitated calibration of SVSIM and C2VSimFG models for California Department of Water Resources staff in Sacramento, February 5-9, 2024
- 2022 – Invited talk (webinar) given to faculty and students at the University of Maryland Baltimore Campus' Center for Urban Environmental Research and Education, Spring 2022 Seminar Series, May 6, 2022.
- 2021 – Invited talk given to faculty and students at Indian Institute of Technology, Madras (IIT Madras) India. November 6, 2021.
- 2020 – Invited talk (webinar) given to faculty and students in India. November 16, 2020.
- 2018 – Provided a groundwater demonstration with a water tank at Discovery Elementary School, Ashburn, Virginia, 2018.
- 2013 – Assisted Mr. Chris Neville in teaching a short course "*Effective Solute Transport Simulation*." GeoMontreal, Montreal, Canada, September 2013.

- 2003 – 2008 – Assisted Dr. Sorab Panday in teaching MODHMS / MODFLOW-SURFACT courses to the following organizations: University of Washington; Federal Energy Regulatory Commission; Malcolm Pirnie; U.S. Army Corps of Engineers; Jacksonville District, Florida; Everglades National Park; National Parks Service, Florida; Florida International University (at HydroGeoLogic, Inc.).

COURSES ATTENDED:

- 2017 – MODFLOW 6 Training Workshop, Golden, CO, May 2017
- 2014 – IWFM Training Workshop in Sacramento, CA, January 2014
- 2013 – Numerical Methods in Hydraulics and Hydrology, Auburn University
- 2013 – MODFLOW-USG 2-day course, Bethesda, MD
- 2013 – Integrated Water Flow Model, IWFM training workshop
- 2012 – Numerical Modeling of Free Surface Flows, Auburn University
- 2012 – Chemical Principles of Environmental Engineering, Auburn University
- 2011 – Subsurface Transport Over Multiple Phases – STOMP short course
- 2010 – Parameter Estimation – PEST short course

Publications & Presentations

Scantlebury, L., Bedekar, V., Tonkin, M.J., Karanovic, M., and Harter, T., 2025. *Texture2Par: A Texture-Driven Tool for Estimating Subsurface Hydraulic Properties*. Environmental Modelling & Software. doi: 10.1016/j.envsoft.2025.106372

Bedekar, V., Hatch, T., Traum, J.A., Tolley, G., Singh, A., and Faunt, C.C., 2024. *Models: Tools for Estimating and Predicting Subsidence*. Hydrovisions, 2024 Spring Issue, p. 14-17.

Hatch, T., Neely, W., Bedekar, V., and Tolley, G., 2023. *California's Sinking Feeling: An Introduction to Subsidence*. Hydrovisions, 2023 Fall Issue, p. 10-12.

Bedekar, V., C. Neville, M.J. Tonkin, R.D. Bartlett, and P. Plato, 2023. *A Unit-Concentration Method to Quantify Source Contribution*: Groundwater, vol 62, issue 2, p. 303-309. doi: 10.1111/gwat.13333

Bedekar, V., R. Goswami, 2023. *Aquifer Characterization Using Texture2Par. Texas Groundwater Summit*, August 29-31, San Antonio, Texas.

Bedekar, V., 2023. *Regional-scale Groundwater Modeling Utilizing Well Log and Geophysical Data*. Arizona Hydrological Society Symposium, September 13-16, Flagstaff, AZ.

Bedekar, V., 2023. *Lessons Learned from Groundwater Management in Arizona*. Western Groundwater Congress, GRA, September 12-14, Burbank, CA.

Tonkin, M., Scantlebury, L., V. Bedekar, M. Ou, J. Baer, M. Cayar, S. Ceyhan, S. Najmus, 2023. *Effective Use of Airborne Electromagnetic (AEM) Data for Groundwater Modeling*. Western Groundwater Congress, GRA, September 12-14, Burbank, CA.

Bedekar, V., 2023. *Groundwater Management in Arizona*. California Water & Environmental Modeling Forum (CWEMF), April 17-19, Folsom, CA.

Bedekar, V., C. Neville, M.J. Tonkin, R.D. Bartlett, and P. Plato, 2023. *A Unit-Concentration Method to Quantify Source Contribution*. California Water & Environmental Modeling Forum (CWEMF), April 17-19, Folsom, CA.

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Bedekar, V., R. Goswami, J. Sharp, Jr., J. Acevedo, and M. Fagan, 2022. *Statewide Mapping of Class II Well*

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Ou, G., V. Bedekar, C. Neville, D. Hayes, M. Fagan, R. Goswami, J. Sharp, Jr., and J. Acevedo, 2022. *A State-Wide Automated Web-Based Tool for Class II Well Wastewater Injectate Analysis, Part 2*. MODFLOW and More 2022, June 5-8, Princeton, NJ.

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S. Panday, N. Brown, T. Foreman, V. Bedekar, J. Kaur, and P.S. Huyakorn, 2009. *Simulating Dynamic Water Supply Systems in a Fully Integrated Surface-Subsurface Flow and Transport Model*. Vadose Zone Journal, v. 8, no. 4, pp. 858-872.

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Panday, S., T. Foreman, V. Bedekar, N. Brown, P. Sampath, and J. Kaur, 2008. *Water Supply Systems in Groundwater/ Surface-Water Models*. The 2008 Computational Methods in Water Resources International Conference, San Francisco, CA, July 6-10, 2008.

Bedekar, V., S. Panday, H. Ahn, and F. Miralles-Wilhelm, 2006. *Surface-Water Groundwater Interaction Model for Marsh Driven Operations to Manage the Ecosystem of the Rocky Glades*. MODFLOW and More 2006: Managing Ground-Water Systems. International Ground Water Modeling Center, Colorado School of Mines Golden, CO, May 22-24, 2006.

Gabora, M., V. Bedekar, B. Linderfelt, and A. Davis, 2006. *Integration of the LAK3 Package into MODFLOW-SURFACT to Simulate an Ephemeral Pit Lake, Northern California*. MODFLOW and More 2006: Managing Ground-Water Systems. International Ground Water Modeling Center, Colorado School of Mines Golden, CO, May 22-24, 2006.

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Interstate Technology & Regulatory Council (ITRC), 2011. *Development of Performance Specifications for Solidification/Stabilization*. S/S-1. Washington, DC: Interstate Technology & Regulatory Council, Solidification/ Stabilization Team. www.itrcweb.org.

Deposition & Testimony Experience

- 2021 – *United States of America, et al. vs. Gila Valley Irrigation District, et al*. United States District Court for the District of Arizona. Case No. CV-31-0059-TUC-SHR. September 22.
- 2021 – *Gila River Indian Community vs. Cranford et al*. United States District Court for the District of Arizona. Case No. 4:19-cv-00407-SHR. September 24.

Gengxin (Michael) Ou, Ph.D.

Senior Project Scientist, Hydrogeologist

Dr. Ou is a hydrologic and groundwater modeler with extensive experience in model implementation and development, water resources planning and assessments, development of graphical user interfaces, and statistical and spatial analysis. He brings strong computational and advanced mathematics skills and experience programming with Python, Fortran, R, and VBA. He has developed many software applications including several MODFLOW packages to enhance model capability. Dr. Ou analyzes and customizes modeling software architecture, performs model simulations, and provides data analysis and data integration.

REPRESENTATIVE EXPERIENCE

S.S. Papadopulos & Associates, Inc. *– Rockville, Maryland*

Private Client, Long Beach, California: Updated and calibrated a groundwater flow and transport model that was used to evaluate the magnitude, extent, and impact to drinking water wells from petroleum releases.

Third-party Review of GULF and Groundwater Management Area 14 (GMA 14) Models, Lone Star Groundwater Conservation District, Conroe, Texas: Modeler for a groundwater model that is currently being developed for joint planning purposes for GMA 14, which partially or fully includes five GCDs and two subsidence districts.

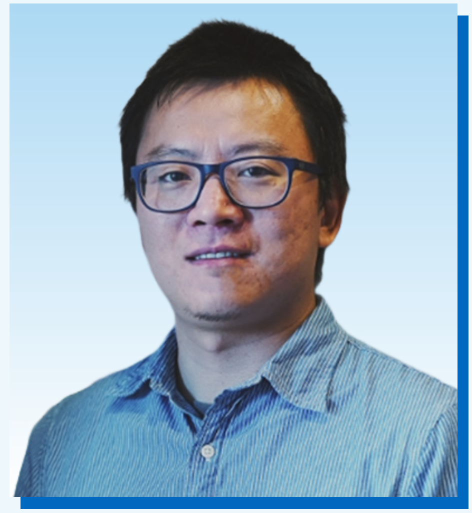
Water Resources Assessment, Lower Rio Grande Basin, New Mexico Interstate Stream Commission: Provided simulation support, model-run processing, and scripting automation. Updated ET and Pumping packages for the LRG model. Prepared automated scenario construction and evaluation workflow.

Assessing Potential Impacts of the Tulla Transfer Application, State of New Mexico, Copper Flats Mine: Lead Modeler for a sensitivity and uncertainty analysis. Evaluated representativeness of groundwater model for site characterization. Performed sensitivity analysis on potential impact estimation of water right transfer. Quantified uncertainty in transfer impact assessment. Drafted final report and presentation.

Water Resources Assessment, Pecos River Basin, State of New Mexico, Roswell and Carlsbad Basins: Lead Modeler for next generation refinements. Reviewed prior Pecos River Basin model and refined the model grid discretization with LiDAR and geologic modeling data. Converted prior Pecos River Basin model using MODFLOW 6. Optimized model numerical solver efficiency and accuracy. Constructed SFR and LAK packages representing the stream-lake-aquifer interactions. Presented project progress and drafted reports.

Private Client, Albuquerque, New Mexico: Updated and calibrated a groundwater flow and transport model that was used to evaluate operations of TCE treatment. Tasks included reconstructing the River package with transient river stage, extending MNW and Well packages with new TCE treatment operation data, and setting up calibration targets with new groundwater level and contaminant measurements. Also calibrated the groundwater flow and transport models to evaluate operations of TCE treatment.

Private Client, Albuquerque, New Mexico: Updated and calibrated a groundwater flow and transport model that was used to evaluate operations of TCE treatment.



YEARS OF EXPERIENCE

10+

EDUCATION

- **PhD**, Civil Engineering (minor in Natural Resource Sciences), University of Nebraska-Lincoln, 2015
- **MS**, Hydrology and Water Resources, Hohai University, Nanjing, China, 2009
- **BE**, Hydrology and Water Resources Engineering, Hohai University, Nanjing, China, 2006

EXAMPLE AREAS OF EXPERTISE

- Groundwater Modeling
- Surface and Vadose Zone Hydrology
- Scientific Programming (Python, Fortran)
- Desktop and Web App Development
- Data Analysis and Visualization
- Geospatial Analysis

LANGUAGES

English, Cantonese, Mandarin

PROFESSIONAL HISTORY

- S.S. Papadopulos & Associates, Inc.: 2020–present
- Long Spring, Inc., Water Resources Engineer, On-Call Services: 2016–2019
- University of Nebraska:
  - Research Assistant Professor: 2018–2020
  - Postdoctoral Research Associate: 2017–2018
- University of Washington, Postdoctoral Research Associate: 2016–2017
- Nebraska Department of Natural Resources, Integrated Water Management Analyst: 2014–2016

EMAIL

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SOFTWARE DEVELOPMENT

MODFLOW-SDA: MODFLOW-SDA is a new MODFLOW package to improve the computational efficiency and reduce the computational noises for stream depletion analyses using MODFLOW. Using the assumption of unchanged flow coefficients between the baseline and scenario runs, the nonlinear groundwater flow system is linearized for solving the flow equations. The new package has been successfully applied to a regional groundwater model in Nebraska to simulate responses to flow perturbations such as streamflow depletion induced by new pumping wells.

MODFLOW-CSR: The Cross-Section streamflow Routing (CSR) package is developed to simulate the streamflow and the interaction between streams and aquifers for streams with a width larger than the MODFLOW grid size. In the CSR package, a cross-section is described by a number of streambed points that determine the geometry and hydraulic properties of the streambed. A rapid algorithm is used to compute the submerged area of the MODFLOW grid. The streambed conductance of a grid cell is computed based on its submerged area, streambed hydraulic conductivity and thickness.

PPSGS: PPSGS is a geostatistical tool developed for stochastic groundwater modeling with pilot point parameterization using sequential Gaussian simulation. PPSGS can be used with PESTPP-IES for model calibration. By implementing the similar concept in PLPROC/PPFAC, PPSGS generates the Kriging weighting factor files that can be used during calibration to recreate various stochastic parameter fields retained in each respective realization. PPSGS can improve uncertainty quantification by taking the kriging errors into account.

CHUMP: The Configuration-Based Uniform Model Post-processor (CHUMP), a framework for post-processing data and model results. CHUMP simplifies the process through a configuration file that uses intuitive keywords to define data abstraction and manipulation parameters, providing coding-level flexibility without requiring programming knowledge. With generalized input, CHUMP directly reads a variety of data and model outputs and applies a series of data processing operations to create consistent, precise, and publication-quality figures and animations.

SWAT-MODFLOW: SWAT-MODFLOW is an integrated surface-water groundwater interaction model that couples SWAT and MODFLOW by a soil water module (SWM), which is developed based on a non-iterative solution of the 1D Richards equation. SWM explicitly represents infiltration, soil evaporation, unsaturated water flow, root water update, and lateral drainage and solves them simultaneously. Taking advantage of the simulation capacities of SWAT, MODFLOW and SWM, the integrated model can simulate the physical hydrologic processes in three domains and their interactions.

RESEARCH AND DEVELOPMENT

- Automated workflow and visualization
- Calibration-constrained stochastic groundwater modeling
- Multi-source, multi-scale data assimilation
- Hydrologic model code development

University of Nebraska-Lincoln *– Lincoln, Nebraska*

Developed curricula and taught Physical Hydrology, Python Programming and Geospatial Information Science. Recent research projects included:

- **Lower Elkhorn Natural Resources District (LENRD) Pilot-scale Groundwater Model with Airborne Electromagnetic Data:** Integrated airborne electromagnetic data in groundwater model development to improve modeling performance. The model is being used as a decision-making tool by the local agency for groundwater resources management.
- **Characterization of Nitrogen Loading in the Unsaturated Zone Using Hydrologic Models in the Central Platte River Basin:** Developed a no-iterative Richards' equation computing scheme to simulate nitrogen movement in the unsaturated zone.
- **Evaluation of Buffalo Creek Reservoir 1 (B-1) for Central Platte Natural Resources District:** Estimated surface water and groundwater supply and demands based on the existing measurement and modeling datasets. Developed a hydrologic model to evaluate hydrologic impacts of the construction of the reservoir.

University of Washington *– Seattle, Washington*

Developed the hydrologic modeling framework Structure for Unifying Multiple Modeling Alternatives (SUMMA); Implemented large-domain hydrologic modeling with SUMMA in the Columbia River Basin.

Nebraska Department of Natural Resources *– Lincoln, Nebraska*

Developed and applied tools and models to assist water resources management in the department.

Publications & Presentations

Ou, G., Bedekar, V., Tonkin, M., Barth, G., 2024. *CHUMP: A Configuration-Based Postprocessing Framework for Automated Workflows*. Presented at MODFLOW and More, 2024, Princeton University, June 5.

Ou, G., Muffels, C., Tonkin, M., Bedekar, V., 2024. *Incorporating Kriging Errors through Sequential Gaussian Simulation for Pilot Point Parameterization*. Presented at MODFLOW and More, 2024, Princeton University, June 5.

Ou, G., 2020. *Development of GUI Applications for Groundwater Modeling Using Python*. Groundwater, v. 58, no. 4, pp. 496-497. doi: 10.1111/gwat.12979

Ou, G., F. Munoz-Arriola, D.R. Uden, D. Martin, C.R. Allen and N. Shank, 2018. *Climate change implications for irrigation and groundwater in the Republican River Basin, U.S.A*. Climatic Change, v. 151, no. 2, pp. 303-316. doi: 10.1007/s10584-018-2278-z

Li, R., G. Ou*, M. Pun, and L. Larson, 2018. *Evaluation of Groundwater Resources in Response to Agricultural Management Scenarios in the Central Valley, California*. Water Resources Planning and Management, v. 144, no. 12: 04018078. doi: 10.1061/(ASCE)WR.1943-5452.00010

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Dong, W., G. Ou*, X. Chen, and Z. Wang, 2014. *Effect of Temperature on Streambed Vertical Hydraulic Conductivity*. Hydrology Research v. 45, no. 1, p. 89. doi:10.2166/nh.2013.021

Ou, G., X. Chen, A. Kilic, S. Bartelt-Hunt, Y. Li, and A. Samal, 2013. *Development of a Cross-Section Based Streamflow Routing Package for MODFLOW*. Environmental Modelling & Software, v. 50, no. 12, pp. 132-143.

Ou, G., X. Chen, C. She, Z. Hu, and X. Li, 2009. *Three Dimensional Visualization of Groundwater Simulation Based on VTK*. Journal of China Hydrology, v. 29, no. 1.

John Riverson, Jr.
Modeling Lead

EDUCATION AND EXPERIENCE
Master of Science, Civil and Environmental Engineering, 1999, University of Virginia
Bachelor of Science, Civil and Environmental Engineering, 1997, University of Virginia

PROFESSIONAL SUMMARY
John has 20 years of experience developing and applying hydrologic models and conducting supporting data analyses services, with a focus on public-domain models typically used to support water resources management and regulations and subject to peer review (e.g., HSPF, LSPC, SWMM, SWAT, TR-55, CE-QUAL-W2, QUAL2E/2K, SUSTAIN). He has an in-depth understanding of meteorological and hydrological processes and interactions, climate change assessment, watershed and stormwater management, water quality, and pollutant source characterization. John led the development of USEPA's LSPC from 2003 and was responsible for designing system architecture and developing algorithms for most of the core LSPC modules including: (1) high-resolution meteorological data (2) crop-associated irrigation, (3) hydraulic withdrawals and diversions, and (4) the time-variable land use module. John's experience also includes computer programming of customized supporting applications to store, manage, process, and analyze complex data sets. He's proficient at engineering highly effective graphical and tabular displays for journal/report- and web-based publication media and has published his work in high-impact peer-reviewed journals (e.g. Water Resources Research, Water Research, Climatic Change). John is regularly sought by different agencies to provide third-party review and QA/QC of modeling applications. He is highly regarded for his ability to present highly technical content to a wide variety of audiences though in-person presentation, webinars, and on-site training workshops.

PROJECT EXPERIENCE
Supply and Demand Assessment Hydrology Modeling, State Water Resources Control Board, CA. Paradigm supports the California State Water Resources Control Board with hydrologic modeling of multiple watersheds across the state, incorporating representation of surface water and groundwater withdrawals. The model development process is data-intensive, sourcing geospatial data sets from various local, state, and national sources. The team is currently developing work plans, calibrated models, and reports for 18 different watersheds across the state using the Loading Simulation Program C++ (LSPC) with linked MODFLOW models in specific watersheds when appropriate. John is serving as the primary technical advisor to the team, providing guidance and critical review of modeling approaches, decisions, and outcomes. He has also provided hands-on modeling training to the client, teaching the modeling philosophy, calibration techniques, results interpretation, and the technical foundation in the underlying Hydrological Simulation Program--Fortran (HSPF) process algorithms used by LSPC.

Water Quality Benefits Evaluation & Analysis. King County Department of Natural Resources & Parks, WA. Paradigm is supporting the King County, WA Department of Natural Resources & Parks in conducting an integrated hydrology, water quality, and stormwater planning modeling study. It includes a linked Loading Simulation Program C++ (LSPC) watershed model, along with a SUSTAIN optimization model, for representing both structural and non-structural stormwater management strategies across King County. The objective of the potential management strategies was to evaluate Benthic Index of Biological Integrity (B-IBI) metrics, reduce tributary pollutant loads, and evaluate the effects on the instream flow duration curve (FDC) across five regional watershed planning units. During Phase 1 of this initiative, Paradigm's team rebuilt multiple HSPF models into a single integrated LSPC model simulating the entirety of King County's watersheds. This effort concluded with a model verification, a step ahead of formal calibration and validation, to demonstrate the current performance of the translated models. The verification not only tested the translation of the HSPF model parameters to LSPC but also demonstrated the robustness of supplementing local observed data with next-generation gridded meteorological boundary conditions (i.e., PRISM, NLDAS). The preliminary outputs of the LSPC water quality model (i.e., HRU unit-area time series) were linked to a Tier-1 SUSTAIN model representing both structural and non-structural practices. Structural practices included LID targeting individual parcels, roadside programs aimed at treating runoff from roads and highways, and regional projects treating larger nested drainage areas. Non-structural strategies included implementation options such as street sweeping and removal of impervious cover. John is serving as a modeling lead providing systems design; support with model setup, configuration, and calibration; and communication and engagement with various municipal and industry stakeholders.

Little Bear Creek Watershed Basin Planning, Snohomish County, WA. In partnership with NHC, Paradigm supported the Department of Public Works Surface Water Management Division in developing a comprehensive basin plan for stormwater management in the Little Bear Creek watershed. Plan development includes linked Hydrological Simulation Program--Fortran (HSPF) and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) models for representing structural and non-structural management strategies for stormwater and agricultural non-point sources. The SUSTAIN network included nested low-impact development BMPs, regional detention/retention ponds, and other programmatic strategies aimed at source control. Management objectives include achieving main stem Benthic Index of Biological Integrity (B-IBI) metrics and reducing tributary pollutant loads. These multi-scale management objectives were formulated using a two-tiered cost-benefit optimization approach in SUSTAIN to identify and prioritize cost-effective management opportunities at the subcatchment, subbasin, and watershed scales. The Little Bear Creek modeling and planning process included collaborative interaction and input from the Department of Public Works and other stakeholder groups to incorporate management strategies that would have a high likelihood of public adoption and easily integrate with existing operation-and-maintenance programs.

San Mateo County Reasonable Assurance Analysis for GI, San Mateo County, CA. Paradigm is currently supporting San Mateo County Co-permittees in modeling to demonstrate reasonable assurance that GI and associated schedules for implementation will result in attainment of MRP requirements and TMDL wasteload allocations. John is serving as lead modeler in the development of HSPF/LSPC and SUSTAIN models to simulate baseline pollutant loadings for all watersheds in the county, optimize selection of GI projects, and demonstrate pollutant load reductions to meet interim and final schedule milestones. John developed procedures for efficient HSPF model development and calibration for all watersheds in the County, and is developing a comprehensive model calibration report to be submitted to the Regional Board. To support this effort, John updated the HSPF model of the Guadalupe River for simulation of sediment transport, performed model calibration, and developed approaches for representing baseline/historic mercury and PCB loads associated with stormwater.

Watershed Management Modeling System (WMMS) 2.0, Los Angeles, County, CA. Alvi led the software updates and enhancements for WMMS 2.0 systems development. WMMS is a comprehensive watershed (LSPC) and best management practice (BMP) modeling (SUSTAIN) system for evaluating hydrologic and water quality management opportunities and the associated cost-benefit implications of different planning scenarios for attaining in-stream water quality objectives. The project involved the development of a representative baseline model for the 12,000 km2 area study area, which was divided into 2,655 catchments and 941 hydraulic routing segments. Alvi supported the hydrology calibration effort and led the water quality calibration of the watershed model. The model calibration captured extremes ranging from the highest storm flows to critical low flow conditions. Alvi also made updates to the EPA SUSTAIN model to support the updates for the WMMS web utilities. Alvi worked closely with the web developers to facilitate seamless linkage and operation of the LSPC and SUSTAIN models with the WMMS online utilities.

HSPF Hydrology Model for the Ventura River Watershed, Including Natural Conditions Scenario, Ventura, CA (*experience from previous employer*) – John supported the development of a detailed HSPF model for the Ventura River watershed for Ventura County, CA. Because the modeling effort was used to support a FEMA flood insurance study, the model used 15-minute and 5-minute time steps and locally derived stream cross-sections to better characterize instream peak flow. Another unique aspect of the model was that it was temporally divided into consecutive snapshots with changing land uses to characterize the impacts of urbanization and land use changes in the watershed. Within the natural areas, land use changes also represented clearing due to some notable forest fires in the watershed. The model also simulated irrigation impacts, groundwater interactions, and reservoir management activities. John assisted with developing meteorological boundary condition for the model to represent 30 years of land use change. He also produced graphical and tabular time series summaries comparing overall water balance and flow of existing conditions versus a simulated "natural" condition of the watershed to help quantify anthropogenic impacts on the hydrologic water budget. The model was later enhanced to include water quality simulations. Services were from 2008-2009.

Khalid Alvi, P.E.

Senior Project Engineer

EDUCATION

Master of Science, Civil and Environmental Engineering, 1999, Asian Institute of Technology, Thailand
Bachelor of Science, Civil Engineering, 1993, University of Engineering and Technology Lahore, Pakistan
Professional Engineer, Virginia No. 0402046509 (since 2010)

PROFESSIONAL SUMMARY

Mr. Alvi is a Professional Engineer and an experienced stormwater, watershed, and water quality modeler, and data and GIS application developer with more than 24 years of experience in the development of watershed and BMP modeling systems. He has extensive experience in developing the practical solutions for a variety of management objectives (e.g., flow volume reduction or pollutant load reduction target) by identifying the best mix of cost-effective stormwater controls using the state-of-the-art optimization algorithms at watershed scale. Alvi was the project manager and technical lead for the development of Opti-Tool, a spreadsheet-based stormwater best management practices optimization tool. The Opti-Tool is designed for use by municipal SW managers and their consultants to assist in developing technically sound and optimized cost-effective SW management plans. The Opti-Tool uses EPA's System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN) optimization module as a back-end computational engine to identify the best mix of cost-effective stormwater controls. He co-led the development of EPA's Loading Simulation Program C++ (LSPC) to modernize the watershed model HSPF and EPA's SUSTAIN - a decision support system for the EPA's Office of Research and Development to develop, evaluate, optimize, select, and place BMPs based on cost and effectiveness. He managed the two-year technical support contract with EPA Region 10 to enhance SUSTAIN version 1.2 and to provide guidance and technical support in applying the enhanced modeling features to the case studies in the State of Washington. He has provided national technical support to EPA 319 grantees in the use of the STEPL model and has conducted several hands-on training courses across the country. Mr. Alvi's programming expertise includes FORTRAN, C++, VBA, and Python.

PROJECT EXPERIENCE

Development of the Loading Simulation Program C++ (LSPC). Since its inception, Alvi has led development of the LSPC modeling framework (working with John Riverson and others). First released in 2003 by the USEPA Office of Research and Development, LSPC has been applied throughout the US and Canada for analysis of hydrology, TMDLs, watershed planning, and climate change, and can be directly applied or linked to other models to support water rights assessment or other environmental and ecosystem resources management studies. The underlying model is based on HSPF routines including snowmelt, hydrology, and water quality; however, because the model input file is a relational database (Microsoft Access) and the computational engine is coded in a C++ platform, LSPC can manage data large datasets for modeling complex watersheds. LSPC enhancements also include: (1) ability to integrate high-resolution spatial and temporal meteorological inputs, (2) crop-associated irrigation module, (3) water withdrawal and diversion management, and (4) time-variable land use change for modeling transient changes on the land. With Paradigm, Alvi continues leading updates and enhancement of this public-domain, open-source model. Alvi has also successfully applied LSPC to support hundreds of TMDL and watershed planning efforts.

Supply and Demand Assessment Hydrology Modeling, State Water Resources Control Board, CA. Paradigm supports the California State Water Resources Control Board with hydrologic modeling of multiple watersheds across the state, incorporating representation of surface water and groundwater withdrawals. The model development process is data-intensive, sourcing geospatial data sets from various local, state, and national sources. The team is currently developing work plans, calibrated models, and reports for 18 different watersheds across the state using the Loading Simulation Program C++ (LSPC) with linked MODFLOW models in specific watersheds when appropriate. Alvi is serving as the project lead for multiple watersheds with direct oversight of model development, calibration, quality assurance, and deliverable preparation. He provides as-needed technical training and support to team members on the underlying Hydrological Simulation Program--Fortran (HSPF) process algorithms used by LSPC. As the primary developer of LSPC, Alvi continues to maintain the LSPC codebase actively in support of the Supply and Demand Assessment modeling by incorporating new features and model outputs as needed to enhance the functionality of the model further to support the client's needs. Development often requires interacting with the underlying HSPF modules and algorithms to adapt outputs or integrate new features into existing parts of the model.

Sustainable Planning of Hydrology: South Fork Eel and Shasta River Watersheds, State Water Resources Control Board, CA. Paradigm supported the State Board in developing hydrologic and temperature characterization models for the South Fork Eel River and Shasta River watersheds. Alvi supported the development and calibration of surface water-groundwater interaction modeling systems to investigate watershed hydrology and simulate flows in both watersheds under various conditions. He performed analyses of spatial datasets characterizing land cover, topography, geology, soil types, and other features that influence hydrology in each watershed. Alvi and utilized these datasets to develop a spatial representation of hydrologic response units (HRUs) that serve as the foundation for parameterizing the hydrologic model. He also led the compilation and analysis of various meteorological datasets (local gages, gridded products from NLDAS and PRISM) to prepare spatially variable time series of hourly rainfall and potential evapotranspiration and processed these time series for the development of boundary conditions to the LSPC hydrology model. Alvi supported the development python codes for the coupling of LSPC and MODFLOW models and supported the development of the modeling reports for the South Fork Eel River and Shasta River watershed. He processed model outputs to demonstrate model calibration and performance and developed maps that reflected key aspects and complexities in the model configuration.

Water Quality Benefits Evaluation & Analysis. King County Department of Natural Resources & Parks, WA. Paradigm is supporting the King County, WA Department of Natural Resources & Parks in conducting an integrated hydrology, water quality, and stormwater planning modeling study. It includes a linked Loading Simulation Program C++ (LSPC) watershed model with a SUSTAIN optimization model for representing both structural and non-structural stormwater management strategies across King County. The objective of the potential management strategies was to evaluate Benthic Index of Biological Integrity (B-IBI) metrics, reduce tributary pollutant loads, and evaluate the effects on the instream flow duration curve (FDC) across five regional watershed planning units. During Phase 1 of this project, Paradigm's team rebuilt multiple Hydrological Simulation Program--Fortran (HSPF) models into a single integrated LSPC model simulating the entirety of King County's watersheds. This effort concluded with a model verification, a step ahead of formal calibration and validation, to demonstrate the current performance of the translated models. The verification tested the translation of the HSPF model parameters to LSPC and demonstrated the robustness of supplementing local observed data with next-generation gridded meteorological boundary conditions (i.e., PRISM, NLDAS). Five streamflow gages representing large watershed confluences were evaluated during Phase 1. Alvi served as the technical lead for this modeling effort, where he was responsible for model development, calibration, quality assurance, and reporting.

Watershed Management Modeling System (WMMS) 2.0, Los Angeles, County, CA. Alvi led the software updates and enhancements for WMMS 2.0 systems development. WMMS is a comprehensive watershed (LSPC) and best management practice (BMP) modeling (SUSTAIN) system for evaluating hydrologic and water quality management opportunities and the associated cost-benefit implications of different planning scenarios for attaining in-stream water quality objectives. The project involved the development of a representative baseline model for the 12,000 km2 area study area, which was divided into 2,655 catchments and 941 hydraulic routing segments. Alvi supported the hydrology calibration effort and led the water quality calibration of the watershed model. The model calibration captured extremes ranging from the highest storm flows to critical low flow conditions. Alvi also made updates to the EPA SUSTAIN model to support the updates for the WMMS web utilities. Alvi worked closely with the web developers to facilitate seamless linkage and operation of the LSPC and SUSTAIN models with the WMMS online utilities.

Eros Bilyeu, PG, CHG, CGWP, QSD/QSP

PROJECT ROLE

CLASSIFICATION
Senior Hydrogeologist I

EDUCATION
BS, Geology, University of South Alabama, 2009

REGISTRATIONS/CERTIFICATIONS
Professional Geologist, CA #9351; Certified Hydrogeologist, CA #1061

Qualified Stormwater Pollution Prevention Plan Developer and Practitioner (QSD/QSP), #27447

Certified Groundwater Professional (CGWP), #4016962

YEARS OF EXPERIENCE

- 17 years total
- 2 years with Wood Rodgers

Eros Bilyeu is a California Certified Hydrogeologist with over 17 years of experience in high-resolution hydrogeologic characterization and three-dimensional conceptual and numerical modeling of groundwater basins, karst terrains, and fractured bedrock aquifer systems. He has provided consulting services to federal, state, military, aerospace, and municipal clients throughout Southern California and across the United States.

Eros has extensive experience in groundwater management and planning, including implementation of key components of Groundwater Sustainability Plans (GSPs) under California's Sustainable Groundwater Management Act (SGMA) in high-priority basins. He has managed and executed a wide range of groundwater and well-related projects, including managed aquifer recharge (MAR), recharge basins, well siting, well design, and construction management for municipal supply wells.

His technical expertise also includes the design and installation of multi-level and nested monitoring wells, remedial extraction wells, and Aquifer Storage and Recovery (ASR) wells, as well as horizontal wells. Eros is skilled in interpreting complex geologic and hydrogeologic datasets and has worked extensively with local, state, and federal agencies to evaluate groundwater resources and characterize the vertical and spatial distribution of groundwater contaminants, including PFAS.

RELEVANT PROJECT EXPERIENCE

Agua Mansa Commerce Park (former Riverside Cement Plant), Viridian Partners – Jurupa Valley, CA | Project Hydrogeologist. Prior to joining Wood Rodgers, served as the lead hydrogeologist on a site located directly along the Rialto-Colton fault boundary at the interface of the Chino and Rialto-Colton Basins, an area recognized for hydrogeologic complexity and uncertainty. Supported site redevelopment efforts under a California Land Reuse and Revitalization Act (CLRRA) agreement with DTSC. Responsibilities included hydrogeologic evaluations, soil and groundwater investigations, and preparation of soil management plans. Performed technical assessment of hexavalent chromium transport and impact on shallow groundwater and deeper production zones, evaluating potential migration pathways into the regional aquifer system. The work integrating geological, soil and water quality, and site-specific hydrostratigraphic data to assess aquifer connectivity, localized recharge behavior, and the historic operations on long-term groundwater quality and yield.

Rialto-Colton Groundwater Well Installations, Kinder Morgan Energy Company – Colton, CA | Hydrogeologist, 2015-2017. Prior to joining Wood Rodgers, Led field operations and project delivery for hydrogeologic investigations near the Rialto-Colton fault zone, within the Upper Santa Ana Valley Groundwater Basin, adjacent to the Chino Basin boundary. Oversaw installation and testing of groundwater monitoring wells across perched, unconfined, and confined/semi-confined alluvial aquifers, with a focus on characterizing aquitards and confining units critical to vertical flow and storage behavior. Developed and implemented qualitative lithologic mapping protocols tied to quantitative USCS grain-size data, enhancing correlation between borehole observations and geophysical resistivity logs across multiple drilling methods. The work informed stratigraphic correlations, hydraulic parameter estimation, and LNAPL delineation, offering valuable insight into aquifer heterogeneity and the performance of numerical groundwater models in alluvial settings with complex boundary conditions.

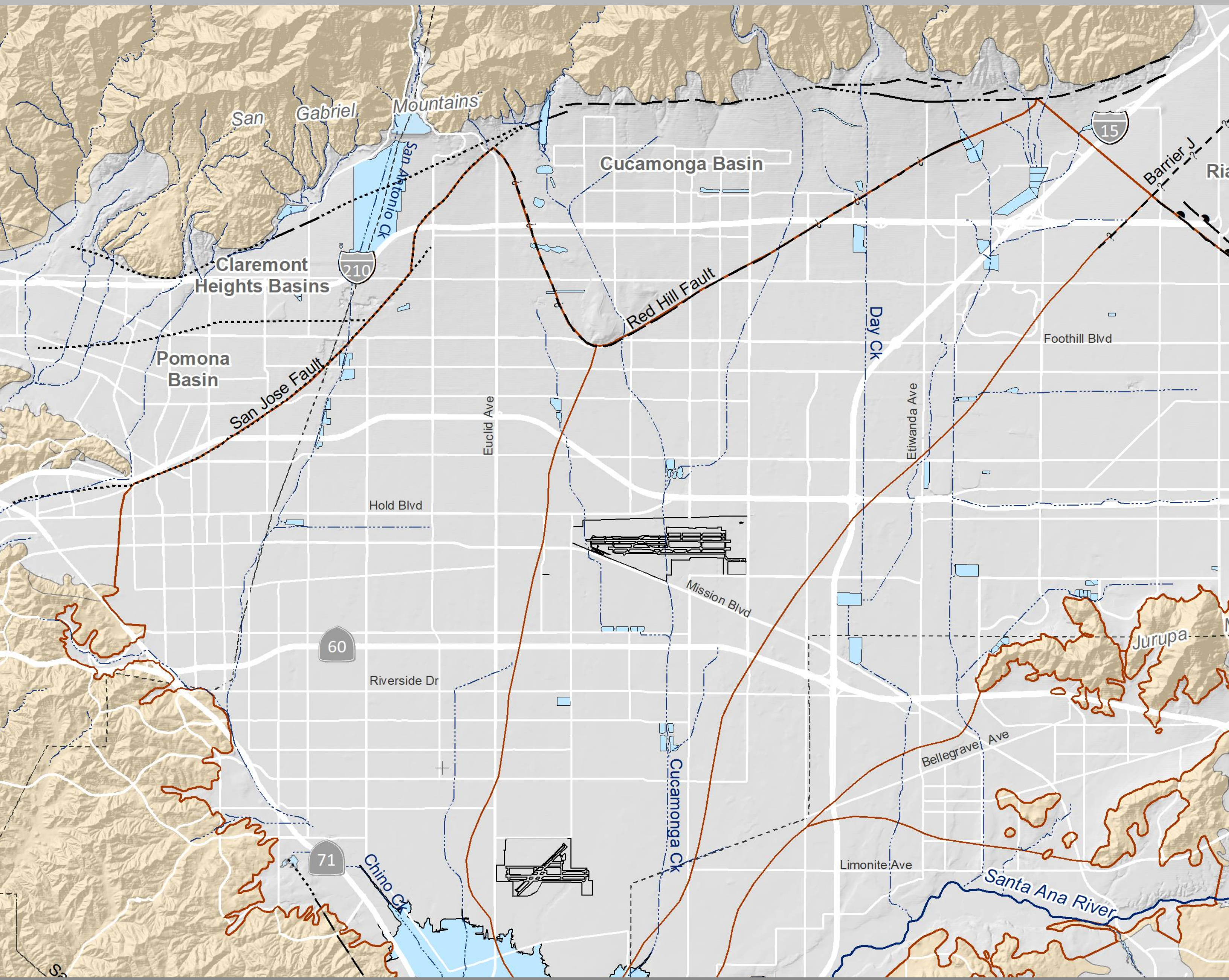
San Bernardino Basin Model (SBBM) Update – Steering Committee Technical Advisor– San Bernardino Valley Municipal Water District, CA | Senior Hydrogeologist. Currently supporting the technical team and steering committee in the update of the San Bernardino Basin groundwater flow model (SBBM), which is used to quantify safe yield and assess groundwater management strategies. Supporting providing peer review of model framework, hydrostratigraphic layering, calibration datasets, and boundary conditions. Supporting evaluating simulation of historical recharge and production data, coordinated with stakeholders and modeling consultants, and provided recommendations for improving model accuracy and applicability for long-term basin sustainability planning.

SGMA Hydrostratigraphic Conceptual and Preliminary Numerical Model of the Los Posas Basins, Calleguas Municipal Water District – Ventura County, CA | Hydrogeologist. Prior to joining Wood Rodgers, developed the SGMA-compliant hydrostratigraphic conceptual model and preliminary numerical groundwater model for the Los Posas Valley and East Las Posas Basins under the Fox Canyon Groundwater Management Agency (FCGMA). Responsibilities included basin-wide subsurface mapping, stakeholder engagement, and interagency coordination with United Water Conservation District and otherstakeholders. Conducted structural and stratigraphic interpretation across 66 square miles and 3,500 feet of subsurface, integrating paleostratigraphic data from proprietary oil well logs into a secure SQL database. Updated the basin hydrostratigraphy, identified structural controls on groundwater flow, refined vertical boundaries, and delineated lateral boundary conditions for inflow/outflow zones to support both the conceptual model and the numerical flow model. Supported groundwater budget development, ASR well field integration, and GSP documentation. Defined aquifer parameters, boundary conditions, and model geometry is directly applicable to assessing assumptions and uncertainty in Net Recharge estimation, storage volume, and structural constraints on flow.

Owner's Agent Contract for Hydrogeological Services in the San Fernando Basin, Los Angeles Department of Water and Power – Los Angeles, CA | Principal Hydrogeologist. Served as the Owner's Agent for the Los Angeles Department of Water and Power (LADWP), delivering expert hydrogeologic and engineering consulting services in support of the San Fernando Groundwater Basin Remediation Program. Prior to joining Wood Rodgers, Eros supported the development, calibration, and application of LADWP's numerical groundwater flow model, which was used to guide well siting, remedial system design, and long-term basin planning. Work included the planning, siting, design, permitting, and construction of groundwater production and monitoring wells, as well as groundwater remediation infrastructure. Led a $1 million remedial investigation and reporting project, updating and incorporating groundwater flow model insights to delineate contaminant pathways, evaluate aquifer responses to pumping, and optimize system designs.This project offered direct involvement in model-based decision-making, evaluation of aquifer parameters, and integration of conceptual hydrogeologic understanding into predictive modeling tools for sustainable basin management and contaminant control.

Perchlorate Cleanup Project – Proposition 1 Grant Funding Project, Water Replenishment District of Southern California – Los Angeles County, CA | Principal Hydrogeologist. Led technical efforts on a Proposition 1–funded cleanup of one of California's most concentrated perchlorate plumes, impacting deep aquifers in the Los Angeles Forebay. Prior to joining Wood Rodgers, Eros was responsible for designing and expanding a nine-well triple-nested monitoring network, along with five remedial progress wells and four extraction wells, to improve plume delineation and guide remedial action. Refined WRD's conceptual model by transitioning from the legacy DWR lithostratigraphy to the comprehensive "Upper San Pedro" hydrostratigraphic framework, now used by USGS and WRD. This framework formed the basis for a newly developed numerical groundwater flow model, which was used to simulate aquifer behavior, define groundwater flow paths, and evaluate the long-term effectiveness of proposed extraction strategies. The modeling work supported both regulatory engagement and grant compliance, while informing the operational design of the extraction system. These efforts are directly supported evaluating aquifer parameter assumptions, boundary condition sensitivity, model calibration, and the use of numerical tools for tracking contaminant transport and assessing Net Recharge in complex, multi-aquifer systems.

S.S. Papadopulos & Associates, Inc.



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June 20, 2025

Chino Basin Watermaster
Board of Directors
Todd Corbin, General Manager
9641 San Bernardino Road
Rancho Cucamonga, CA 91730

Re: Peace Agreement Meet & Confer Process
Economic Evaluation

Board of Directors and Mr. Corbin:

Yesterday, parties to the Chino Basin Peace Agreement met and conferred to consider any new or modified terms which may be requested or required by each party in order to renew the term of the Agreement for another 30 years. This included a request, submitted by Monte Vista Water District and previously discussed by the Appropriative Pool (AP), for Watermaster to engage a consultant to conduct an economic evaluation to implement the Agreement past 2030.

The AP has discussed conducting an economic evaluation for some time, and early this year the Pool requested and received from Watermaster staff a draft scope for such an evaluation. Among AP members attending yesterday's meeting and consistent with prior discussions, there is support for Watermaster moving forward, with full participation and input from all Peace Agreement parties, in finalizing the scope and initiating the process to engage an outside consultant to conduct this evaluation.

This request is made solely in my capacity as AP counsel in connection with the AP being a signatory to the Peace Agreement. It is not intended to nor does it represent the viewpoints or positions of individual AP members or other Peace Agreement parties[1].

Sincerely,

John J. Schatz

John Schatz
Counsel for the Appropriative Pool

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1 It was noted by one party at yesterday's meeting that the economic study is not required in order to determine to extend or not extend the Peace Agreement.
At yesterday's meeting, some Peace Agreement parties, including Ag. Pool legal counsel, reserved any expression of support or opposition to the economic evaluation.

Proposal to Update the Chino Basin Economic Studies from 2006 and 2007.

Introduction

The **Analysis of Aggregate Costs and Benefits of Hydraulic Control, Basin Re-Operation and Desalter Elements of Non-Binding Term Sheet (2006)** and the **Report on the Distribution of Benefits to Basin Agencies from Major Program Elements Encompassed by the Peace Agreement and Non-Binding Term Sheet (2007)** performed by David Sunding, provided comprehensive analyses of the projected costs and benefits associated with the Peace I and II Agreements and achieving hydraulic control in the Chino Basin. Given the significant changes in economic, environmental, and technological conditions since these reports were published and in the context of the mandatory meet and confer process for the renewal option spelled out in the Peace Agreement, it is essential to update these studies to reflect current realities and provide actionable insights for future water management strategies.

Objectives

1. **Update Economic and Environmental Data**: Incorporate the latest data on groundwater rights, water demand, water supply, local infrastructure, and financial metrics.
2. **Revised Conceptual Framework**: Enhance the existing models with new methodologies to account for subsequent court orders which changed CBWM accounting for assessments.
3. **Scenario Analysis**: Develop new baseline and alternative scenarios based on current data and agree-upon changes, by the Appropriative Pool, to assumptions used.
4. **Distribution of Benefits**: Reassess the distribution of net benefits among various agencies.
5. **Sensitivity Analysis**: Conduct a new sensitivity analysis to assess the robustness of the updated results.
6. **Reporting and Recommendations**: Provide a comprehensive report with updated findings and actionable recommendations.

Methodology

1. **Data Collection**:
    - Gather updated data on groundwater rights, water demand, and supply for the Chino Basin agencies.
    - Collect relevant financial data, including costs of extraction, conveyance, and new infrastructure developments.
    - Obtain updated information on the implementation status and outcomes of the Peace I and Peace II Agreements.
2. **Revised Conceptual Framework**:
    - Update the model of groundwater value to reflect current economic conditions and basin utilization, including changes in interest rates and cost structures.

- Revise assumptions, for example, of the Santa Ana River New Yield is treated in the model.
- Incorporate new methodologies to match the current CBWM accounting for assessments.

3. **Distribution of Benefits**:
    - Reassess the distribution of net benefits among the various agencies, considering changes in agency size, water demand, production history and other relevant factors.
    - Evaluate the impact of new agreements or collaborations among the agencies.
4. **Sensitivity Analysis**:
    - Conduct a new sensitivity analysis to assess for the robustness of the updated results against variations in key assumptions.
    - Identify new risks or uncertainties that may affect the distribution of benefits.
5. **Scenario Analysis**:
    - Develop updated baseline and alternative scenarios based on the latest data, trends, and requests from Chino Basin parties.
    - Re-evaluate the net benefits of the Peace I and Peace II[i] Agreements under these new scenarios.
    - Consider additional program elements or policy changes introduced since the original reports.
    - After the preliminary results of the updated model and calculations, request feedback from stakeholders about evaluating new scenarios and analysis
6. **Reporting and Recommendations**:
    - Prepare a comprehensive report summarizing the updated analysis, including detailed findings and recommendations.
    - Provide actionable insights for stakeholders to optimize the management of groundwater resources in the Chino Basin and make informed decisions during the meet and confer process.

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[i] While the Peace II agreement is set to expire in 2030 and there is no renewal clause, parties may want to explore cost and benefits of continued or modified arrangements contained in the agreement.

Project Status: Wineville/Jurupa/RP3 Basin Improvements

Budget:

- Authorized capital budget: $28,846,016

Available Funding:

- $15.4 M in SRF Loan at 0.55%
- $10.8 M is State and Federal Grants

Cost Summary:

- Actual Cost as of June 6, 2025: **$ 26,736,992**
- Remaining Budget: **$ 2,109,024**

Progress:

- Construction Contract with MNR is 95% completed (June 2025)
- Overall construction is 85% completed (March 2026)

Completed scope items

- Rubber dam system at Wineville Basin's spillway
- Control slide gates within Wineville Basin
- Basin grading for a new pump station at Wineville
- Power, controls, and communication systems at Wineville
- 2-miles of 30-Inch Pipeline passing through Fontana and Ontario.
- Stormwater diversion to Jurupa Basin.

Remaining scope items:

- Testing of SCADA and Communication Systems
- Purchase pumps for Wineville Basin and Jurupa Basin
- Install and test the new pumps

Updates:

- Addressing seismic modifications to Jurupa Pum
- Issued purchase order for Pumps
- Requesting additional SRF funds
- See updated progress schedule

TASK	PROGRESS	START	END
Prepare Solicitation Documents		**06-Jun-24**	**11-Nov-24**
Draft Documents	100%	06-Jun-24	22-Aug-24
Review Documents	100%	23-Aug-24	28-Aug-24
Finalize Documents	100%	29-Aug-24	11-Nov-24
Request for Qualification of Pump Suppliers		**19-Nov-24**	**14-Jan-25**
Enter into PlanetBids	100%	19-Nov-24	19-Nov-24
Solicitation (Q&A Period)	100%	20-Nov-24	12-Dec-24
Final Week of Solicitation for RFQ	100%	16-Dec-24	19-Dec-24
Close Solicitation for RFQ (milestone)	100%	19-Dec-24	19-Dec-24
Review Responses to the RFQ	100%	20-Dec-24	13-Jan-25
Notify Prequalified Suppliers (milestone)	100%	14-Jan-25	14-Jan-25
Request for Proposal of Prequalified Suppliers		**14-Jan-25**	**21-May-25**
Prequalified Supplier Draft Initial Submittal and Pricing	100%	14-Jan-25	13-Feb-25
Receive Initial Submittal (milestone)	100%	13-Feb-25	13-Feb-25
Review Initial Submittal	100%	13-Feb-25	27-Feb-25
Prequalified Supplier Draft Final Submittal	100%	28-Feb-25	21-Mar-25
Receive Final Submittal (milestone)	100%	21-Mar-25	21-Mar-25
IEUA Reviews Final Submittal to Decide Pump Supplier	100%	24-Mar-25	07-Apr-25
Board of Directors' Authorization of Purchase Order (milestone)	100%	21-May-25	21-May-25
Pump Fabrication/Installation/Testing/Close-out		**22-May-25**	**19-Feb-26**
Finalized Pump Submittals	38%	22-May-25	20-Jun-25
Fabrication (22 weeks)	7%	22-May-25	23-Oct-25
Delivery	0%	23-Oct-25	06-Nov-25
Installation	0%	06-Nov-25	05-Jan-26
Testing	0%	05-Jan-26	05-Feb-26
Close Out	0%	05-Feb-26	19-Feb-26

Outlet Control Gate/Rubber Dam System

Control/Pump Station Building

Inland Empire Utilities Agency
A MUNICIPAL WATER DISTRICT

Chino Basin Watermaster — Partners in Basin Management

CDA — Chino Basin Desalter Authority

Chino Basin Day

Regional Board Offices/Hybrid
3737 Main Street Suite 500, Riverside, CA (5th Floor Conference Room)
May 27, 2025
8:30 AM to 12:00 PM

Teams Link: **Join the meeting now**

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Agenda

- Introductions
- Discussion with Regional Board:
  - Stormwater MS4
  - Recycled Water Release Reporting
  - Reach 3 Special Study
  - PFAS Activities
- Shared Updates (IEUA, CDA, CBWM):
  - Water Quality Scenario Planning
  - Chino Basin Program
  - Basin Plan Amendment
  - Chino Creek 1B
  - CDA Operations Update
    - South Archibald Plume
    - Chino Airport Plume
  - Update of Septic to Sewer Study
  - MWD Update
    - Diamond Valley Lake (DVL) to Rialto
- Future Updates:
  - Safe Yield Update
  - California Institute for Men (CIM) Sewage Flows