of this optional task depends on the number and locations of new wells installed or the number of well measurement devices that will be upgraded.

10.5 Developing Annual Reports

Following GSP submission, Annual Reports must be submitted to DWR by April 1 per the California Code of Regulations. Annual Reports must include three key sections as follows:

- General Information
- Basin Conditions
- Plan Implementation Progress

Annual reporting will be completed in a manner and format consistent with SGMA regulations Section 356.2, Annual Reports. As annual reporting continues, it is possible this outline will change to reflect Basin conditions, GSA priorities, and applicable requirements. An outline of the information that will be provided in each of the annual report sections is included below.

10.5.1 General Information

General information will include an executive summary that highlights the key content of the Annual Report. As part of the executive summary, this section will include a description of the Basin's sustainability goals, an annually updated implementation schedule, and a Basin map. As required by SGMA regulations, key components of the Annual Report general information section include the following:

- Executive Summary
- Basin Map

10.5.2 Basin Conditions

Basin conditions will describe current groundwater conditions and monitoring results. This section will compare and evaluate: 1) how conditions have changed in the Basin compared to the previous year, and 2) groundwater data for the year compared to historical groundwater data. Pumping data, the effects of project implementation (e.g., outreach or conservation data, if applicable), surface water flows, total water use, and groundwater storage will be included.

To aid in estimating groundwater extraction, an annual land use survey will be conducted. Each groundwater pumping entity in the basin will be required to annually report to the GSA (by December 1) their irrigated acreages and crop types (and any other land uses requiring groundwater) for the previous water year and any anticipated changes for the upcoming year. The GSA will compare this information to recent aerial imagery available. As required by SGMA regulation, key components on the Annual Report's basin conditions section will include the following:

- Groundwater elevation data from the monitoring network
- Hydrographs of elevation data
- Groundwater extraction data
- Surface water supply data
- Total water use data
- Change in groundwater storage, including maps

10.5.3 Plan Implementation Progress

The plan implementation progress section will document the GSA's progress toward successful GSP implementation. This section of the Annual Report would document progress made toward achieving interim milestones and implementation of projects and management actions, if applicable. If any planning threshold exceedances occurred and triggered project management implementation, this section would describe what has been completed to date in the Annual Report. As required by SGMA regulations, key components of this section of the annual report will include the following:

- Plan implementation progress
- Sustainability progress

10.6 Developing 5-Year Evaluation Reports

SGMA requires GSAs to evaluate their GSPs every five years and to assess progress toward meeting approved sustainability goals. This 5-year evaluation report must also document whether a GSP has been amended. Information that will be included in the SPV GSA 5-year evaluation reports is described below. The 5-year evaluation report will be prepared in a manner consistent with SGMA regulations Section 356.4, Periodic Evaluation by Agency, and will include the following sections:

- Sustainability Evaluation—This section describes sustainability and identifies if GSP implementation is on track.
- Plan Implementation Progress—This section describes the status of implementation of GSP activities, updates the implementation schedule, and adjusts projects and management actions as needed.
- Reconsideration of GSP Elements—This section updates GSP components to reflect increased understanding available from continued monitoring and other changes.
- Monitoring Network Update—This section reports the assessment of the GSP monitoring networks function with an analysis of data collected to date and any actions taken to improve the monitoring networks.
- New Information—This section includes new information that became available during the time between updates.
- Regulations or Ordinances and Legal or Enforcement Actions—This section describes any new regulations, ordinances, legal actions, or enforcement actions that affect the Basin.
- Plan Amendments—This section describes any amendments that have been made to the GSP and discusses potential future amendments if identified.
- Coordination—This section describes any coordination within or outside of the Basin.

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Final

San Pasqual Valley Groundwater Basin

Groundwater Sustainability Plan

Volume 2: Appendices

September 2021

Prepared by

WOODARD & CURRAN

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Appendix A
Preparation Checklist
for Groundwater Sustainability Plan Submittal

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San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
Article 3. Technical and Reporting Standards				
352.2	-	Monitoring Protocols	• Monitoring protocols adopted by the GSA for data collection and management • Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin	Section 7, Monitoring Networks - Appendix M
Article 5. Plan Contents, Subarticle 1. Administrative Information				
354.4	-	General Information	• Executive Summary • List of references and technical studies	• Executive Summary • Section 11
354.6	-	Agency Information	• GSA mailing address • Organization and management structure • Contact information of Plan Manager • Legal authority of GSA • Estimate of implementation costs	• Section 1.3, Agency Information • Section 10.2, Implementation Costs and Funding Sources
354.8(a)	10727.2(a)(4)	Map(s)	• Area covered by GSP • Adjudicated areas, other agencies within the basin, and areas covered by an alternative • Jurisdictional boundaries of federal or State land • Existing land use designations • Density of wells per square mile	Section 2, Plan Area
354.8(b)	-	Description of the Plan Area	• Summary of jurisdictional areas and other features	Section 2.1, Plan Area Description
354.8(c)	10727.2(g)	Water Resource	• Description of water resources monitoring and management programs	Section 7, Monitoring Networks

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
			• Description of how the monitoring networks of those plans will be incorporated into the GSP • Description of how those plans may limit operational flexibility in the basin • Description of conjunctive use programs	
354.8(d) 354.8(e)	-	Monitoring and Management Programs	-	-
354.8(f)	10727.2(g)	Land Use Elements or Topic Categories of Applicable General Plans	• Summary of general plans and other land use plans • Description of how implementation of the GSP may change water demands or affect achievement of sustainability and how the GSP addresses those effects • Description of how implementation of the GSP may affect the water supply assumptions of relevant land use plans • Summary of the process for permitting new or replacement wells in the basin • Information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management	Section 2.2, Existing Water Management Programs
354.8(g)	10727.4	Additional GSP Contents	Description of Actions related to: • Control of saline water intrusion • Wellhead protection • Migration of contaminated groundwater • Well abandonment and well destruction program • Replenishment of groundwater extractions • Conjunctive use and underground storage • Well construction policies	Section 2.3, Plan Elements from CWC Section 10727.4

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
			• Addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects • Efficient water management practices • Relationships with State and federal regulatory agencies • Review of land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity • Impacts on groundwater dependent ecosystems	
354.10	-	Notice and Communication	• Description of beneficial uses and users • List of public meetings • GSP comments and responses • Decision-making process • Public engagement • Encouraging active involvement • Informing the public on GSP implementation progress	Section 1.4, Notice and Communication Section 10, Implementation
Article 5. Plan Contents, Subarticle 2. Basin Setting				
354.14	-	Hydrogeologic Conceptual Model	• Description of the Hydrogeologic Conceptual Model • Two scaled cross-sections • Map(s) of physical characteristics: topographic information, surficial geology, soil characteristics, surface water bodies, source and point of delivery for imported water supplies	• Section 3, Hydrogeologic Conceptual Model
354.14(c)(4)	10727.2(a)(5)	Map of Recharge Areas	Map delineating existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas	Section 3.1.3, Areas of Recharge, Potential Recharge, and Groundwater Discharge
-	10727.2(d)(4)	Recharge Areas	Description of how recharge areas identified in the plan substantially contribute to the replenishment of the basin	Section 3.1.3, Areas of Recharge, Potential

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
				Recharge, and Groundwater Discharge Section 5, Water Budgets
354.16	10727.2(a)(1) 10727.2(a)(2)	Current and Historical Groundwater Conditions	• Groundwater elevation data • Estimate of groundwater storage • Seawater intrusion conditions • Groundwater quality issues • Land subsidence conditions • Identification of interconnected surface water systems • Identification of groundwater-dependent ecosystems	• Section 4, Groundwater Conditions • Appendix J – Groundwater-Dependent Ecosystems Technical Memorandum
354.18	10727.2(a)(3)	Water Budget Information	• Description of inflows, outflows, and change in storage • Quantification of overdraft • Estimate of sustainable yield • Quantification of current, historical, and projected water budgets	• Section 5.5, Historical, Current, and Projected Water Budgets • Section 5.6, Sustainable Yield Estimates
-	10727.2(d)(5)	Surface Water Supply	Description of surface water supply used or available for use for groundwater recharge or in-lieu use	Section 5.5, Historical, Current, and Projected Water Budgets
354.20	-	Management Areas	• Reason for creation of each management area • Minimum thresholds and measurable objectives for each management area • Level of monitoring and analysis • Explanation of how management of management areas will not cause undesirable results outside the management area • Description of management areas	• Section 9.2, Management Areas
Article 5. Plan Contents, Subarticle 3. Sustainable Management Criteria				

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
354.24	-	Sustainability Goal	Description of the sustainability goal	Section 6.2, Sustainability Goal
354.26	-	Undesirable Results	• Description of undesirable results • Cause of groundwater conditions that would lead to undesirable results • Criteria used to define undesirable results for each sustainability indicator • Potential effects of undesirable results on beneficial uses and users of groundwater	Section 6, Undesirable Results
354.28	10727.2(d)(1) 10727.2(d)(2)	Minimum Thresholds	• Description of each minimum threshold and how they were established for each sustainability indicator • Relationship for each sustainability indicator • Description of how selection of the minimum threshold may affect beneficial uses and users of groundwater • Standards related to sustainability indicators • How each minimum threshold will be quantitatively measured	Section 8, Minimum Thresholds, Measurable Objectives, and Interim Milestones
354.30	10727.2(b)(1) 10727.2(b)(2) 10727.2(d)(1) 10727.2(d)(2)	Measurable Objectives	• Description of establishment of the measurable objectives for each sustainability indicator • Description of how a reasonable margin of safety was established for each measurable objective • Description of a reasonable path to achieve and maintain the sustainability goal, including a description of interim milestones	Section 8, Minimum Thresholds, Measurable Objectives, and Interim Milestones

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
Article 5. Plan Contents, Subarticle 4. Monitoring Networks				
354.34	10727.2(d)(1) 10727.2(d)(2) 10727.2(e) 10727.2(f)	Monitoring Networks	• Description of monitoring network • Description of monitoring network objectives • Description of how the monitoring network is designed to: demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features; estimate the change in annual groundwater in storage; monitor seawater intrusion; determine groundwater quality trends; identify the rate and extent of land subsidence; and calculate depletions of surface water caused by groundwater extractions • Description of how the monitoring network provides adequate coverage of Sustainability Indicators • Density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends • Scientific rational (or reason) for site selection • Consistency with data and reporting standards • Corresponding sustainability indicator, minimum threshold, measurable objective, and interim milestone • Location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used • Description of technical standards, data collection methods, and other procedures or protocols to ensure comparable data and methodologies	Section 7, Monitoring Networks
354.36	-	Representative Monitoring	• Description of representative sites • Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators	Section 7, Monitoring Networks

San Pasqual Valley Basin Groundwater Sustainability Plan - Preparation Checklist for GSP Submittal

GSP Regulations Section	Water Code Section	Requirement	Description	GSP Section and Status
			• Adequate evidence demonstrating site reflects general conditions in the area	
354.38	-	Assessment and Improvement of Monitoring Network	• Review and evaluation of the monitoring network • Identification and description of data gaps • Description of steps to fill data gaps • Description of monitoring frequency and density of sites	Section 7, Monitoring Networks
Article 5. Plan Contents, Subarticle 5. Projects and Management Actions				
354.44	-	Projects and Management Actions	• Description of projects and management actions that will help achieve the basin's sustainability goal • Measurable objective that is expected to benefit from each project and management action • Circumstances for implementation • Public noticing • Permitting and regulatory process • Time-table for initiation and completion, and the accrual of expected benefits • Expected benefits and how they will be evaluated • How the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included. • Legal authority required • Estimated costs and plans to meet those costs • Management of groundwater extractions and recharge	Section 9, Projects and Management Actions
354.44(b)(2)	10727.2(d)(3)	-	Overdraft mitigation projects and management actions	Section 7, Monitoring Networks

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Appendix B
City of San Diego and County of San Diego Memorandum of Understanding to Create Groundwater Sustainability Agency

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MEMORANDUM OF UNDERSTANDING
DEVELOPMENT OF A GROUNDWATER SUSTAINABILITY PLAN
FOR THE SAN PASQUAL VALLEY GROUNDWATER BASIN

This Memorandum of Understanding for the Development of a Groundwater Sustainability Plan ("GSP") for the San Pasqual Valley Groundwater Basin ("MOU") is entered into and effective this 29 day of June, 2017 by and between the County of San Diego ("County") and the City of San Diego ("City"). The County and the City are each sometimes referred to herein as a "Party" and are collectively sometimes referred to herein as the "Parties."

RECITALS

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act ("Act") found at California Water Code Section 10720, *et seq*;

WHEREAS, Act went into effect on January 1, 2015;

WHEREAS, Act seeks to provide sustainable management of groundwater basins, enhance local management of groundwater; establish minimum standards for sustainable groundwater management; and provide local groundwater agencies the authority and the technical and financial assistance necessary to sustainably manage groundwater;

WHEREAS, the Parties have each declared to be a Groundwater Sustainability Agency ("GSA") overlying portions of San Pasqual Valley Groundwater Basin ("San Pasqual Basin"), identified as Basin Number 9.10, a Bulletin 118 designated (medium-priority) basin;

WHEREAS, each Party has statutory authorities that are essential to groundwater management and Act compliance;

WHEREAS, Section 10720.7 of Act requires all basins designated as high- or medium-priority basins designated in Bulletin 118 be managed under a GSP or coordinated GSPs pursuant to Act;

WHEREAS, Section 10720.7 of Act requires that all basins designated high- or medium- priority basins designated in Bulletin 118 that are not critically overdrafted basins be managed under a GSP by January 31, 2022;

WHEREAS, the Parties intend to eliminate overlap of the Parties by forming a multi-agency GSA (San Pasqual Valley GSA) over the entire San Pasqual Basin (Attachment A) and collectively developing and implementing a single GSP to sustainably manage San Pasqual Basin pursuant to section 10727 *et seq.* of Act;

WHEREAS, the Parties wish to use the authorities granted to them pursuant to the Act and utilize this MOU to memorialize the roles and responsibilities for developing the GSP;

WHEREAS, it is the intent of the Parties to complete the GSP as expeditiously as possible in a manner consistent with Act and its implementing regulations;

WHEREAS, it is the intent of the Parties to cooperate in the successful implementation of the GSP not later than the date as required by the Act for the San Pasqual Basin;

WHEREAS, the Parties wish to memorialize their mutual understandings by means of this MOU; and

NOW, THEREFORE, in consideration of the promises, terms, conditions, and covenants contained herein, the County of San Diego and the City of San Diego hereby agree as follows:

I. Purposes and Authorities.

This MOU is entered into by the Parties for the purpose of establishing a cooperative effort to develop and implement a single GSP to sustainably manage the San Pasqual Basin that complies with the requirements set forth in the Act and its associated implementing regulations. The Parties recognize that the authorities afforded to a GSA pursuant to Section 10725 of the Act are in addition to and separate from the statutory authorities afforded to each Party individually. The Parties intend to memorialize roles and responsibilities for GSP implementation during preparation of the GSP.

II. Definitions.

As used in this Agreement, unless context requires otherwise, the meanings of the terms set forth below shall be as follows:

1. "Act" refers to the Sustainable Groundwater Management Act.
2. "Core Team" refers to the working group created in Section III of the MOU.
3. "Cost Recovery Plan" refers to a component of the Plan that includes an evaluation of fee recovery options and proposed fee recovery alternative(s) available to GSAs pursuant to Sections 10730 and 10730.2 of SGMA.
4. "City" refers to the City of San Diego, a Party to this MOU. The City has designated the Deputy Director for Long-Range Planning and Water Resources Division, Public Utilities Department or their designee(s), as the City department representative to carry out the terms of this MOU for the City.
5. "County" refers to the County of San Diego, a Party to this MOU. The County has designated the Director, Planning & Development Services, or his designee(s), as the County department representative to carry out the terms of this MOU for the County.
6. "DWR" refers to the California Department of Water Resources.
7. "Effective Date" means the date on which the last Party executes this Agreement.
8. "Executive Group" refers to the group created in Section III of the MOU.
9. "Governing Body" means the legislative body of each Party: the City Council and the County Board of Supervisors, respectively.
10. "Groundwater Sustainability Plan ("GSP")" is the basin plan for the San Pasqual Basin that the Parties to this MOU are seeking to develop and implement pursuant to the Act.
11. "Memorandum of Understanding ("MOU")" refers to this agreement.
12. "Party" or "Parties" refer to the City of San Diego and County of San Diego.

13. “GSP Schedule” includes all the tasks necessary to complete the GSP and the date scheduled for completion.

14. “State” means the State of California.

III. **Agreement.**

This section establishes the process for the San Pasqual Basin GSP Core Team, Executive Group and Stakeholder Engagement.

1. Core Team Structure

   a. Details of Core Team structure (number of members and interests represented) will be determined during GSP development.

   b. The Core Team will be coordinated by a City designated person. The City designated person will be responsible for developing the scope of work, schedule, and budget for GSP development for consideration by the Core Team’s members.

2. Establishment and Responsibilities of the GSP Core Team (“Core Team”).

   a. The Core Team will consist of representatives from each Party to this MOU working cooperatively together to achieve the objectives of the Act, and is coordinated by the City. Core Team members serve at the pleasure of their appointing Party and may be removed/changed by their appointing Party at any time. A Party must notify all other Parties to this MOU in writing if that Party removes or replaces Core Team members.

   b. The Core Team shall develop a coordinated GSP. The GSP shall include, but not be limited to, enforcement measures, a detailed breakdown of each Parties responsibilities for GSP implementation, anticipated costs of implementing the GSP, and cost recovery mechanisms (if necessary).

   c. The Core Team shall develop a stakeholder engagement plan (Engagement Plan), which shall detail outreach strategies to involve stakeholders and other interested parties in the preparation of the GSP.

   d. Each member of the Core Team shall be responsible for keeping his/her respective management and governing body informed of the progress towards the development of the GSP and for obtaining any necessary approvals from management/governing body. Each member of the Core Team shall keep the other members reasonably informed as to all material developments so as to allow for the efficient and timely completion of the GSP.

   e. Each Core Team member’s compensation for their service on the Core Team is the responsibility of the appointing Party.

3. Establishment and Responsibilities of the Executive Group.

   a. The Executive Group shall consist of representatives, typically directors, general managers, or chief executives, from each Party.

   b. The Executive Group for San Pasqual discussions will be coordinated by a City representative.

c. The Executive Group's primary responsibilities are to provide information and individual advice to the Core Team on matters such as: progress on meeting goals and objectives, progress on implementing actions undertaken pursuant to the MOU and resolving issues related to those actions, and formulating measures to increase efficiency in reaching the MOUs goals. Executive Group members also provide direction and oversight regarding activities that should be undertaken by their Party's representative(s) on the Core Team.

d. The Executive Group shall develop and approve a "Guiding Principles" document, which will provide a foundation for collaborative discussion, planning, operational values, and mutual understandings among members of the Core Team. Prior to beginning GSP preparation, the "Guiding Principles" will be prepared and included as part of this MOU through reference.

4. Core Team and Executive Group Meetings.

a. The Core Team will establish a meeting schedule and choice of locations for regular meetings to discuss GSP development and implementation activities, assignments, milestones and ongoing work progress.

b. The Core Team shall establish and schedule public meetings to coordinate development and implementation of the GSP.

c. Attendance at all Core Team meetings may be augmented to include staff or consultants to ensure that the appropriate expertise is available.

d. The Core Team agrees to host a minimum of one Executive Group Meeting per calendar year prior to Plan adoption. The purpose of such meetings will be to discuss, review, and resolve details and issues brought forward from the Core Team regarding the development of the Plan and other related activities.

IV. Interagency Communication.

1. To provide for consistent and effective communication between Parties, each Party agrees that a single member from each Party's Core Team will be their central point of contact on matters relating to this MOU. Additional representatives may be appointed to serve as points of contact on specific actions or issues.

2. The Core Team shall appoint a representative from the City to communicate actions conducted under this MOU to DWR and be the main point of contact with DWR. The appointee shall not communicate formal actions or decisions without prior written approval from the Core Team.

3. Informal communications between the Parties and DWR are acceptable.

V. Roles and Responsibilities of the Parties.

1. The Parties are responsible for developing a coordinated GSP that meets the requirements of the Act.

2. The Parties are each responsible for implementing the GSP in their respective

jurisdictional areas (see attached map of jurisdictional areas)

3. The Parties will jointly establish their roles and responsibilities for implementing a coordinated GSP for the San Pasqual Basin in accordance with the Act.
4. The Parties will jointly work in good faith and coordinate all activities to meet the objectives of SGMA compliance. The Parties shall cooperate with one another and work as efficiently as possible in the pursuit of all activities and decisions described in the MOU.
5. As part of the Engagement Plan, and prior to GSP preparation, the Parties agree to explore the option of an advisory committee comprised of diverse social, cultural, and economic elements of the population and area stakeholders within the San Pasqual Basin. If implemented, the advisory committee makeup and structure will be determined prior to GSP development with input from local stakeholders.
6. Each of the Parties will provide expertise, guidance, and data on those matters for which it has specific expertise or statutory authority, as needed to carry out the objectives of this MOU. Further development of roles and responsibilities of each Party will occur during GSP development.
7. After execution of this MOU as soon as reasonably possible, the Core Team shall develop a timeline that describes the anticipated tasks to be performed under this MOU and dates to complete each task ("GSP Schedule"); and scope(s) of work and estimated costs for GSP development. The GSP Schedule will allow for the preparation of a legally defensible GSP acceptable to the Parties and include allowances for public review and comment, and approval by Governing Bodies prior to deadlines required in the Act. The GSP Schedule will be determined at the beginning of GSP development and will be referred and amended as necessary to conform to developing information, permitting, and other requirements. Therefore, this GSP Schedule may be revised from time to time upon mutual agreement of the Core Team. Costs shall be funded and shared as outlined in Section VI.
8. The Core team shall be coordinated by the City and its Executive Group member. Core Team members will collaborate to meet sustainability objectives as defined in SGMA and apply the Guiding Principles developed by the Executive Group prior to developing the GSP.
9. The Core Team shall work in a manner that seeks to achieve full agreement (consensus) amongst the Parties. In the event that the Core Team has attempted, in good faith, to resolve the matter on its own and is unsuccessful, the Core Team agrees to seek resolution through Executive Group Meetings.

VI. <u>Contracting and Funding for GSP Development.</u>

1. The Parties shall mutually develop a scope of work, budget, and Cost Recovery Plan for the work to be undertaken pursuant to this MOU. The GSP Cost Recovery Plan shall be included and adopted in the final San Pasqual Basin GSP. The budget shall be determined prior to any financial expenditures or incurrence of any financial obligations related to consultant costs.
2. The City shall hire consultant(s) to complete required components of the GSP. The

contracting shall be subject to the City's competitive bid process.

3. The Parties agree that consultant costs for GSP development shall be proportionately based on the jurisdictional area of each Party in the San Pasqual Basin such that the City shall pay 90 percent of any consultant cost(s) to prepare a GSP for the San Pasqual Basin while the County shall pay the remaining 10 percent. Compensation for each member's representatives on the Core Team shall be borne by the Party. The Parties shall enter into a cost reimbursement agreement for the preparation of the Plan.
4. Specifically, to fulfill the requirements of the Act, the Core Team will collaboratively agree upon a scope of work for the consultants needed to prepare the GSP. The scope of work and budget shall include only what is required by the Act. In the event that one or more stakeholders requests a non-essential component or additional detail in the scope of work, the Parties will discuss the request, and if appropriate, any deviation from the 90/10 split will be agreed upon in writing prior to execution of that task.
5. The Parties agree that each Party will bear its own staff costs to develop the GSP.

VII. Approval.

1. The Parties agree to make best efforts to adhere to the required GSP Schedule and will forward a final San Pasqual Basin GSP to their respective Governing Body for approval and subsequent submission to DWR for evaluation as provided for in Act.
2. Approval and amendments will be obtained from the County Board of Supervisors prior to submission to the City Council.
3. Each Governing Body retains full authority to approve, amend, or reject the proposed GSP, provided the other Governing Body subsequently confirms any amendments. Both Parties also recognize that the failure to adopt and submit a GSP for the San Pasqual Basin to DWR by January 31, 2022, risks allowing for State intervention in managing the San Pasqual Basin.
4. The Parties agree that they will use good-faith efforts to resolve any issues that one or both Governing Bodies may have with the final proposed GSP for the San Pasqual Basin in a timely manner so as to avoid the possibility of State intervention. An amendment to this MOU is anticipated upon acceptance of the San Pasqual Basin GSP by both Governing Bodies.

VIII. Staffing.

Each Party agrees that it will devote sufficient staff time and other resources to actively participate in the development of the GSP for the San Pasqual Basin, as set forth in this MOU.

IX. Indemnification.

1. Claims Arising From Sole Acts or Omissions of City.
The City of San Diego ("City") hereby agrees to defend and indemnify the County, its agents, officers and employees (hereinafter collectively referred to in this paragraph as "County"), from any claim, action or proceeding against County,

arising solely out of the acts or omissions of City in the performance of this MOU. At its sole discretion, County may participate at its own expense in the defense of any claim, action or proceeding, but such participation shall not relieve City of any obligation imposed by this MOU. The County shall notify City promptly of any claim, action or proceeding and cooperate fully in the defense.

2. <u>Claims Arising From Sole Acts or Omissions of the County</u>.
   The County hereby agrees to defend and indemnify the City of San Diego, its agents, officers and employees (hereafter collectively referred to in this paragraph as 'City') from any claim, action or proceeding against City, arising solely out of the acts or omissions of County in the performance of this MOU. At its sole discretion, City may participate at its own expense in the defense of any such claim, action or proceeding, but such participation shall not relieve the County of any obligation imposed by this MOU. City shall notify County promptly of any claim, action or proceeding and cooperate fully in the defense.

3. <u>Claims Arising From Concurrent Acts or Omissions</u>.
   The City of San Diego ("City") hereby agrees to defend itself, and the County hereby agrees to defend itself, from any claim, action or proceeding arising out of the concurrent acts or omissions of City and County. In such cases, City and County agree to retain their own legal counsel, bear their own defense costs, and waive their right to seek reimbursement of such costs, except as provided in paragraph 5 below.

4. <u>Joint Defense</u>.
   Notwithstanding paragraph 3 above, in cases where City and County agree in writing to a joint defense, City and County may appoint joint defense counsel to defend the claim, action or proceeding arising out of the concurrent acts or omissions of County and City. Joint defense counsel shall be selected by mutual agreement of City and County. City and County agree to share the costs of such joint defense and any agreed settlement in equal amounts, except as provided in paragraph 5 below. City and County further agree that neither Party may bind the other to a settlement agreement without the written consent of both City and County.

5. <u>Reimbursement and/or Reallocation</u>.
   Where a trial verdict or arbitration award allocates or determines the comparative fault of the Parties, City and County may seek reimbursement and/or reallocation of defense costs, settlement payments, judgments and awards, consistent with such comparative fault.

X. Litigation.

In the event that any lawsuit is brought against, either Party based upon or arising out of the terms of this MOU by a third party, the Parties shall cooperate in the defense of the action. Each Party shall bear its own legal costs associated with such litigation.

XI. Books and Records.

Each Party shall have access to and the right to examine any of the other Party's pertinent books, documents, papers or other records (including, without limitation, records contained on electronic media) relating to the performance of that Party's obligations pursuant to this MOU, *providing that* nothing in this paragraph shall be construed to operate as a waiver of any applicable privilege. The Parties shall keep the information exchanged pursuant to this section confidential to the greatest extent allowed by law.

XII. Notice.

All notices required by this MOU will be deemed to have been given when made in writing and delivered or mailed to the respective representatives of City and the County at their respective addresses as follows:

For the City:	For the County:
Lan C. Wiborg Deputy Director Public Utilities Department 525 B Street, Suite 300 San Diego, CA 92101	San Diego County Administrative Officer San Diego County 1600 Pacific Highway San Diego, CA 92101
With a copy to:	With a copy to:
Raymond C. Palmucci Deputy City Attorney, Civil Division Office of the San Diego City Attorney 1200 Third Avenue, Suite 1100 San Diego, CA 92101	Justin Crumley, Senior Deputy Office of County Counsel 1600 Pacific Highway, Rm 355 San Diego, CA 92101

Any Party may change the address or facsimile number to which such communications are to be given by providing the other Parties with written notice of such change at least fifteen (15) calendar days prior to the effective date of the change.

All notices will be effective upon receipt and will be deemed received through delivery if personally served or served using facsimile machines, or on the fifth (5^{th}) day following deposit in the mail if sent by first class mail.

XIII. Miscellaneous.

1. Term of MOU**.** This MOU shall remain in full force and effect until the date upon which the Parties have both executed a document terminating the provisions of this MOU.
2. No Third Party Beneficiaries. This MOU is not intended to, and will not be construed to, confer a benefit or create any right on a third party, or the power or right to bring an action to enforce any of its terms.
3. Amendments. This MOU may be amended only by written instrument duly signed and executed by the City and the County.
4. Compliance with Law. In performing their respective obligations under this MOU, the Parties shall comply with and conform to all applicable laws, rules, regulations and ordinances.

5. Jurisdiction and Venue. This MOU shall be governed by and construed in accordance with the laws of the State of California, except for its conflicts of law rules. Any suit, action, or proceeding brought under the scope of this MOU shall be brought and maintained to the extent allowed by law in the County of San Diego, California.
6. Waiver. The waiver by either Party or any of its officers, agents or employees, or the failure of either Party or its officers, agents or employees to take action with respect to any right conferred by, or any breach of any obligation or responsibility of this MOU, will not be deemed to be a waiver of such obligation or responsibility, or subsequent breach of same, or of any terms, covenants or conditions of this MOU, unless such waiver is expressly set forth in writing in a document signed and executed by the appropriate authority of the City and the County.
7. Authorized Representatives. The persons executing this MOU on behalf of the Parties hereto affirmatively represent that each has the requisite legal authority to enter into this MOU on behalf of their respective Party and to bind their respective Party to the terms and conditions of this MOU. The persons executing this MOU on behalf of their respective Party understand that both Parties are relying on these representations in entering into this MOU.
8. Successors in Interest. The terms of this MOU will be binding on all successors in interest of each Party.
9. Severability. The provisions of this MOU are severable, and the adjudicated invalidity of any provision or portion of this MOU shall not in and of itself affect the validity of any other provision or portion of this MOU, and the remaining provisions of the MOU shall remain in full force and effect, except to the extent that the invalidity of the severed provisions would result in a failure of consideration or would materially adversely affect either Party's benefit of its bargain. If a court of competent jurisdiction were to determine that a provision of this MOU is invalid or unenforceable and results in a failure of consideration or materially adversely affects either Party's benefit of its bargain, the Parties agree to promptly use good faith efforts to amend this MOU to reflect the original intent of the Parties in the changed circumstances.
10. Construction of MOU. This MOU shall be construed and enforced in accordance with the laws of the United States and the State of California.
11. Entire MOU.
    a. This MOU constitutes the entire agreement between the City and the County and supersedes all prior negotiations, representations, or other agreements, whether written or oral.
    b. In the event of a dispute between the Parties as to the language of this MOU or the construction or meaning of any term hereof, this MOU will be deemed to have been drafted by the Parties in equal parts so that no presumptions or inferences concerning its terms or interpretation may be construed against any Party to this MOU.

IN WITNESS WHEREOF, the Parties hereto have set their hand on the date first above written.

CITY OF SAN DIEGO

By: ______________________________
Kristina Peralta
Director, Purchasing & Contracting

I HEREBY APPROVE the form of the foregoing Agreement on this 29 day of 6, 2017.

MARA ELLIOTT, City Attorney

By: ______________________________
Ray Palmucci
Deputy City Attorney

R-311212-1

COUNTY OF SAN DIEGO,
a political subdivision of
the State of California

By: ______________________
Clerk of the Board of Supervisors

DATE: 6/27/17

Approved and/or authorized by the
Board of Supervisors of the County of San Diego.
Meeting Date: 6/21/17 Minute Order No. 4
By: ______________ Date: 6/27/17
Deputy Clerk of the Board Supervisors

APPROVED AS TO FORM AND LEGALITY
BY COUNTY COUNSEL

By: ______________________ 6/21/17
Senior Deputy

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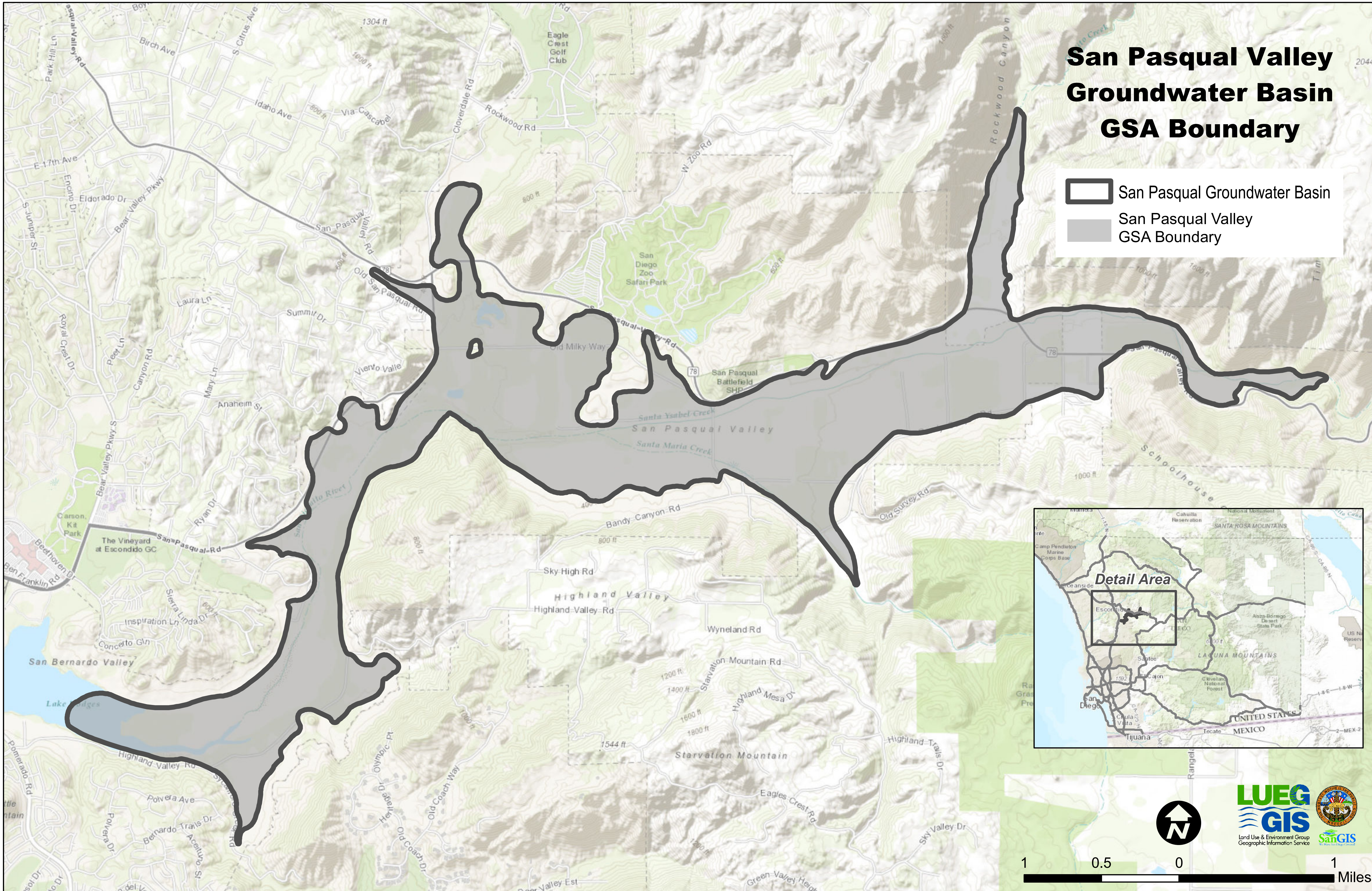

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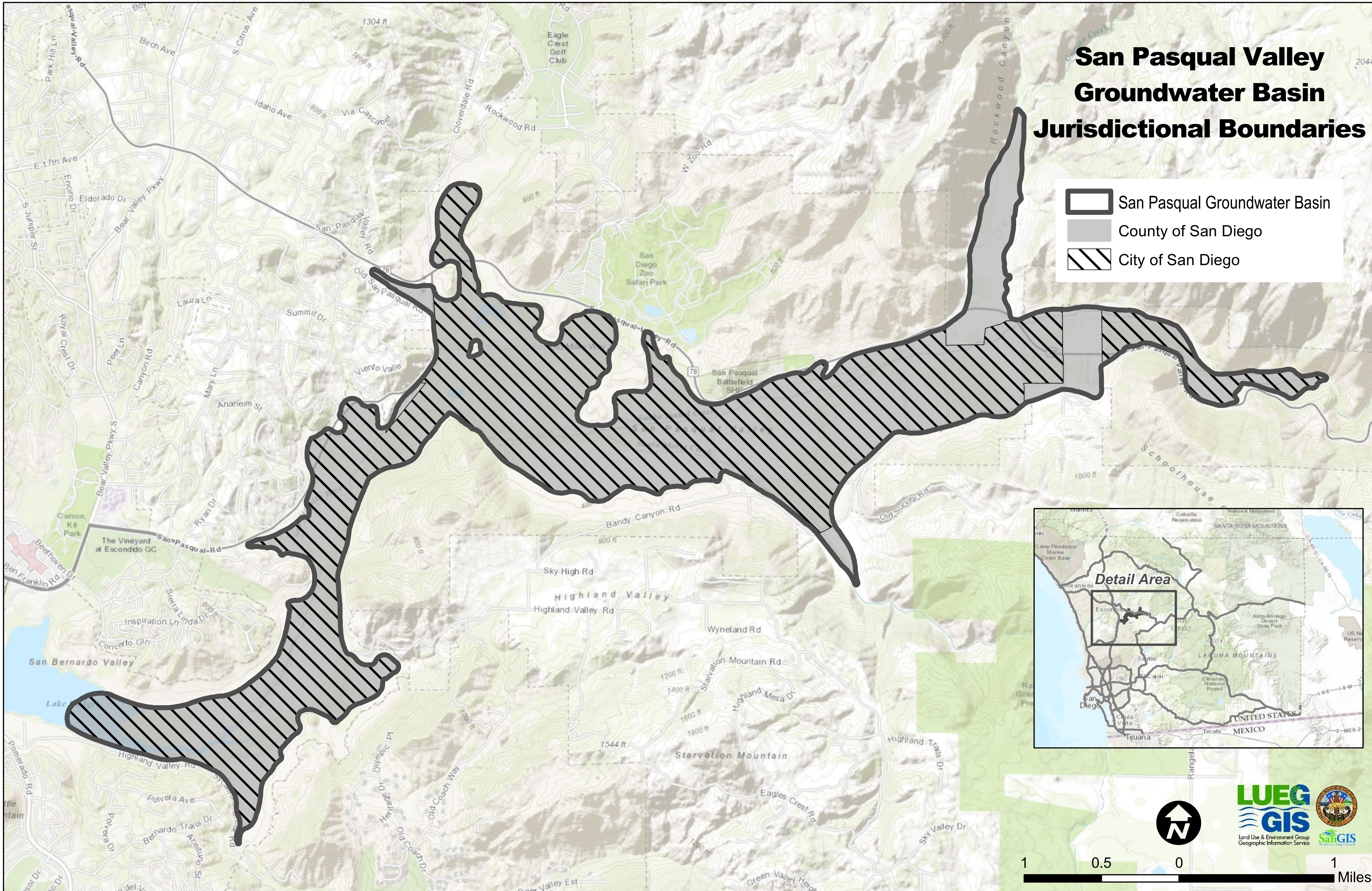

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Appendix C
Notification of Intent to Form a Groundwater Sustainability Agency

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County of San Diego

MARK WARDLAW
DIRECTOR

PLANNING & DEVELOPMENT SERVICES
5510 OVERLAND AVENUE, SUITE 310, SAN DIEGO, CA 92123
(858) 694-2962 • Fax (858) 694-2555
www.sdcounty.ca.gov/pds

June 28, 2017

Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
Department of Water Resources
901 P Street, Room 213A
Post Office Box 942836
Sacramento, CA 94236

Delivery via E-Mail
(Mark.Nordberg@water.ca.gov)

GSA NOTIFICATION: MEMORANDUM OF UNDERSTANDING FOR THE SAN PASQUAL VALLEY GROUNDWATER SUSTAINABILITY AGENCY

Dear Mr. Nordberg:

Pursuant to California Water Code (Water Code) Section 10723.8, the County of San Diego (County) provided notice on August 25, 2016 to the California Department of Water Resources (DWR) of the County's decision to become a Groundwater Sustainability Agency (GSA) for the San Pasqual Valley Groundwater Basin (San Pasqual Basin [DWR Basin No. 9-10]) (Attachment 1). Since the City of San Diego (City) also provided notice to become a GSA for the San Pasqual Basin, the County and City collaborated on a Memorandum of Understanding (MOU) to eliminate any overlap in the areas proposed to be managed. This MOU (Attachment 2) was approved by the County Board of Supervisors on June 21, 2017 and the City Council on June 27, 2017. The MOU establishes the San Pasqual Valley GSA as a multi-agency GSA for the San Pasqual Basin.

The MOU identifies the terms under which each agency agrees to work collaboratively to engage stakeholders and prepare a single Groundwater Sustainability Plan (GSP) that complies with the requirements of the Sustainable Groundwater Management Act (SGMA) to sustainably manage groundwater in the San Pasqual Basin.

The San Pasqual Valley GSA intends to work collaboratively with stakeholders to develop a GSP for the entire San Pasqual Basin that is acceptable to DWR and complies with SGMA. The County and City are committed to considering the interests of all beneficial uses and users of groundwater. To aid this effort, the County and City will develop a stakeholder engagement plan and provide an opportunity for interested parties to participate in the development and implementation of the GSP via regularly-scheduled public workshops, in accordance with Water Code Section 10727.8(a). Interested parties may sign up to receive information about GSP development at the County's SGMA webpage located at: http://www.sandiegocounty.gov/pds/SGMA.html.

The County and City concur that this agreement does not involve a material change from the information in the posted notices from the County and the City, yet eliminates the overlap as required by California Water Code Section 10723.8(c).

If you have any questions, or require additional information, please contact the County Groundwater Geologist, Jim Bennett, at (858) 694-3820.

Sincerely,

MARK WARDLAW, Director
Planning & Development Services

Attachments:
Attachment 1 – San Pasqual Valley Groundwater Basin Map
Attachment 2 – MEMORANDUM OF UNDERSTANDING FOR THE SAN PASQUAL VALLEY GROUNDWATER SUSTABILITY AGENCY

cc.
Jim Bennett, Groundwater Geologist, County of San Diego
(jim.bennett@sdcounty.ca.gov)
George Adrian, City of San Diego

County of San Diego

MARK WARDLAW
DIRECTOR
PHONE (858) 694-2962
FAX (858) 694-2555

PLANNING & DEVELOPMENT SERVICES
5510 OVERLAND AVENUE, SUITE 310, SAN DIEGO, CA 92123
www.sdcounty.ca.gov/pds

DARREN GRETLER
ASSISTANT DIRECTOR
PHONE (858) 694-2962
FAX (858) 694-2555

August 25, 2016

Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
Department of Water Resources
901 P Street, Room 213A
Post Office Box 942836
Sacramento, CA 94236

Delivery via E-Mail
(MarkNordberg@water.ca.gov)

NOTICE OF ELECTION TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SAN LUIS REY VALLEY, SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS

Dear Mr. Nordberg:

Pursuant to California Water Code Section 10723.8, the County of San Diego (County), a political subdivision of the State of California, gives notice to the California Department of Water Resources (DWR) of the County's decision to become a Groundwater Sustainability Agency (GSA) and to undertake sustainable groundwater management in each of the San Luis Rey Valley Groundwater Basin (DWR Basin No. 9-7), the San Pasqual Valley Groundwater Basin (DWR Basin No. 9-10) and the San Diego River Valley Groundwater Basin (DWR Basin No. 9-15) [Basins]. The County overlies the Basins as indicated on the maps included with Attachment 1.

On August 3, 2016, the County Board of Supervisors held a public hearing in accordance with California Water Code Section 10723(b). The public hearing was noticed in *The Daily Transcript* for two successive weeks as required by Government Code Section 6066 (Attachment 2).

After holding the public hearing, the County Board of Supervisors adopted Resolution Number 16-102 (Attachment 1) electing to become a GSA over San Luis Rey Valley, the San Pasqual Valley and the San Diego River Valley Groundwater Basins. No new bylaws, ordinances, or authorities pertaining to those actions were adopted by the County at that time.

The County is coordinating with other local agencies that overlie each medium-priority basin within San Diego County and intends to work cooperatively with those agencies to jointly manage groundwater in each basin. It should be noted that based on prior decisions by the State of California, the groundwater in the Mission, Bonsall, and Pala Subbasins of the San Luis Rey Valley Basin have been determined to be a subterranean stream flowing through known and definite channels (i.e., does not contain groundwater). Since SGMA specifically excludes subterranean streams from its requirements, the County decided to be GSA over the groundwater portion (Pauma Valley Subbasin).

The County Board of Supervisors authorized the Director of Planning & Development Services to negotiate inter-agency agreements with local public agencies overlying each basin, as necessary for the purpose of implementing a cooperative and coordinated governance structure to sustainably manage each basin. To date, Mootamai, Pauma, Valley Center, and Yuima Municipal Water Districts (MWDs) and Pauma Valley Community Services District have provided notice to DWR of their intent to form GSAs over portions of the San Luis Rey Valley Groundwater Basin in Pauma Valley. No other entities within the County's proposed GSA boundaries have provided notice to DWR to become a GSA.

Pursuant to California Water Code Section 10723.2, the County will consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a Groundwater Sustainability Plan (GSP). An initial list of stakeholders and interested parties is described below.

a) Holders of overlying groundwater rights – The majority of individuals and entities exercising overlying groundwater rights within the County have an existing relationship with the County via well permitting requirements and compliance with the County's Groundwater Ordinance. Those entities include agricultural users, domestic well owners, other overlying groundwater users, and public and private land owners.

b) Municipal well operators/water districts – City of San Diego, Padre Dam MWD, Helix Water District, Lakeside Water District, Yuima MWD, Pauma MWD, Mootamai MWD, Valley Center MWD, Rincon Del Diablo MWD.

c) Public water systems – Several mutual water companies.

d) Local land use planning agencies – County, cities of San Diego, Santee, and Escondido.

e) Environmental users of groundwater.

f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies.

g) The federal government, including, but not limited to, the military and managers of federal lands – There are several federal agencies that may hold or manage land overlying groundwater basins within the jurisdictional boundary of San Diego County GSAs, including, without limitation, the following:

1) U.S. Bureau of Land Management,
2) U.S. Marines (Marine Corps Base Camp Pendleton),
3) U.S. Navy (Fallbrook Naval Weapons Station),
4) U.S. Postal Service,
5) U.S. Bureau of Reclamation,
6) U.S. Department of Agriculture (Cleveland National Forest),
7) U.S. General Services Administration, and
8) U.S. Army Corps of Engineers.

h) California Native American tribes – La Jolla, Pala, Pauma, Rincon and San Pasqual Bands of Mission Indians.

i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems.

j) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency – The County and cities of San Diego and Oceanside; and the Helix, Lakeside, Yuima, and Padre Dam Municipal Water Districts have filed, contributed and/or maintain California Statewide Groundwater Elevation Monitoring (CASGEM) monitoring data with the DWR.

The County intends to work cooperatively with stakeholders to develop and implement GSPs for the Basins and will maintain a list of interested parties to be included in the formation of the GSP. By this notification, the County has provided DWR with all applicable information in California Water Code Section 10723.8(a).

If you have any questions, or require additional information, please contact the County Groundwater Geologist, Jim Bennett, at (858) 694-3820.

Sincerely,

MARK WARDLAW, Director
Planning & Development Services

Attachments:
Attachment 1 – Resolution No. 16-102 (Including: A – SGMA Mandated Basins in San Diego County Map; B – San Luis Rey Valley Groundwater Basin Map; C – San Pasqual Valley Groundwater Basin Map; D – San Diego River Valley Groundwater Basin Map)
Attachment 2 – Proof of Publication

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Attachment 1 – Resolution No. 16-102 (Including: A – SGMA Mandated Basins in San Diego County Map; B – San Luis Rey Valley Groundwater Basin Map; C – San Pasqual Valley Groundwater Basin Map; D – San Diego River Valley Groundwater Basin Map)

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Resolution No.: 16-102
Meeting Date: 08/03/16 (3)

RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF SAN DIEGO TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY OVER EACH OF THE SAN LUIS REY VALLEY, SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS.

WHEREAS, on September 16, 2014, the Sustainable Groundwater Management Act (SGMA) was signed into law and adopted into the California Water Code, commencing with Section 10720, and became effective on January 1, 2015;

WHEREAS, the legislative intent of the SGMA is to provide for sustainable management of groundwater basins and sub-basins defined by the California Department of Water Resources (DWR), to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater;

WHEREAS, Water Code Section 10723(a) authorizes local land use authorities, water suppliers, and certain other local agencies, or a combination of local agencies, overlying a groundwater basin to elect to become a Groundwater Sustainability Agency (GSA) for the basin;

WHEREAS, San Diego County (County) is a local agency qualified to become a GSA under SGMA;

WHEREAS, the County overlies the following DWR-designated medium-priority, non-adjudicated groundwater basins identified in the DWR Bulletin No. 118, as shown on the map on Attachments "A" through "D" attached to this Resolution:

- San Luis Rey Valley (9-7)
- San Pasqual Valley (9-10)
- San Diego River Valley (9-15)

WHEREAS, the County recognizes that SGMA does not provide a local agency regulatory authority to implement SGMA over tribal or federal government lands;

WHEREAS, California Water Code Section 10723.8 requires that a local agency electing to serve as a GSA notify DWR of its election to form the GSA and undertake sustainable groundwater management within a basin;

WHEREAS, California Water Code Section 10723.8 mandates that within 90 days of the posting of a notice by DWR of an entity's election to form a GSA, that entity shall be presumed to be the exclusive GSA for that area unless another entity provides notice to DWR of its intent to form a GSA, or notice that the entity has formed a GSA;

WHEREAS, California Water Code Section 10724(a) states that if there is an area within the basin that is not within the management area of another entity, the County will be presumed to be the GSA for that area;

WHEREAS, no other entities have jurisdiction over the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins in their entirety;

WHEREAS, the County intends to work cooperatively with other local agencies and community interests to form GSAs over San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins;

WHEREAS, the County is uniquely qualified to become GSAs over San Diego River Valley, San Pasqual Valley and San Luis Rey Valley Groundwater Basins as a result of its;

- current jurisdiction over the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins (reference Attachments "A" through "D");
- experience in regulating groundwater through the San Diego County Groundwater Ordinance (San Diego County Code Title 6, Division 7, Chapter 7 Groundwater), and groundwater monitoring via the County's role of administering and enforcing State standards and local ordinances pertaining to the construction or destruction of any well or boring within the County (Article 4, Section 67 of the San Diego County Code and the California Well Standards Bulletin 74-90); and
- experience in regulating groundwater use by making land use decisions based on the availability of groundwater for project use and whether or not the project will negatively impact groundwater quantity or quality.

WHEREAS, establishing the County as a GSA will enable the County to coordinate well permitting and extraction allocations with Groundwater Sustainability Plan (GSP) requirements, apply uniform basin management requirements, and ensure diverse stakeholder interests are represented during GSP development for each basin;

WHEREAS, the County is committed to the management of its groundwater resources to create and promote sustainable groundwater use for the residents of the State of California and the County of San Diego;

WHEREAS, the County held a public hearing on August 3, 2016 after publication of notice pursuant to Government Code Section 6066 to consider adoption of this Resolution; and

WHEREAS, no new bylaws were adopted in conjunction with this Resolution and the County's existing Board of Supervisors will serve for governance purposes of the GSA or until the County and other local agencies cooperatively adopt a governing structure for a unified GSA for each basin; and

WHEREAS, adoption of this Resolution does not constitute a "Project" under the California Environmental Quality Act (CEQA) pursuant to 15060(c)(3) and 15378(b)(5) of the State CEQA Guidelines because it is an administrative action that does not result in any direct or indirect physical change in the environment.

THEREFORE, BE IT RESOLVED that the Board of Supervisors of the County of San Diego does hereby elect to become a GSA for San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins (DWR Basins No. 9-7, 9-10 and 9-15, respectively), pursuant to California Water Code Section 10723, as shown on <u>Attachments "A" though "D"</u> attached to this Resolution.

BE IT FURTHER RESOLVED that the County shall develop an outreach program to ensure that all beneficial uses and users of groundwater are considered.

BE IT FURTHER RESOLVED that the Department of Planning & Development Services is hereby directed to submit to DWR, on behalf of the County, a notice of this action to become a GSA and undertake sustainable groundwater management in accordance with SGMA for DWR Basins No. 9-7, 9-10 and 9-15.

BE IT FURTHER RESOLVED that the notification to DWR shall include the boundaries for DWR Basins No. 9-7, 9-10 and 9-15 that the County intends to sustainably manage, a copy of this Resolution, and the initial list of interested parties developed pursuant to California Water Code Section 10723.2, including an explanation of how their interests will be considered in the development and implementation of the GSP.

Approved as to form and legality

Senior Deputy County Counsel
By: Justin Crumley

ON MOTION of Supervisor Jacob, seconded by Supervisor Horn, the above Resolution was passed and adopted by the Board of Supervisors, County of San Diego, State of California, on this 3rd day of August, 2016, by the following vote:

AYES: Cox, Jacob, D. Roberts, R. Roberts, Horn

\- - -

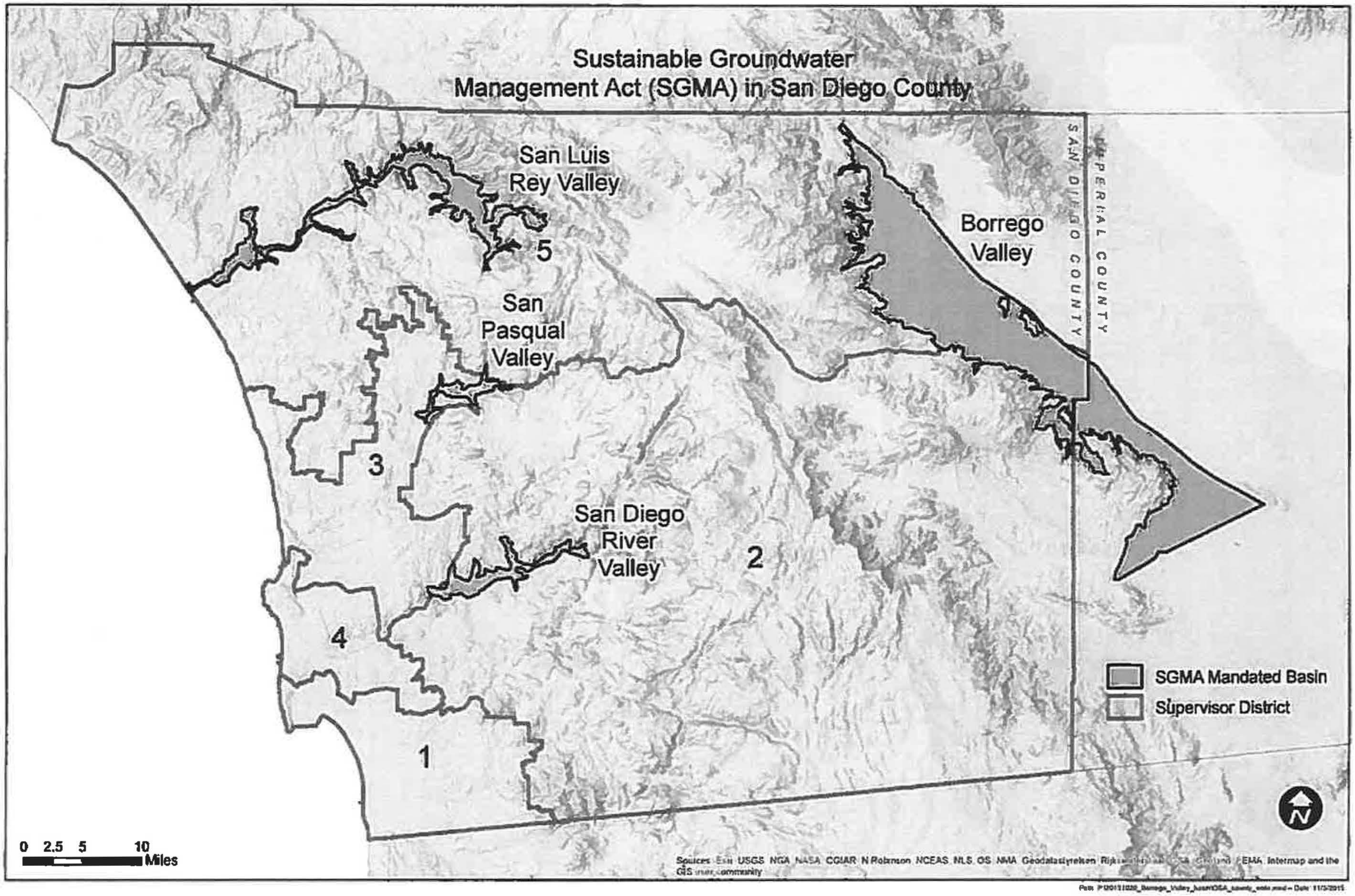
STATE OF CALIFORNIA)
County of San Diego)SS

I hereby certify that the foregoing is a full, true and correct copy of the Original Resolution entered in the Minutes of the Board of Supervisors.

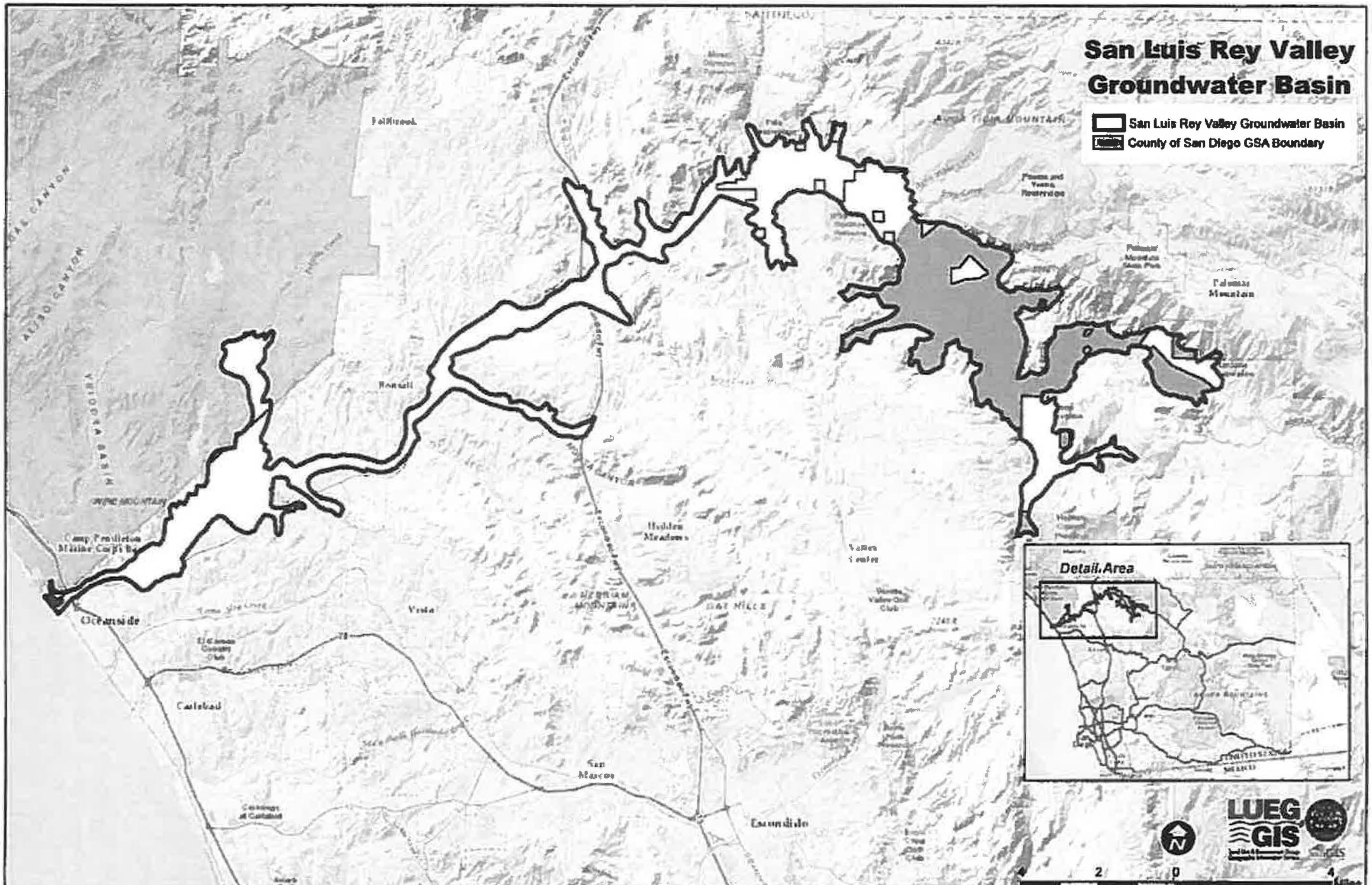
DAVID HALL
Clerk of the Board of Supervisors

By: Elizabeth Miller, Deputy

Resolution No. 16-102
Meeting Date: 08/03/16 (3)

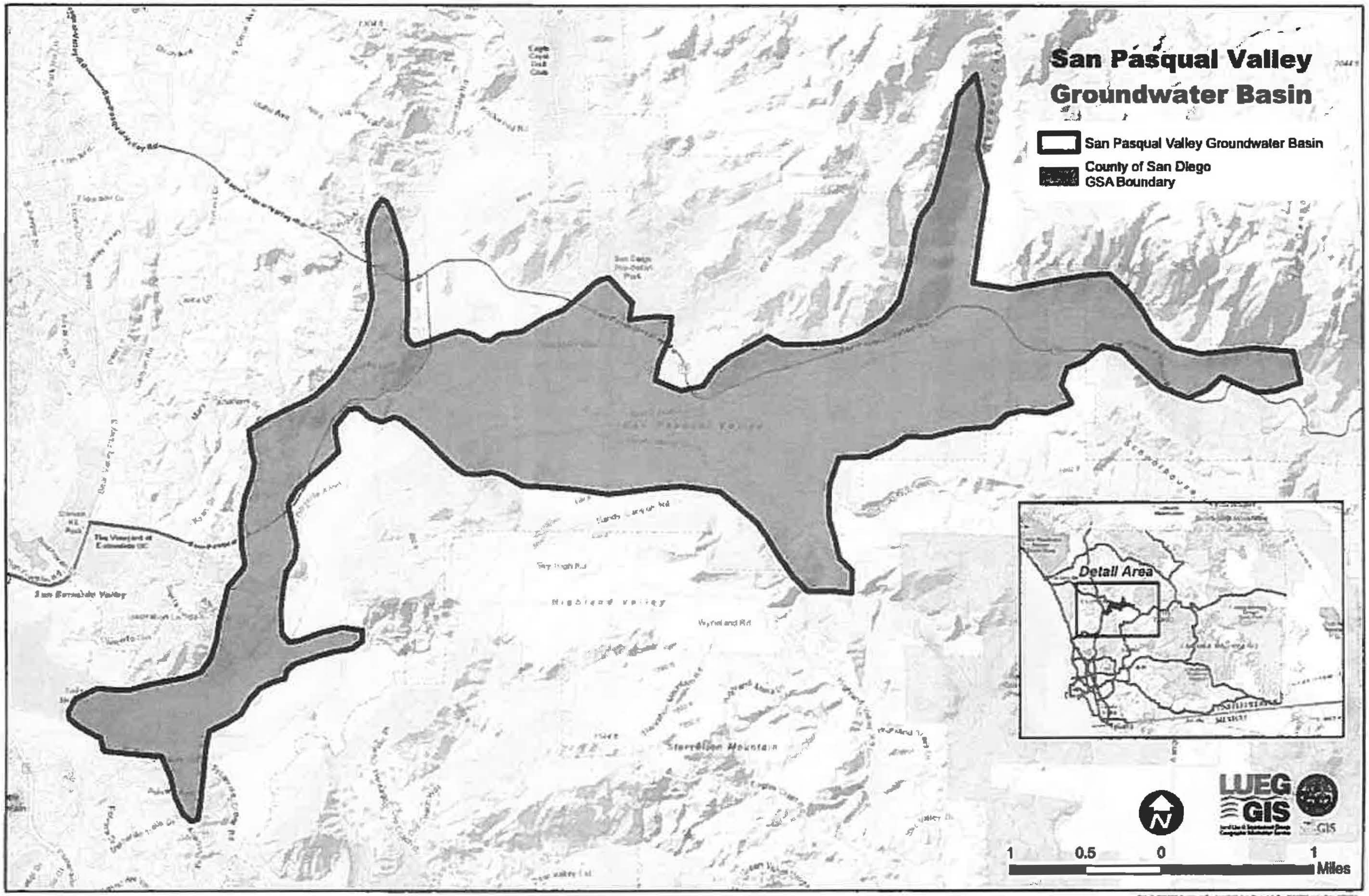


Attachment A



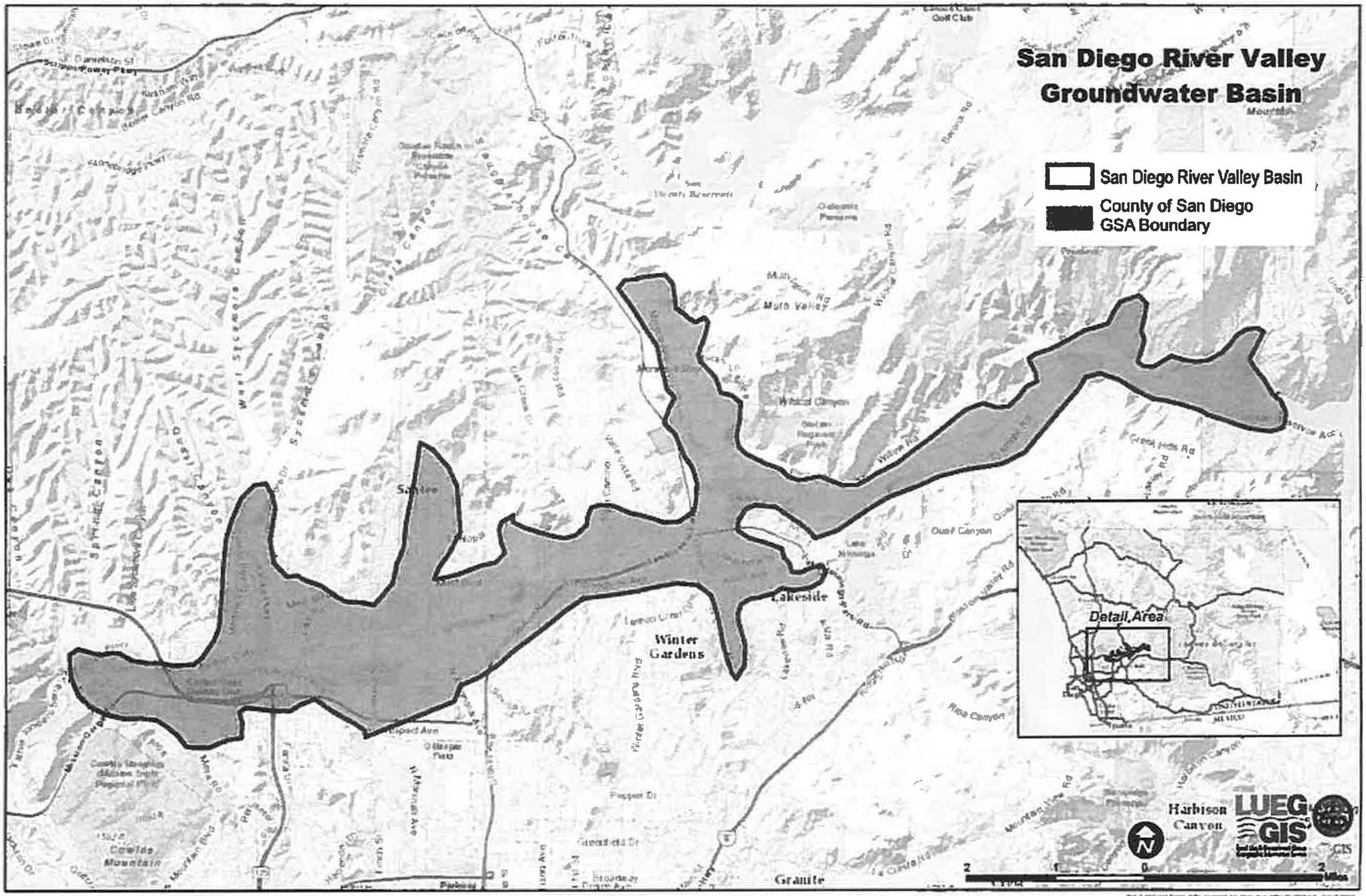
Note: The Federal government and any federally recognized Indian tribe are exempt from the requirements of SGMA and, therefore, not included in the County of San Diego GSA Boundary.

Attachment B



Attachment C

Attachment D



Attachment 2 – Proof of Publication

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NOTICE OF PUBLIC HEARING

COUNTY OF SAN DIEGO

(Including Summary of Resolution)

NOTICE IS HEREBY GIVEN that the Board of Supervisors of the County of San Diego will hold a public hearing on whether to become a Groundwater Sustainability Agency over each of the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins which includes the following proposed Resolution:

"RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF SAN DIEGO TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY OVER EACH OF THE SAN LUIS REY VALLEY, SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS."

HEARING INFORMATION:

	BOARD OF SUPERVISORS
Date:	August 3, 2016
Time:	9:00 A.M. (at or after)
Location:	County Administration Center, Room 310, 1600 Pacific Highway, San Diego, CA

PROJECT DESCRIPTION AND LOCATION: This item is a request for the Board of Supervisors to consider a resolution to establish a Groundwater Sustainability Agency (GSA) over the San Luis Rey Valley Groundwater Basin (SLR Basin), the San Pasqual Valley Groundwater Basin (San Pasqual Basin) and San Diego River Valley Groundwater Basin (SD River Basin) in accordance with the State of California's Sustainable Groundwater Management Act (SGMA). The primary purpose of a GSA under SGMA is to develop a Groundwater Sustainability Plan to achieve long-term groundwater sustainability.

SUMMARY OF RESOLUTION: Resolution of the Board of Supervisors of the County of San Diego to become a Groundwater Sustainability Agency over each of the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins.

ENVIRONMENTAL REVIEW: It is recommended that the proposed action be determined to be exempt from environmental review, under Sections 15061(b)(3) and 15378(b)(5) of the State CEQA Guidelines, because the resolution to become GSAs over the SLR Basin, San Pasqual Basin and SD River Basins is an administrative activity that does not result in any direct or indirect physical change in the environment.

GENERAL INFORMATION: This public hearing is accessible to individuals with disabilities. If interpreter services for the hearing impaired are needed, please call the Americans With Disabilities Coordinator at (619) 531-5205 or California Relay Service, if notifying by TDD, no later than seven days prior to the date of the hearing.

If you challenge the Board's action in court, you may be limited to raising only those issues you or someone else raised at a public hearing, or in written correspondence delivered to the Hearing Body at or before the hearing. Rules of the Hearing Body may limit or impose requirements on the submittal of such written correspondence.

A copy of the full text of the resolution is posted at the Clerk of the Board of Supervisors, Room 402 of County Administration Center.

For additional information regarding this proposal, contact Jim Bennett, Groundwater Geologist, at (858) 694-3820.

THE DAILY TRANSCRIPT

This space for filing stamp only

2652 4TH AVE 2ND FL, SAN DIEGO, CA 92103
Telephone (619) 232-3486 / Fax (619) 270-2503

Renee Loewer
SD CO CLERK OF THE BOARD
1600 PACIFIC HWY., RM. 402
SAN DIEGO, CA - 92101

PROOF OF PUBLICATION

(2015.5 C.C.P.)

State of California)
County of SAN DIEGO) ss

Notice Type: GOV - GOVERNMENT LEGAL NOTICE

Ad Description:

AUTHORIZATION FOR THE COUNTY OF SAN DIEGO TO BECOME A GROUNDWATE

I am a citizen of the United States and a resident of the State of California; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer and publisher of THE DAILY TRANSCRIPT, a newspaper published in the English language in the city of SAN DIEGO, and adjudged a newspaper of general circulation as defined by the laws of the State of California by the Superior Court of the County of SAN DIEGO, State of California, under date of 05/13/2003, Case No. GIC808715. That the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

07/18/2016, 07/25/2016

Executed on: 07/25/2016
At Los Angeles, California

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Signature

Email * A 0 0 0 0 0 4 1 7 2 0 7 3 *

SD#: 2904262

NOTICE OF PUBLIC HEARING
COUNTY OF SAN DIEGO
(Including Summary of Resolution)

NOTICE IS HEREBY GIVEN that the Board of Supervisors of the County of San Diego will hold a public hearing on whether to become a Groundwater Sustainability Agency over each of the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins which includes the following proposed Resolution:

"RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF SAN DIEGO TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY OVER EACH OF THE SAN LUIS REY VALLEY, SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS."

HEARING INFORMATION:

BOARD OF SUPERVISORS
Date: August 3, 2016
Time: 9:00 A.M (at or after)
Location County Administration Center, Room 310, 1600 Pacific Highway, San Diego, CA

PROJECT DESCRIPTION AND LOCATION: This item is a request for the Board of Supervisors to consider a resolution to establish a Groundwater Sustainability Agency (GSA) over the San Luis Rey Valley Groundwater Basin (SLR Basin), the San Pasqual Valley Groundwater Basin (San Pasqual Basin) and San Diego River Valley Groundwater Basin (SD River Basin) in accordance with the State of California's Sustainable Groundwater Management Act (SGMA). The primary purpose of a GSA under SGMA is to develop a Groundwater Sustainability Plan to achieve long-term groundwater sustainability.

SUMMARY OF RESOLUTION: Resolution of the Board of Supervisors of the County of San Diego to become a Groundwater Sustainability Agency over each of the San Luis Rey Valley, San Pasqual Valley and San Diego River Valley Groundwater Basins.

ENVIRONMENTAL REVIEW. It is recommended that the proposed action be determined to be exempt from environmental review, under Sections 15061(b)(3) and 15378(b)(5) of the State CEQA Guidelines, because the resolution to become GSAs over the SLR Basin, San Pasqual Basin and SD River Basins is an administrative activity that does not result in any direct or indirect physical change in the environment.

GENERAL INFORMATION: This public hearing is accessible to individuals with disabilities. If interpreter services for the hearing impaired are needed, please call the Americans With Disabilities Coordinator at (619) 531-5205 or California Relay Service, if notifying by TDD no later than seven days prior to the date of the hearing

If you challenge the Board's action in court, you may be limited to raising only those issues you or someone else raised at a public hearing, or in written correspondence delivered to the Hearing Body at or before the hearing. Rules of the Hearing Body may limit or impose requirements on the submittal of such written correspondence.

A copy of the full text of the resolution is posted at the Clerk of the Board of Supervisors, Room 402 of County Administration Center.

For additional information regarding this proposal, contact Jim Bennett, Groundwater Geologist, at (858) 694-3820.
7/18, 7/25/16

SD-2904262#

November 10, 2016

Sent via U.S. Postal Service & Electronic Mail MarkNordberg@water.ca.gov

Mr. Mark Nordberg, GSA Project Manager
Senior Engineering Geologist
Department of Water Resources
901 P Street, Room 213A
Post Office Box 942836
Sacramento, CA 94236

Subject: Notice of Election to Become a Groundwater Sustainability Agency for the San Pasqual Valley and the San Diego River Valley Groundwater Basins

Dear Mr. Nordberg:

Pursuant to California Water Code Section 10723.8, the City of San Diego (City), a political subdivision of the State of California, gives notice to the California Department of Water Resources (DWR) of the City's decision to become a Groundwater Sustainability Agency (GSA) and to undertake sustainable groundwater management in each of the San Pasqual Valley Groundwater Basin (DWR Basin No. 9-10) and the San Diego River Valley Groundwater Basin (DWR Basin No. 9-15) (Basins). The City overlies the Basins as indicated on the Exhibit maps included with Enclosure 1, within the boundary of the City's jurisdiction.

On October 25, 2016, the San Diego City Council (Council) held a public hearing in accordance with California Water Code Section 10723 (b). The public hearing was noticed in the Daily Journal in accordance with Government Code Section 6066 (Enclosure 2).

After holding the public hearing, the Council adopted Resolution Number R- 310746 (Enclosure 1), electing to become a GSA over the portion of the San Pasqual and San Diego River Valley Groundwater Basins within the jurisdiction of the City. No new bylaws, ordinances, or authorities were adopted by the City at that time.

The City is coordinating with other local agencies that overlie these two medium-priority basins within the County of San Diego (County) and intends to work cooperatively with these agencies to jointly manage groundwater in each Basin.

The Council authorized the City's Public Utilities Department (PUD) Director, Halla Razak, to negotiate inter-agency agreements with local public agencies overlying each of the groundwater basins, as necessary, for the purpose of implementing a cooperative and coordinated governance structure to sustainably manage each Basin.

To date, the County has provided notice to DWR of its intent to form GSAs over the San Pasqual and the San Diego River Valley Groundwater Basins. Also, the City of Santee and the Lakeside Water District have provided notice to DWR of each agency's intent to form a GSA, within its jurisdiction, over the San Diego River Valley Groundwater Basin. No other entities within the City's proposed GSA boundaries have provided notice to DWR to become a GSA.

Pursuant to California Water Code Section 10723.2, the City will consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing a Groundwater Sustainability Plan (GSP). An initial list of stakeholders and interested parties is described below.

a) Holders of overlying groundwater rights - The majority of individuals and entities exercising overlying groundwater rights within the two groundwater basins have a County well permit and compliance with the County's Groundwater Ordinance. Those entities include agricultural users, domestic well owners, other overlying groundwater users, and public and private land owners.

b) Municipal well operators/water districts - City of San Diego, Padre Dam Municipal Water District (MWD), Helix Water District, and Lakeside Water District.

c) Public water systems – Padre Dam MWD, Helix Water District and Lakeside Water District.

d) Local land use planning agencies - County, cities of San Diego and Santee.

e) Environmental users of groundwater.

f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies.

g) California Native American tribes - none.

h) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems or ratepayers and domestic well owners.

i) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency - The County and cities of San Diego and Santee; Padre Dam MWD, Helix Water District and Lakeside Water District have filed, contributed and/or maintain California Statewide Groundwater Elevation Monitoring (CASGEM) monitoring data with the DWR.

The City intends to work cooperatively with stakeholders to develop and implement GSPs for the Basins and will maintain a list of interested parties to be included in the formation of the GSP.

The following information is included in this notice and transmittal pursuant to California Water Code Section 10723.8 (a):

1. City of San Diego Resolution No. R- 310746 (with Exhibit A and B – San Pasqual and San Diego River Valley Groundwater Basin Maps, respectively)

2. Notice of Public Hearing Pursuant to Government Code Section 6066

3. City of San Diego GSA Boundary Shape Files

If you have any questions, or require additional information, please contact the City PUD Long-Range Planning & Water Resources Division Program Manager, George Adrian, at (619) 533-4680 or via email at GAdrian@sandiego.gov.

Sincerely,

Halla Razak
Director, Public Utilities Department

HR/slh

Enclosures: 1. City of San Diego Resolution No. R- 310746 (with Exhibit A and B – San Pasqual and San Diego River Valley Groundwater Basin Maps, respectively)
2. Notice of Public Hearing Pursuant to Government Code Section 6066
3. City of San Diego GSA Boundary Shape File (electronic file only)

cc: Lee Ann Jones-Santos, Assistant Director, Public Utilities Department
Lan C. Wiborg, Deputy Director, Long-Range Planning & Water Resources Division
George Adrian, Program Manager, Long-Range Planning & Water Resources Division
Sandra Carlson, Associate Civil Engineer, Long-Range Planning & Water Resources Division

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Enclosure 1

City of San Diego Resolution No. R-310746 (with Exhibit A and B – San Pasqual and San Diego River Valley Groundwater Basin Maps, respectively)

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#110
SUB-A 10-25-16
(R-2017-121)

RESOLUTION NUMBER R-__310746__

DATE OF FINAL PASSAGE __NOV 07 2016__

A RESOLUTION OF THE COUNCIL OF THE CITY OF SAN DIEGO AUTHORIZING THE CITY TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS.

WHEREAS, in 2014, the California Legislature and the Governor passed into law the Sustainable Groundwater Management Act (SGMA) for best management of groundwater resources in California through the formation of Groundwater Sustainability Agencies (GSAs) and through preparation and implementation of Groundwater Sustainability Plans (GSPs); and

WHEREAS, The City has two groundwater basins that need to be managed by forming a GSA and that are governed by SGMA legislation, the San Pasqual Valley Groundwater Basin and the San Diego River Valley Groundwater Basin extending from Santee in the west to El Capitan Reservoir in the east, and a GSA must be formed for each basin by June 30, 2017; and

WHEREAS, on August 3, 2016, the County of San Diego held a public hearing and approved a resolution to elect to become a GSA over the San Pasqual Valley and the San Diego River Valley Groundwater Basins starting a 90-day window within which the City must declare to become a GSA within any overlapping areas of the two groundwater basins; and

WHEREAS, the Public Utilities Department believes it is essential that the City is part of these GSAs, as SGMA provides GSAs with access to various powers and authorities to ensure sustainable management and will confirm the City's role as the local groundwater management agency, ensure access to SGMA authorities, and preserve access to grant funding or other opportunities that may be limited to GSAs; and

WHEREAS, under the San Diego Charter section 99, a two-thirds vote of the Council is required for passage of this ordinance. NOW, THEREFORE,

BE IT RESOLVED, by the Council of the City of San Diego, as follows:

1. The Mayor or his designee is authorized to sign a resolution for the City of San Diego to become a Groundwater Sustainability Agency over each of the San Pasqual Valley and San Diego River Valley Groundwater Basins.

APPROVED: JAN I. GOLDSMITH, City Attorney

By ______________________
Raymond C. Palmucci
Deputy City Attorney

RCP:mt
October 7, 2016
Or.Dept:Public Utilites
Doc. No. 1372206

I hereby certify that the foregoing Resolution was passed by the Council of the City of San Diego, at this meeting of OCT 25 2016

ELIZABETH S. MALAND
City Clerk

By ______________________
Deputy City Clerk

Approved: 10/31/16
(date)

____
KEVIN L. FAULCONER, Mayor

Vetoed: ______________________
(date)

____
KEVIN L. FAULCONER, Mayor

Passed by the Council of The City of San Diego on OCT 25 2016, by the following vote:

Councilmembers	Yeas	Nays	Not Present	Recused
Sherri Lightner	☑	☐	☐	☐
Lorie Zapf	☑	☐	☐	☐
Todd Gloria	☑	☐	☐	☐
Myrtle Cole	☑	☐	☐	☐
Mark Kersey	☑	☐	☐	☐
Chris Cate	☑	☐	☐	☐
Scott Sherman	☑	☐	☐	☐
David Alvarez	☑	☐	☐	☐
Marti Emerald	☐	☐	☑	☐

Date of final passage NOV 07 2016.

(Please note: When a resolution is approved by the Mayor, the date of final passage is the date the approved resolution was returned to the Office of the City Clerk.)

AUTHENTICATED BY:

KEVIN L. FAULCONER
Mayor of The City of San Diego, California.

(Seal)

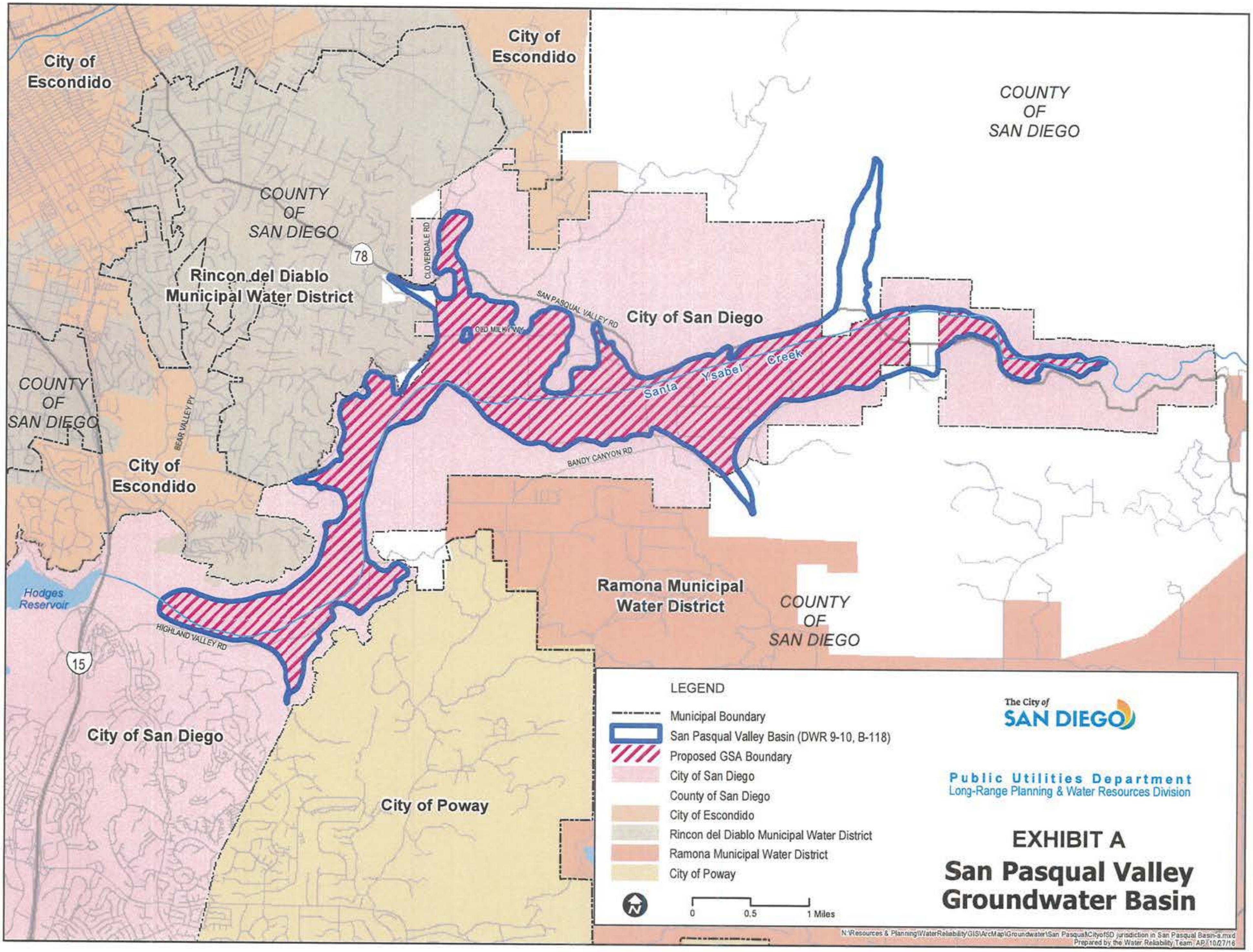
ELIZABETH S. MALAND
City Clerk of The City of San Diego, California.

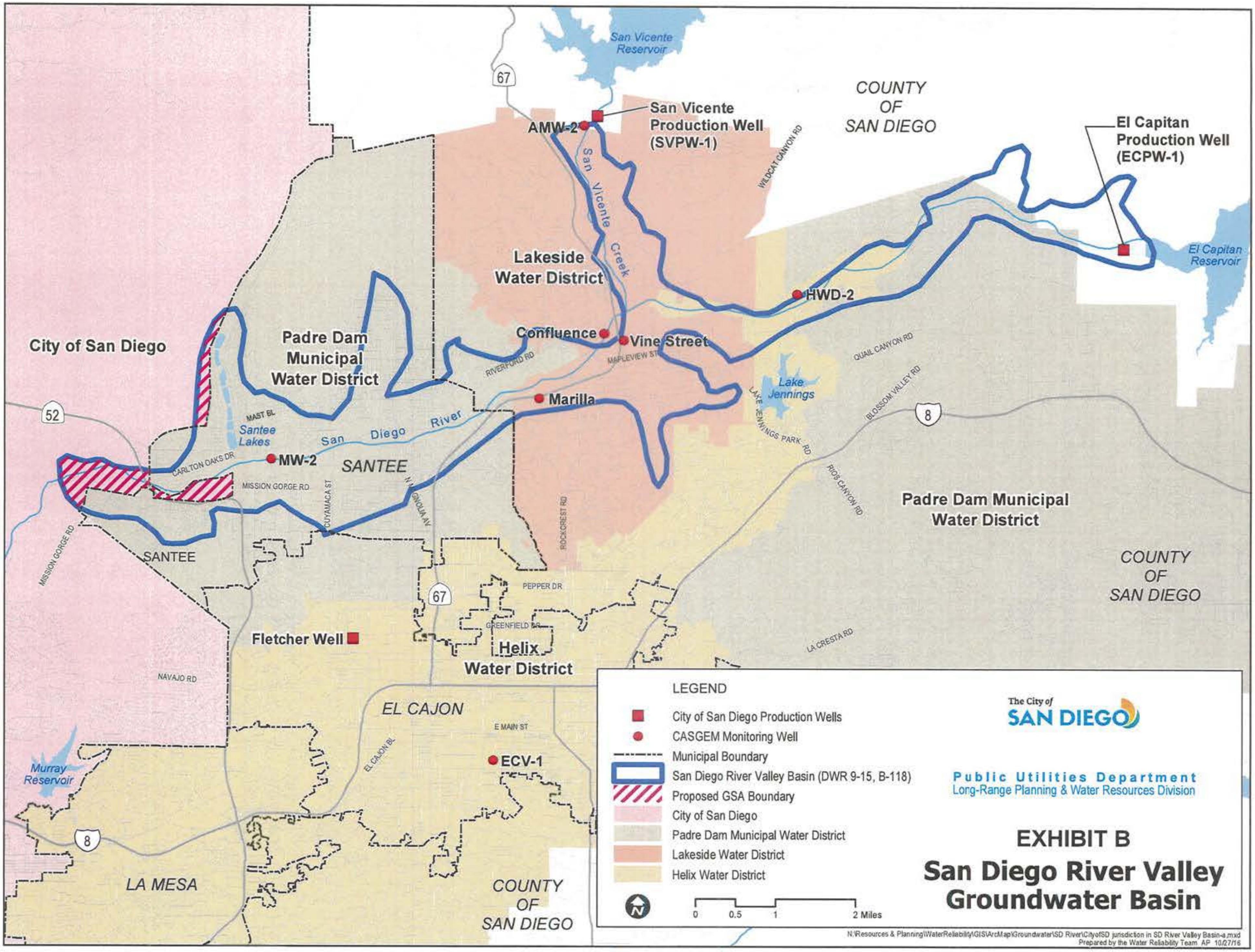
By [signature], Deputy

Office of the City Clerk, San Diego, California

Resolution Number R- 310746

Exhibit 1 – City of San Diego Groundwater Basins


City of Escondido
City of Escondido
COUNTY OF SAN DIEGO
COUNTY OF SAN DIEGO
Rincon del Diablo Municipal Water District
78
CLOVERDALE RD
SAN PASQUAL VALLEY RD
City of San Diego
OLD MILKY WY
Santa Ysabel Creek
COUNTY OF SAN DIEGO
BEAR VALLEY PY
City of Escondido
BANDY CANYON RD
Hodges Reservoir
Ramona Municipal Water District
COUNTY OF SAN DIEGO
HIGHLAND VALLEY RD
15
City of San Diego
City of Poway
LEGEND
Municipal Boundary
San Pasqual Valley Basin (DWR 9-10, B-118)
Proposed GSA Boundary
City of San Diego
County of San Diego
City of Escondido
Rincon del Diablo Municipal Water District
Ramona Municipal Water District
City of Poway
0 0.5 1 Miles
The City of SAN DIEGO
Public Utilities Department
Long-Range Planning & Water Resources Division
EXHIBIT A
San Pasqual Valley Groundwater Basin
Prepared by the Water Reliability Team AP 10/27/16



San Vicente Reservoir
67
COUNTY OF SAN DIEGO
San Vicente Production Well (SVPW-1)
AMW-2
El Capitan Production Well (ECPW-1)
WILDCAT CANYON RD
San Vicente Creek
El Capitan Reservoir
Lakeside Water District
HWD-2
City of San Diego
Padre Dam Municipal Water District
Confluence
Vine Street
MAPLEVIEW ST
RIVERFORD RD
QUAIL CANYON RD
Lake Jennings
BLOSSOM VALLEY RD
Marilla
8
52
MAST BL
Santee Lakes
San Diego River
LAKE JENNINGS PARK RD
CARLTON OAKS DR
MW-2
SANTEE
MISSION GORGE RD
CUYAMACA ST
N MAGNOLIA AV
RIOS CANYON RD
ROCKCREST RD
Padre Dam Municipal Water District
MISSION GORGE RD
SANTEE
COUNTY OF SAN DIEGO
PEPPER DR
67
GREENFIELD DR
Fletcher Well
Helix Water District
LA CRESTA RD
NAVAJO RD
EL CAJON
E MAIN ST
ECV-1
EL CAJON BL
Murray Reservoir
8
LA MESA
COUNTY OF SAN DIEGO
LEGEND
City of San Diego Production Wells
CASGEM Monitoring Well
Municipal Boundary
San Diego River Valley Basin (DWR 9-15, B-118)
Proposed GSA Boundary
City of San Diego
Padre Dam Municipal Water District
Lakeside Water District
Helix Water District
0 0.5 1 2 Miles
The City of SAN DIEGO
Public Utilities Department
Long-Range Planning & Water Resources Division
EXHIBIT B
San Diego River Valley Groundwater Basin
N:\Resources & Planning\WaterReliability\GIS\ArcMap\Groundwater\SD River\CityofSD jurisdiction in SD River Valley Basin-a.mxd
Prepared by the Water Reliability Team AP 10/27/16

Enclosure 2

Notice of Public Hearing Pursuant to Government Code Section 6066

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THE DAILY TRANSCRIPT

2652 4TH AVE 2ND FL, SAN DIEGO, CA 92103
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Monique Ross
SAN DIEGO CITY CLERK (LEAD ACCT)
202 C STREET MS 2A
SAN DIEGO, CA - 92101

PROOF OF PUBLICATION

(2015.5 C.C.P.)

State of California)
County of SAN DIEGO) ss

Notice Type: HRG - NOTICE OF HEARING

Ad Description:

RESOLUTION REQUEST FOR AUTHORIZING THE CITY TO BECOME A GROUNDWA

I am a citizen of the United States and a resident of the State of California; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer and publisher of THE DAILY TRANSCRIPT, a newspaper published in the English language in the city of SAN DIEGO, and adjudged a newspaper of general circulation as defined by the laws of the State of California by the Superior Court of the County of SAN DIEGO, State of California, under date of 05/13/2003, Case No. GIC808715. That the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

10/10/2016

Executed on: 10/10/2016
At Los Angeles, California

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Signature

Email *A000004244049*

SD#: 2933928

NOTICE OF CITY COUNCIL PUBLIC HEARING

DATE OF MEETING: TUESDAY, OCTOBER, 25, 2016

TIME OF MEETING: 2:00 P.M.

PLACE OF MEETING: COUNCIL CHAMBERS, 12TH FLOOR, CITY ADMINISTRATION BUILDING, 202 "C" STREET, SAN DIEGO, CALIFORNIA, 92101

PROJECT NAME: RESOLUTION REQUEST FOR AUTHORIZING THE CITY TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY OVER EACH OF THE SAN PASQUAL VALLEY AND SAN DIEGO RIVER VALLEY GROUNDWATER BASINS

APPLICANT: City of San Diego Public Utilities

COMMUNITY PLAN AREA: Citywide

COUNCIL DISTRICT: Citywide

FOR ADDITIONAL INFORMATION, PLEASE CONTACT CITY PROJECT MANAGER/PHONE: Sandra Carlson at (619) 533-4235 / CarlsonS@sandiego.gov

PLEASE ACCEPT THIS AS A NOTICE TO INFORM YOU, as a property owner, tenant or interested citizen, that the Council of The City of San Diego, California will conduct a public hearing, as part of a scheduled City Council meeting, on the following project:

Notice is hereby given that the Council of the City of San Diego will consider authorizing the City to become a Groundwater Sustainability Agency (GSA) over each of the San Pasqual Valley and San Diego River Valley Groundwater Basins, per California Water Code Sections 10723 to 10727. In 2014, the California Legislature and the Governor passed into law the Sustainable Groundwater Management Act (SGMA), which provides a new framework for best management of groundwater resources in California. Implementation of SGMA is achieved through the formation of GSAs and through preparation and implementation of Groundwater Sustainability Plans (GSPs). The City has two groundwater basins that are governed by SGMA legislation, the San Pasqual Valley Groundwater Basin and the San Diego River Valley Groundwater Basin. These two groundwater basins are designated by the State as medium priority basins and must comply with SGMA requirements.

Once the GSA is formed, the City will then be required to develop and implement a GSP that provides a roadmap for managing each basin on a sustainable basis. The Public Utilities Department believes it is essential for the City to be part of these GSAs. SGMA provides GSAs with access to various powers and authorities to ensure sustainable management. Becoming a GSA will confirm the City's role as the local groundwater management agency, ensure access to SGMA authorities, and preserve access to grant funding or other opportunities that may be limited to GSAs.

The decision of the City Council is final.

COMMUNICATIONS

This item may begin at any time after the time specified. Any interested person may address the City Council to express support or opposition to this issue. **Time allotted to each speaker is determined by the Chair and, in general, is limited to three (3) minutes;** moreover, collective testimony by those in support or opposition shall be limited to no more than fifteen (15) minutes total per side.

Those unable to attend the hearing may write a letter to the Mayor and City Council, Attention: City Clerk, City Administration Building, 202 "C" Street, San Diego, CA 92101-3862, Mail Station 2A; OR you can reach us by E-mail at: **Hearings1@sandiego.gov or FAX: (619) 533-4045.** All communications will be forwarded to the Mayor and Council.

If you wish to challenge the Council's actions on the above proceedings in court, you may be limited to raising only those issues you or someone else raised at the public hearing described in this notice, or in written correspondence to the City Council at or prior to the public hearing. All correspondence should be delivered to the City Clerk (at the above address) to be included in the record of the proceedings.

This material is available in alternative formats upon request. To order information in an alternative format, or to arrange for a sign language or oral interpreter for the meeting, please call the City Clerk's office at least 5 working days prior to the meeting at (619) 533-4000 (voice) or (619) 236-7012 (TT).

ELIZABETH MALAND
SAN DIEGO CITY CLERK
10/11/16

SD-2933928#

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Enclosure 3

City of San Diego GSA Boundary Shape Files (included on CD-ROM)

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Appendix D
California Department of Water Resources
California's Groundwater: Bulletin 118—
Update 2003

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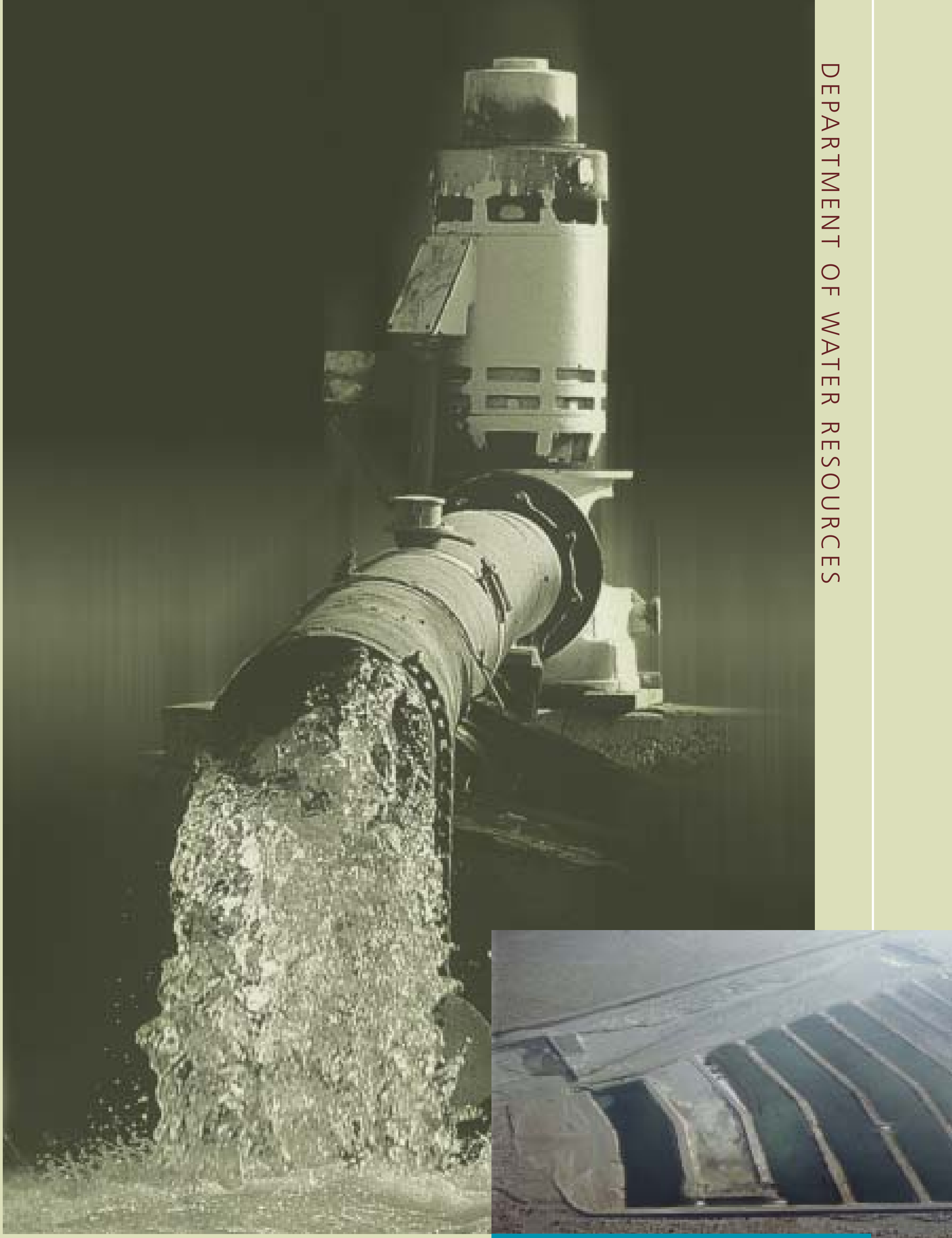
DEPARTMENT OF WATER RESOURCES



BULLETIN 118 · UPDATE 2003

CALIFORNIA'S GROUNDWATER

Cover photograph:
A typical agricultural well with the water discharge pipe and the electric motor that drives the pump.

Inset photograph:
Groundwater recharge ponds in the Upper Coachella Valley near the Whitewater River that use local and imported water. Recharge ponds are also called spreading basins or recharge basins.

State of California
The Resources Agency
Department of Water Resources

CALIFORNIA'S GROUNDWATER

BULLETIN 118 *Update 2003*

October 2003

GRAY DAVIS
Governor
State of California

MARY D. NICHOLS
Secretary of Resources
The Resources Agency

MICHAEL J. SPEAR
Interim Director
Department of Water Resources

If you need this publication in an alternate form, contact the Department's Office of Water Education at 1-800-272-8869.

Foreword

Groundwater is one of California's greatest natural resources. In an average year, groundwater meets about 30 percent of California's urban and agricultural water demands. In drought years, this percentage increases to more than 40 percent. In 1995, an estimated 13 million Californians, nearly 43 percent of the State's population, were served by groundwater. The demand on groundwater will increase significantly as California's population grows to a projected 46 million by the year 2020. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality impacts, or limited by a lack of data, management, and coordination between agencies.

Over the last few years, California voters and the Legislature have provided significant funding to local agencies for conjunctive use projects, groundwater recharge facilities, groundwater monitoring, and groundwater basin management activities under Proposition 13 and the Local Groundwater Management Assistance Act of 2000. Most recently, the 2002 passage of Proposition 50 will result in additional resources to continue recent progress toward sustaining our groundwater resources through local agency efforts. We are beginning to see significant benefits from these investments.

The State Legislature recognizes the need for groundwater data in making sound local management decisions. In 1999, the Legislature approved funding and directed the Department of Water Resources (DWR) to update the inventory of groundwater basins contained in Bulletin 118 (1975), *California's Ground Water* and Bulletin 118-80 (1980), *Ground Water Basins in California.* In 2001, the Legislature passed AB 599, requiring the State Water Resources Control Board to establish a comprehensive monitoring program to assess groundwater quality in each groundwater basin in the State and to increase coordination among agencies that collect groundwater contamination information. In 2002, the Legislature passed SB 1938, which contains new requirements for local agency groundwater management plans to be eligible for public funds for groundwater projects.

Effective management of groundwater basins is essential because groundwater will play a key role in meeting California's water needs. DWR is committed to assisting local agencies statewide in developing and implementing effective, locally planned and controlled groundwater management programs. DWR is also committed to federal and State interagency efforts and to partnerships with local agencies to coordinate and expand data monitoring activities that will provide necessary information for more effective groundwater management. Coordinated data collection at all levels of government and local planning and management will help to ensure that groundwater continues to serve the needs of Californians.

Michael J. Spear
Interim Director

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State of California
Gray Davis, *Governor*

The Resources Agency
Mary D. Nichols, *Secretary for Resources*

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Division of Planning and Local Assistance
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Statewide Water Planning Branch
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Conjunctive Water Management Branch
John Woodling, Chief

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Final coordination by
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with assistance from
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Linda Sinnwell, *Art Director*

Marilee Talley **Alice Dyer** **Xiaojun Li** **Gretchen Goettl** **Joanne Pierce**

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Successful completion of this update and continued implementation of this program would not be possible without the dedicated efforts of the Central, Northern, San Joaquin, and Southern District Offices of the California Department of Water Resources. The information in this report is the result of contributions from many local, state, and federal agencies outside DWR. We would like to acknowledge the contributions of the following agencies.

California Department of Pesticide Regulation
California Department of Toxic Substances Control
California Department of Health Services
California State Water Resources Control Board
California Regional Water Quality Control Boards
United States Geological Survey
United States Bureau of Reclamation

We also wish to thank numerous reviewers who provided valuable comments on the April 2003 public review draft of this bulletin.

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Acronyms and abbreviations

AB Assembly Bill
BMO Basin management objective
CAS California Aquifer Susceptibility
CVP Central Valley Project
DBCP Dibromochloropropane
DCE Dichloroethylene
DHS California Department of Health Services
DPR California Department of Pesticide Regulation
DTSC California Department of Toxic Substances Control
DWR California Department of Water Resources
DWSAP Drinking Water Source Assessment Program
EDB Ethylene dibromide
EC Electrical conductivity
EMWD Eastern Municipal Water District
EWMP Efficient water management
EPA U.S. Environmental Protection Agency
ESA Federal Endangered Species Act
ET Evapotranspiration
ETAW Evapotranspiration of applied water
EWA Environmental Water Account
GAMA Groundwater Ambient Monitoring and Assessment
GIS Geographic information system
GMA Groundwater Management Agency
gpm Gallons per minute
GRID Groundwater Resources Information Database
GRIST Groundwater Resources Information Sharing Team
H & S Health and Safety Code
HR Hydrologic region
ISI Integrated Storage Investigations
ITF Interagency Task Force
JPA Joint powers agreement
maf Million acre-feet
MCL Maximum contaminant level
mg/L Milligrams per liter
MOU Memorandum of understanding
MTBE Methyl tertiary-butyl ether
OCWD Orange County Water District
PAC Public Advisory Committee
PCE Tetrachloroethylene
PCA Possible contaminating activity
PPIC Public Policy Institute of California
ROD Record of Decision
RWQCB Regional Water Quality Control Board
SB Senate Bill
SGA Sacramento Groundwater Authority
SVOC Semi-volatile organic compound
SVWD Scotts Valley Water District
SWRCB State Water Resources Control Board

taf Thousand acre-feet
TCE Trichloroethylene
TDS Total dissolved solids
UWMP Urban water management plan
USACE U.S. Army Corps of Engineers
USBR U.S. Bureau of Reclamation
USC United States Code
USGS U.S. Geological Survey
VOC Volatile organic compound
WQCP Water Quality Control Plan

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Findings

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Major Findings

1. **Groundwater provides about 30% of the State's water supply in an average year, yet in many basins the amount of groundwater extracted annually is not accurately known.**
   - In some regions, groundwater provides 60% or more of the supply during dry years.
   - Many small- to moderate-sized towns and cities are entirely dependent on groundwater for drinking water supplies.
   - 40% to 50% of Californians rely on groundwater for part of their water supply.
   - In many basins, groundwater use is indirectly estimated by assuming crop evapotranspiration demands and surveying the acreage of each crop type.

2. **Opportunities for local agencies to manage their groundwater resources have increased significantly since the passage of Assembly Bill 3030 in 1992. (Water Code § 10750 et seq.). In the past several years more agencies have developed management programs to facilitate conjunctive use, determine the extent of the resource, and protect water quality.**
   - The act provides the authority for many local agencies to manage groundwater.
   - The act has resulted in more than 200 local agencies adopting groundwater management plans to date.
   - The act encourages regional cooperation in basins and allows private water purveyors to participate in groundwater management through memoranda of understanding with public agencies.
   - Many local agencies are recognizing their responsibility and authority to better manage groundwater resources.

3. **Agencies in some areas have not yet developed groundwater management plans.**
   - Concerns about cooperative management, governance, and potential liabilities have kept some agencies from developing management plans.
   - Development of management programs to maintain a sustainable groundwater supply for local use has not been accomplished throughout the State.

4. **A comprehensive assessment of overdraft in the State's groundwater basins has not been conducted since Bulletin 118-80, but it is estimated that overdraft is between 1 million and 2 million acre-feet annually.**
   - Historical overdraft in many basins is evident in hydrographs that show a steady decline in groundwater levels for a number of years.
   - Other basins may be subject to overdraft in the future if current water management practices are continued.
   - Overdraft can result in increased water production costs, land subsidence, water quality impairment, and environmental degradation.
   - Few basins have detailed water budgets by which to estimate overdraft.
   - While the most extensively developed basins tend to have information, many basins have insufficient data for effective management or the data have not been evaluated.
   - The extent and impacts of overdraft must be fully evaluated to determine whether groundwater will provide a sustainable water supply.
   - Modern computer hardware and software enable rapid manipulation of data to determine basin conditions such as groundwater storage changes or groundwater extraction, but a lack of essential data limits the ability to make such calculations.
   - Adequate statewide land use data for making groundwater extraction estimates are not available in electronic format.

5. **Surface water and groundwater are connected and can be effectively managed as integrated resources.**
   - Groundwater originates as surface water.
   - Groundwater extraction can affect flow in streams.
   - Changes in surface water flow can affect groundwater levels.
   - Legal systems for surface water and groundwater rights can make coordinated management complex.

6. **Groundwater quality and groundwater quantity are interdependent and are increasingly being considered in an integrated manner.**
   - Groundwater quantity and groundwater quality are inseparable.
   - Groundwater in some aquifers may not be usable because of contamination with chemicals, either from natural or human sources.
   - Unmanaged groundwater extraction may cause migration of poor quality water.
   - Monitoring and evaluating groundwater quality provides managers with the necessary data to make sound decisions regarding storage of water in the groundwater basin.
   - State agencies conduct several legislatively mandated programs to monitor different aspects of groundwater quality.
   - California Department of Water Resources (DWR) monitors general groundwater quality in many basins throughout the State for regional evaluation.

7. **Land use decisions affecting recharge areas can reduce the amount of groundwater in storage and degrade the quality of that groundwater.**
   - In many basins, little is known about the location of recharge areas and their effectiveness.
   - Protection and preservation of recharge areas are seldom considered in land use decisions.
   - If recharge areas are altered by paving, channel lining, or other land use changes, available groundwater will be reduced.
   - Potentially contaminating activities can degrade the quality of groundwater and require wellhead treatment or aquifer remediation before use.
   - There is no coordinated effort to inform the public that recharge areas should be protected against contamination and preserved so that they function effectively.

Additional Important Findings

8. **Funding to assist local groundwater management has recently been available in unprecedented amounts.**
   - Proposition 13 (Water Code, § 79000 et seq.) authorized $230 million in loans and grants for local groundwater programs and projects, almost all of which has been allocated.
   - The Local Groundwater Management Assistance Act of 2000 (Water Code, § 10795) has resulted in more than $15 million in grants to local agencies in fiscal years 2001, 2002, and 2003.
   - Proposition 50 (Water Code, § 79500 et seq) will provide funding for many aspects of water management, including groundwater management and groundwater recharge projects.
   - Funding for the California Bay-Delta program has provided technical and facilitation assistance to numerous local groundwater planning efforts.

9. **Local governments are increasingly involved in groundwater management.**
    - Twenty-four of the 27 existing county groundwater management ordinances have been adopted since 1990.
    - Most ordinances require the proponents of groundwater export to demonstrate that a proposed project will not cause subsidence, degrade groundwater quality, or deplete the water supply before the county will issue an export permit.
    - While the ordinances generally require a permit for export of groundwater, most do not require a comprehensive groundwater management plan designed to ensure a sustainable water resource for local use.
    - Some local governments are coordinating closely with local water agencies that have adopted groundwater management plans.
    - Many local governments are monitoring and conducting studies in an effort to better understand groundwater resources.

10. **Despite the increased groundwater management opportunities and activities, the extent of local efforts is not well known.**
    - There is no general requirement that groundwater management plans be submitted to DWR, so the number of adopted plans and status of groundwater management throughout the State are not currently known.
    - There are no requirements for evaluating the effectiveness of adopted plans, other than during grant proposal review.
    - No agency is responsible for tracking implementation of adopted plans.
    - Unlike urban water management plans, groundwater management plans are not required to be submitted to DWR, making the information unavailable for preparing the California Water Plan.

11. **Despite the fact that several agencies often overlie each groundwater basin, there are few mechanisms in place to support and encourage agencies to manage the basin cooperatively.**
    - Some local agencies have recognized the benefits of initiating basinwide and regional planning for groundwater management and have recorded many successes.
    - Regional cooperation and coordination depends on the ability of local agencies to fund such efforts.
    - There is no specific State or federal program to fund and support coordination efforts that would benefit all water users in a region and statewide.

12. **The State Legislature has recognized the need to consider water supplies as part of the local land use planning process.**
    - Three bills—Senate Bill 221[1], SB 610[2], and AB 901[3]—were enacted in 2001 to improve the assessment of water supplies. The new laws require the verification of sufficient water supply as a condition for approving certain developments and compel urban water suppliers to provide more information on the reliability of groundwater as an element of supply.
    - The Government Code does not specifically require local governments to include a water resources element in their general plans.

---

[1] Business and Professions Code Section 11010, Government Code Sections 65867.5, 66455.3, and 66473.7.
[2] Public Resources Code Section 21151.9, Water Code Sections 10631, 10656, 10657, 10910-10912, 10915.
[3] Water Code Sections 10610.2, 10631, 10634.

13. **The need to monitor groundwater quality and contamination of groundwater continues to grow.**
    - As opportunities for developing additional surface water supplies become more limited, subsequent growth will increasingly rely on groundwater.
    - Human activities are likely the cause of more than half the exceedances of maximum contaminant levels in public water supply wells.
    - New contaminants are being regulated and standards are becoming more stringent for others, requiring increased monitoring and better management of water quality.

14. **Monitoring networks for groundwater levels and groundwater quality have not been evaluated in all basins to ensure that the data accurately represent conditions in the aquifer(s).**
    - Groundwater levels are monitored in about 10,000 active wells including those basins where most of the groundwater is used.
    - Groundwater levels are not monitored in approximately 200 basins, where population is sparse and groundwater use is generally low.
    - Groundwater quality monitoring networks are most dense near population centers and may not be representative of the basin as a whole.
    - Many of the wells being monitored are not ideally constructed to provide water level or water quality information that is representative of a specific aquifer.
    - Many wells are too deep to monitor changes in the unconfined (water table) portion of basins.

15. **The coordination of groundwater data collection and evaluation by local, State, and federal agencies is improving.**
    - The State Water Resources Control Board (SWRCB) recently formed the Groundwater Resources Information Sharing Team (GRIST) consisting of several State and federal agencies with groundwater-related programs.
    - DWR established a website in 1996 that has provided water-level data and hydrographs for more than 35,000 active and inactive wells monitored by DWR and cooperating agencies.
    - DWR collects and maintains water level data in part through partnerships with local agency cooperators.
    - DWR staff collaborated with many local, State, and federal agencies in developing this update of Bulletin 118.
    - SWRCB recently formed an interagency task force to develop a comprehensive groundwater quality monitoring program for assessing every groundwater basin in the State as required by the Groundwater Quality Monitoring Act of 2001 (AB 599; Water Code, § 10780 et seq.).
    - Water purveyors have concerns about balancing public access to data with water supply security.

16. **Boundaries of groundwater basins have been determined using the best available geologic and hydrologic information. These boundaries are important in determining the availability of local water supplies.**
    - Basin boundaries were derived primarily by identifying alluvial sediments on geologic maps using the best available information, but are subject to change when new information becomes available.
    - The Water Code requires the use of basin boundaries defined in Bulletin 118 in groundwater management plans and urban water management plans.
    - The location of basin boundaries will become more critical as the demand for water continues to increase.
    - Subbasin boundaries may be delineated for management convenience rather than based on hydrogeologic conditions.

17. **Little is known about the stream-aquifer interaction in many groundwater basins.**
    - Groundwater and surface water are closely linked in the hydrologic cycle.
    - The relationship between streamflow and extraction of groundwater is not fully understood in most basins and is generally not monitored.
    - Groundwater extraction in many basins may affect streamflow.
    - Interaction of groundwater flow and surface water may affect environmental resources in the hyporheic zone.
    - An understanding of stream-aquifer interaction will be essential to evaluating water transfers in many areas of the State.

18. **Although many new wells are built in fractured rock areas, insufficient hydrogeologic information is available to ensure the reliability of groundwater supplies.**
    - Population is increasing rapidly in foothill and mountain areas in which groundwater occurs in fractured rock.
    - The cumulative effect of groundwater development may reduce the yield of individual wells, lower the flow of mountain streams, and impact local habitat.
    - Characterization of groundwater resources in fractured rock areas can be very expensive and complex.
    - Many groundwater users in these areas have no other water supply alternatives.
    - Recent dry years have seen many wells go dry in fractured rock areas throughout the State.
    - Groundwater management in these areas is beginning, but there is insufficient data to support quantitative conclusions about the long-term sustainable yield.

19. **When new wells are built, drillers are required to file a Well Completion Report with DWR. That report contains a lithologic log, the usability of which varies considerably from driller to driller.**
    - The Well Completion Reports are confidential and not available to the public, as stipulated by the Water Code, unless the owner's permission is obtained.
    - The usefulness of the information in Well Completion Reports varies but is not fully realized.
    - Public access to Well Completion Reports would increase understanding of groundwater conditions and issues.
    - There is no provision in the Water Code that requires submission of geophysical logs, which would provide an accurate log of the geologic materials within the aquifer.
    - Geophysical logs would provide a greatly improved database for characterization of aquifers.

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Recommendations

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Major Recommendations

1. **Local or regional agencies should develop groundwater management plans if groundwater constitutes part of their water supply. Management objectives should be developed to maintain a sustainable long-term supply for multiple beneficial uses. Management should integrate water quantity and quality, groundwater and surface water, and recharge area protection.**
   - Groundwater management in California is a local agency responsibility.
   - In basins where there is more than one management agency, those agencies should coordinate their management objectives and program activities.
   - A water budget should be completed that includes recharge, extraction and change in storage in the aquifer(s).
   - Changes in groundwater quality should be monitored and evaluated.
   - Stakeholders should be identified and included in development of groundwater management plans.

2. **The State of California should continue programs to provide technical and financial assistance to local agencies to develop monitoring programs, management plans, and groundwater storage projects to more efficiently use groundwater resources and provide a sustainable supply for multiple beneficial uses. DWR should:**
   - Post information about projects that have successfully obtained funding through various grant and loan programs.
   - Provide additional technical assistance to local agencies in the preparation of grant and loan applications.
   - Continue outreach efforts to inform the public and water managers of grant and loan opportunities.
   - Participate, when requested, in local efforts to develop and implement groundwater management plans.
   - Continue to assess, develop, and modify its groundwater programs to provide the greatest benefit to local agencies.
   - Develop grant criteria to ensure funding supports local benefits as well as Statewide priorities, such as development of the California Water Plan and meeting Bay-Delta objectives.

3. **DWR should continue to work with local agencies to more accurately define historical overdraft and to more accurately predict future water shortages that could result in overdraft.**
   - A water budget should be developed for each basin.
   - The annual change in storage should be determined for each basin.
   - The amount of annual recharge and discharge, including pumping, should be determined.
   - Changes in groundwater quality that make groundwater unusable or could allow additional groundwater to be used should be included in any evaluation of overdraft.

4. **Groundwater management agencies should work with land use agencies to inform them of the potential impacts various land use decisions may have on groundwater, and to identify, prioritize, and protect recharge areas.**
   - Local planners should consider recharge areas when making land use decisions that could reduce recharge or pose a risk to groundwater quality.
   - Recharge areas should be identified and protected from land uses that limit recharge rates, such as paving or lining of channels.

- Both local water agencies and local governments should pursue education and outreach to inform the public of the location and importance of recharge areas.
- DWR should inform local agencies of the availability of grant funding and technical assistance that could support these efforts.

5. **DWR should publish a report by December 31, 2004 that identifies those groundwater basins or subbasins that are being managed by local or regional agencies and those that are not, and should identify how local agencies are using groundwater resources and protecting groundwater quality.**
    - Such information will be necessary to confirm whether agencies are meeting the requirements of SB 1938 (Water Code Section 10753.7).
    - Collection and summary of existing groundwater management plans will provide a better understanding of the distribution and coordination of groundwater management programs throughout the State.
    - Successful strategies employed by specific local agencies should be highlighted to assist others in groundwater management efforts.
    - Similarly, the impact of groundwater management ordinances throughout the State should be evaluated to provide a better understanding of the effect of ordinances on groundwater management.

6. **Water managers should include an evaluation of water quality in a groundwater management plan, recognizing that water quantity and water quality are inseparable.**
    - Local water managers should obtain groundwater quality data from federal, state, and local agencies that have collected such data in their basin.
    - Local agencies should evaluate long-term trends in groundwater quality.
    - Local agencies should work closely with the SWRCB and DWR in evaluating their groundwater basins.
    - Local agencies should establish management objectives and monitoring programs that will maintain a sustainable supply of good quality groundwater.

7. **Water transfers that involve groundwater (or surface water that will be replaced with groundwater) should be consistent with groundwater management in the source area that will assure the long term sustainability of the groundwater resource.**

8. **Continue to support coordinated management of groundwater and surface water supplies and integrated management of groundwater quality and groundwater quantity.**
    - Future bond funding should be provided for conjunctive use facilities to improve water supply reliability.
    - Funding for feasibility and pilot studies, in addition to construction of projects will help maximize the potential for conjunctive use.
    - DWR should continue and expand its efforts to form partnerships with local agencies to investigate and develop locally controlled conjunctive use programs.

9. **Local, State, and federal agencies should improve data collection and analysis to better estimate groundwater basin conditions used in Statewide and local water supply reliability planning. DWR should:**
    - Assist local agencies in the implementation of SB 221, SB 610, and AB 901 to help determine water supply reliability during the local land use planning process.
    - Provide and continue to update information on groundwater basins, including basin boundaries, groundwater levels, monitoring data, aquifer yield, and other aquifer characteristics.

- Identify areas of rapid development that are heavily reliant on groundwater and prioritize monitoring activities in these areas to identify potential impacts on these basins.
- Evaluate the existing network of wells monitored for groundwater elevations, eliminate wells of questionable value from the network, and add wells where data are needed.
- Work cooperatively with local groundwater managers to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts, beginning with the most heavily used basins.
- Expand DWR and local agency monitoring programs to provide a better understanding of the interaction between groundwater and surface water.
- Work with SWRCB to investigate temporal trends in water quality to identify areas of water quality degradation that should receive additional attention.
- Estimate groundwater extraction using a land use based method for over 200 basins with little or no groundwater budget information.
- Integrate groundwater budgets into the California Water Plan Update process.

10. **Increase coordination and sharing of groundwater data among local, State, and federal agencies and improve data dissemination to the public. DWR should:**
    - Use the established website to continually update new groundwater basin data collected after the publication of California's Groundwater (Bulletin 118-Update 2003).
    - Publish a summary update of Bulletin 118 every five years coincident with the California Water Plan (Bulletin 160).
    - Publish, in cooperation with SWRCB, a biennial groundwater report that addresses current groundwater quantity and quality conditions.
    - Coordinate the collection and storage of its groundwater quality monitoring data with programs of SWRCB and other agencies to ensure maximum coverage statewide and reduce duplication of effort.
    - Make groundwater basin information more compatible with other Geographic Information System-based resource data to improve local integrated resources planning efforts.
    - Compile data collected by projects funded under grant and loan programs and make data available to the public on the DWR website.
    - Encourage local agency cooperators to submit data to the DWR database.
    - Maximize the accuracy and usefulness of data and develop guidelines for quality assurance and quality control, consistency, and format compatibility.
    - Expand accessibility of groundwater data by the public after considering appropriate security measures.
    - State, federal and local agencies should expand accessibility of groundwater data by the public after considering appropriate security measures.
    - Local agencies should submit copies of adopted groundwater management plans to DWR.

Additional Important Recommendations

11. **Local water agencies and local governments should be encouraged to develop cooperative working relationships at basinwide or regional levels to effectively manage groundwater. DWR should:**
    - Provide technical and financial assistance to local agencies in the development of basinwide groundwater management plans.
    - Provide a preference in grant funding for groundwater projects for agencies that are part of a regional or basinwide planning effort.
    - Provide Proposition 50 funding preferences for projects that are part of an integrated regional water management plan.

12. **Groundwater basin boundaries identified in Bulletin 118 should be updated as new information becomes available and the basin becomes better defined. DWR should:**
    - Identify basin boundaries that are based on limited data.
    - List the kind of information that is necessary to better define basin boundaries.
    - Develop a systematic procedure to obtain and evaluate stakeholder input on groundwater basin boundaries.

13. **Improve the understanding of groundwater resources in fractured rock areas of the State.**
    - DWR, in cooperation with local and federal agencies, should conduct studies to determine the amount of groundwater that is available in fractured rock areas, including water quality assessment, identification of recharge areas and amounts, and a water budget when feasible.
    - Local agencies and local governments should conduct studies in their areas to quantify the local demands on groundwater and project future demands.
    - The Legislature should consider expanding the groundwater management authority in the Water Code to include areas outside of alluvial groundwater basins
    - DWR should include information on the most significant fractured rock groundwater sources in future updates of Bulletin 118.

14. **Develop a program to obtain geophysical logs in areas where additional data are needed.**
    - DWR should encourage submission of geophysical logs, when they are conducted, as a part of the Well Completion Report.
    - The geophysical logs would be available for use by public agencies to better understand the aquifer, but would be confidential as stipulated by the Water Code.
    - DWR should seek funding to work with agencies and property owners to obtain geophysical logs of new wells in areas where additional data are needed.
    - Geophysical logs would be used to better characterize the aquifers within each groundwater basin.

15. **Educate the public on the significance of groundwater resources and on methods of groundwater management.**
    - DWR should continue to educate the public on statewide groundwater issues and assist local agencies in their public education efforts.
    - Local agencies should expand their outreach efforts during development of groundwater management plans under AB 3030 and other authority.
    - DWR should develop educational materials to explain how they quantify groundwater throughout the State, as well as the utility and limitations of the information.
    - DWR should continue its efforts to educate individual well owners and small water systems that are entirely dependent on groundwater.

Introduction

Introduction

Groundwater is one of California's greatest natural resources. In an average water supply year, groundwater meets about 30 percent of California's urban and agricultural demand. In drought years, this percentage increases to 40 percent or even higher (DWR 1998). Some cities, such as Fresno, Davis, and Lodi, rely solely on groundwater for their drinking water supply. In 1995, an estimated 13 million Californians (nearly 43 percent of the State's population) used groundwater for at least a portion of their public supply needs (Solley and others 1998). With a projected population of nearly 46 million by the year 2020, California's demand on groundwater will increase significantly. In many basins, our ability to optimally use groundwater is affected by overdraft and water quality, or limited by a lack of data, lack of management, and coordination between agencies.

In the last few years, California has provided substantial funds to local agencies for groundwater management. For example, the nearly $2 billion Water Bond 2000 (Proposition 13) approved by California voters in March 2000 specifically authorizes funds for two groundwater programs: $200 million for grants for feasibility studies, project design, and the construction of conjunctive use facilities; and $30 million for loans for local agency acquisition and construction of groundwater recharge facilities and grants for feasibility studies for recharge projects. Additionally, the Local Groundwater Management Assistance Act of 2000 (AB 303) resulted in $15 million in fiscal years 2001, 2002, and 2003 for groundwater studies and data collection intended to improve basin and subbasin groundwater management. These projects focus on improving groundwater monitoring, coordinating groundwater basin management, and conducting groundwater studies.

The State Legislature has increasingly recognized the importance of groundwater and the need for monitoring in making sound groundwater management decisions. Significant legislation was passed in 2000, 2001 and 2002. AB 303 authorizes grants to help local agencies develop better groundwater management strategies. AB 599 (2001) requires, for the first time, that the State Water Resources Control Board (SWRCB), in cooperation with other agencies, develop a comprehensive monitoring program capable of assessing groundwater quality in every basin in the State with the intent of maintaining a safe groundwater supply. SB 610 (2001) and SB 901 (2001) together require urban water suppliers, in their urban water management plans, to determine the adequacy of current and future supplies to meet demands. Detailed groundwater information is required for those suppliers that use groundwater. SB 221 (2001) prohibits approval of certain developments without verification of an available water supply. These bills are significant with respect to groundwater because much of California's new development will rely on groundwater for its supply.

Finally, SB 1938 (2002) was enacted to provide incentives to local agencies for improved groundwater management. The legislation modified the Water Code to require that specific elements be included in a groundwater management plan for an agency to be eligible for certain State funding administered by the Department of Water Resources for groundwater projects. AB 303 is exempt from that requirement.

History of Bulletin 118

DWR has long recognized the need for collection, summary, and evaluation of groundwater data as tools in planning optimal use of the groundwater resource. An example of this is DWR's Bulletin 118 series. Bulletin 118 presents the results of groundwater basin evaluations in California. The Bulletin 118 series was preceded by Water Quality Investigations Report No. 3, *Ground Water Basins in California* (referred to in this bulletin as Report No. 3), published in 1952 by the Department of Public Works, Division of Water Resources (the predecessor of DWR). The purpose of Report No. 3 was to create a base index map of the "more important ground water basins" for carrying out DWR's mandate in Section 229 of the Water Code. Section 229 directed Public Works to:

> …investigate conditions of the quality of all waters within the State, including saline waters, coastal and inland, as related to all sources of pollution of whatever nature and shall report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters.

Report No. 3 identified 223 alluvium-filled valleys that were believed to be basins with usable groundwater in storage. A statewide numbering system was created in cooperation with the State Water Pollution Control Board (now the State Water Resources Control Board) based on the boundaries of the nine Regional Water Quality Control Boards. In 1992, Water Code Section 229 was amended, resulting in the elimination of the annual reporting requirements.

In 1975, DWR published Bulletin 118, *California's Ground Water*, (referred to in this report as Bulletin 118-75). Bulletin 118-75 summarized available information from DWR, U.S. Geological Survey, and other agencies for individual groundwater basins to "help those who must make decisions affecting the protection, additional use, and management of the State's ground water resources."

Bulletin 118-75 contains a summary of technical information for 248 of the 461 identified groundwater basins, subbasins, and what were referred to as "areas of potential ground water storage" in California as well as maps showing their location and extent. The Bulletin 118-75 basin boundaries were based on geologic and hydrogeologic conditions except where basins were defined by a court decision.

In 1978, Section 12924 was added to the California Water Code:

> The Department shall, in conjunction with other public agencies, conduct an investigation of the State's groundwater basins. The Department shall identify the State's groundwater basins on the basis of geologic and hydrogeologic conditions and consideration of political boundary lines whenever practical. The Department shall also investigate existing general patterns of groundwater pumping and groundwater recharge within such basins to the extent necessary to identify basins which are subject to critical conditions of overdraft.

DWR published the report in 1980 as *Ground Water Basins in California: A Report to the Legislature in Response to Water Code Section 12924* (referred to in this report as Bulletin 118-80). The bulletin included 36 groundwater basins with boundaries different from Bulletin 118-75. The changed boundaries resulted by combining several basins based on geologic or political considerations and by dividing the San Joaquin Valley groundwater basin into many smaller subbasins based primarily on political boundaries. These changes resulted in the identification of 447 groundwater basins, subbasins, and areas of potential groundwater storage. Bulletin 118-80 also identified 11 basins as subject to critical conditions of overdraft.

Box A Which Bulletin 118 Do You Mean?

Mention of an update to Bulletin 118 causes some confusion about which Bulletin 118 the California Department of Water Resources (DWR) has updated. In addition to the statewide Bulletin 118 series (Bulletin 118-75, Bulletin 118-80, and Bulletin 118-03), DWR released several other publications in the 118 series that evaluate groundwater basins in specific areas of the State. Region-specific Bulletin 118 reports are listed below.

- Bulletin 118-1. Evaluation of Ground Water Resources: South San Francisco Bay
  Appendix A. Geology, 1967
  Volume 1. Fremont Study Area, 1968
  Volume 2. Additional Fremont Study Area, 1973
  Volume 3. Northern Santa Clara County, 1975
  Volume 4. South Santa Clara County, 1981
- Bulletin 118-2. Evaluation of Ground Water Resources: Livermore and Sunol Valleys, 1974
  Appendix A. Geology, 1966
- Bulletin 118-3. Evaluation of Ground Water Resources: Sacramento County, 1974
- Bulletin 118-4. Evaluation of Ground Water Resources: Sonoma County
  Volume 1. Geologic and Hydrologic Data, 1975
  Volume 2. Santa Rosa Plain, 1982
  Volume 3. Petaluma Valley, 1982
  Volume 4. Sonoma Valley, 1982
  Volume 5. Alexander Valley and Healdsburg Area, 1983
- Bulletin 118-5. Bulletin planned but never completed.
- Bulletin 118-6. Evaluation of Ground Water Resources: Sacramento Valley, 1978

The Need for Bulletin 118 Update 2003

Despite California's heavy reliance on groundwater, basic information for many of the groundwater basins is lacking. Particular essential data necessary to provide for both the protection and optimal use of this resource is not available. To this end, the California Legislature mandated in the Budget Act of 1999 that DWR prepare:

> ...the statewide update of the inventory of groundwater basins contained in Bulletin 118-80, which includes, but is not limited to, the following: the review and summary of boundaries and hydrographic features, hydrogeologic units, yield data, water budgets, well production characteristics, and water quality and active monitoring data; development of a water budget for each groundwater basin; development of a format and procedures for publication of water budgets on the Internet; development of the model groundwater management ordinance; and development of guidelines for evaluating local groundwater management plans.

The information on groundwater basins presented in Bulletin 118 Update 2003 is mostly limited to the acquisition and compilation of existing data previously developed by federal, State, and local water agencies. While this bulletin is a good starting reference for basic data on a groundwater basin, more recent data and more information about the basin may be available in recent studies conducted by local water management agencies. Those agencies should be contacted to obtain the most recent data.

Report Organization

Bulletin 118 Update 2003 includes this report and supplemental material consisting of individual descriptions and a Geographic Information System-compatible map of each of the delineated groundwater basins in California. The basin descriptions will be updated as new information becomes available, and can be viewed or downloaded at http://www.waterplan.water.ca.gov/groundwater/118index.htm (Appendix A). Basin descriptions will not be published in hard copy.

This report is organized into the following topics:

- Groundwater is one of California's most important natural resources, and our reliance on it has continued to grow (Chapter 1).
- Groundwater has a complex legal and institutional framework in California that has shaped the groundwater management system in place today (Chapter 2).
- Groundwater management occurs primarily at the local water agency level, but may also be instituted at the local government level. At the request of the Legislature, DWR has developed some recommendations for a model groundwater management ordinance and components for inclusion in a groundwater management plan (Chapter 3).
- Groundwater has had a flurry of activity in the Legislature and at the ballot box in recent years that will affect the way groundwater is managed in California (Chapter 4).
- Groundwater programs with a variety of objectives exist in many State and federal agencies (Chapter 5).
- Groundwater concepts and definitions should be made available to a wide audience (Chapter 6).
- Groundwater basins with a wide range of characteristics and concerns exist in each of California's 10 hydrologic regions (Chapter 7).

Chapter 1
Groundwater – California's Hidden Resource

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Groundwater – California's Hidden Resource

In 1975, *California's Ground Water – Bulletin 118* described groundwater as "California's hidden resource." Today, those words ring as true as ever. Because groundwater cannot be directly observed, except under a relatively few conditions such as at a spring or a wellhead, most Californians do not give much thought to the value that California's vast groundwater supply has added to the State. It is unlikely that California could have achieved its present status as the largest food and agricultural economy in the nation and fifth largest overall economy in the world without groundwater resources. Consider that about 43 percent of all Californians obtain drinking water from groundwater. California is not only the single largest user of groundwater in the nation, but the estimated 14.5 million acre-feet (maf) of groundwater extracted in California in 1995 represents nearly 20 percent of all groundwater extracted in the entire United States (Solley and others 1998).

California's Hydrology

California's climate is dominated by the Pacific storm track. Numerous mountain ranges cause orographic lifting of clouds, producing precipitation mostly on the western slopes and leaving a rain shadow on most eastern slopes (Figure 1 and Figure 2). These storms also leave tremendous accumulations of snow in the Sierra Nevada during the winter months. While the average annual precipitation in California is about 23 inches (DWR 1998), the range of annual rainfall varies greatly from more than 140 inches in the northwestern part of the State to less than 4 inches in the southeastern part of the State.

Snowmelt and rain falling in the mountains flow into creeks, streams, and rivers. The average annual runoff in California is approximately 71 maf (DWR 1998). As these flows make their way into the valleys, much of the water percolates into the ground. The vast majority of California's groundwater that is accessible in significant amounts is stored in alluvial groundwater basins. These alluvial basins, which are the subject of this report, cover nearly 40 percent of the geographic area of the State (Figure 3).

This bulletin focuses on groundwater resources, but in reality groundwater and surface water are inextricably linked in the hydrologic cycle. As an example, groundwater may be recharged by spring runoff in streams, but later in the year the base flow of a stream may be provided by groundwater. So, although the land surface is a convenient division for categorizing water resources, it is a somewhat arbitrary one. It is essential that water managers recognize and account for the relationship between groundwater and surface water in their planning and operations.

Figure 1 Shaded relief map of California

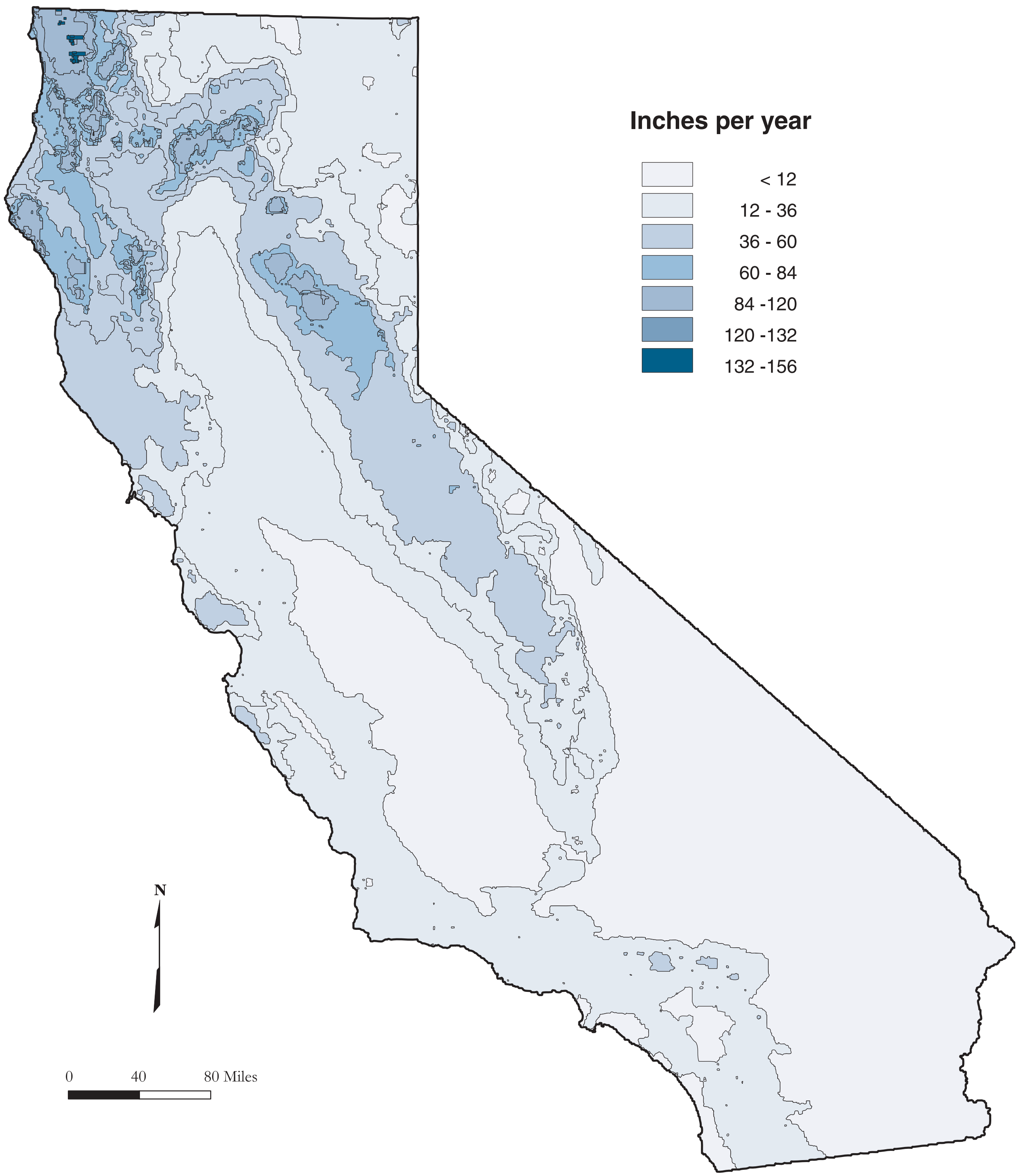

Figure 2 Mean annual precipitation in California, 1961 to 1990

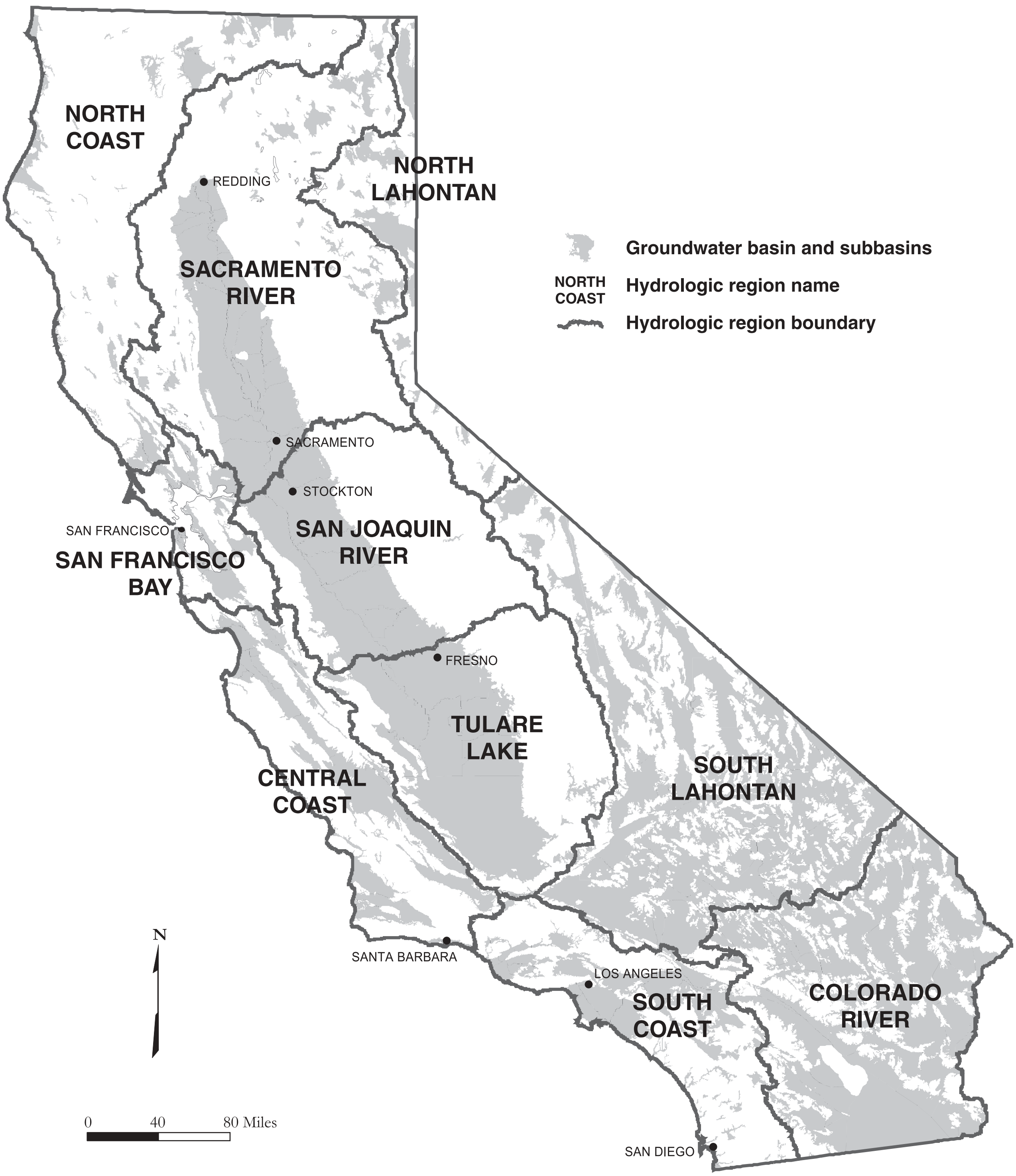

Figure 3 Groundwater basins, subbasins and hydrologic regions

California's Water Supply System

The economic success achieved in California could not have been foreseen a century ago. California's natural hydrologic system appeared too limited to support significant growth in population, industry, and agriculture. The limitations revolved around not only the relative aridity of the State, but the geographic, seasonal, and climatic variability that influence California's water supply. Approximately 70 percent of the State's average annual runoff occurs north of Sacramento, while about 75 percent of the State's urban and agricultural water needs are to the south. Most of the State's precipitation falls between October and April with half of it occurring December through February in average years. Yet, the peak demand for this water occurs in the summer months. Climatic variability includes dramatic deviations from average supply conditions by way of either droughts or flooding. In the 20^{th} century alone, California experienced multiyear droughts in 1912–1913, 1918–1920, 1922–1924, 1929–1934, 1947–1950, 1959–1961, 1976–1977, and 1987–1992 (DWR 1998).

California has dealt with the limitations resulting from its natural hydrology and achieved its improbable growth by developing an intricate system of reservoirs, canals, and pipelines under federal, State and local projects (Figure 4). However, a significant portion of California's water supply needs is also met by groundwater. Typically, groundwater supplies about 30 percent of California's urban and agricultural uses. In dry years, groundwater use increases to about 40 percent statewide and 60% or more in some regions.

The importance of groundwater to the State's development may have been underestimated at the beginning of the 20^{th} century. At that time, groundwater was seen largely as just a convenient resource that allowed for settlement in nearly any part of the State, given groundwater's widespread occurrence. Significant artesian flow from confined aquifers in the Central Valley allowed the early development of agriculture. When the Water Commission Act defined the allocation of surface water rights in 1914, it did not address allocation of the groundwater resource. In the 1920s, the development of the deep-well turbine pump and the increased availability of electricity led to a tremendous expansion of agriculture, which used these high-volume pumps and increased forever the significance of groundwater as a component of water supply in California.

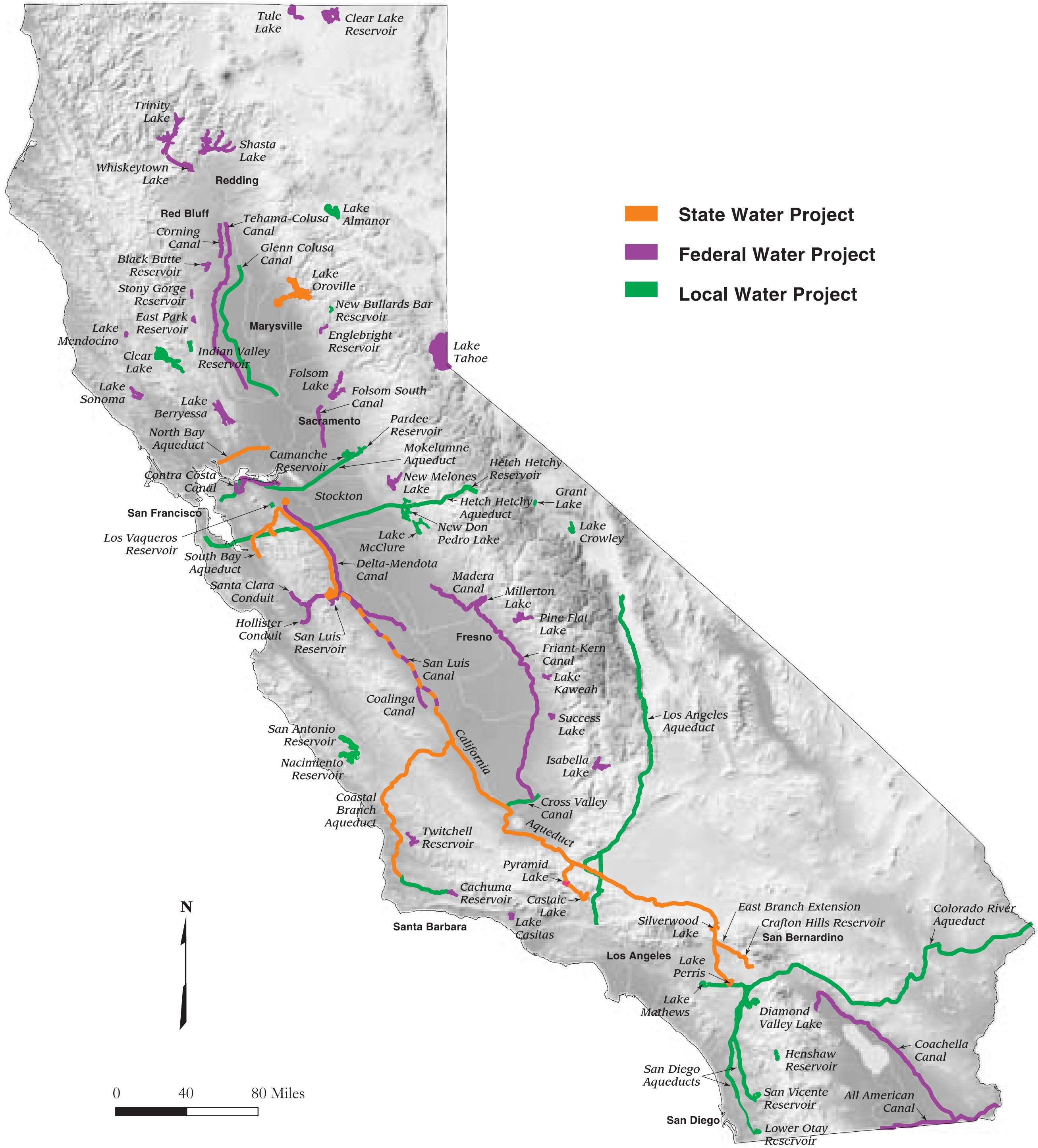

Figure 4 Water projects in California

Box B Will Climate Change Affect California's Groundwater?

California's water storage and delivery system can be thought of as including three reservoir systems—the snowpack of the Sierra Nevada, an extensive system of dams, lakes, and conveyance systems for surface water, and finally the aquifers that store groundwater. Precipitation in the form of snow is stored in the Sierra in winter and early spring and under ideal conditions melts in a manner that allows dams to capture the water for use during California's dry season. When snow melts faster, the dams act as flood control structures to prevent high runoff from flooding lowland areas. Water storage and delivery infrastructure—dams and canals—has been designed largely around the historical snowpack, while aquifers have played a less formal and less recognized role.

What will be the effect of climate change on California's water storage system? How will groundwater basins and aquifers be affected?

The latest report of the Intergovernmental Panel on Climate Change (2001) reaffirms that climate is changing in ways that cannot be accounted for by natural variability and that "global warming" is occurring. Studies by the National Water Assessment Team for the U.S. Global Change Research Program's National Assessment of the Potential Consequences of Climate Variability and Change identify potential changes that could affect water resources systems. For California, these include higher snow levels leading to more precipitation in the form of rain, earlier runoff, a rise in sea level, and possibly larger floods. In addition to affecting the balance between storage and flood control of our reservoirs, such changes in hydrology would affect wildlands, resulting in faunal and floral displacement and resulting in changes in vegetative water consumption. These changes would also affect patterns of both irrigated and dryland farming.

A warmer, wetter winter would increase the amount of runoff available for groundwater recharge; however, this additional runoff in the winter would be occurring at a time when some basins, particularly in Northern California, are either being recharged at their maximum capacity or are already full. Conversely, reductions in spring runoff and higher evapotranspiration because of warmer temperatures could reduce the amount of water available for recharge and surface storage.

The extent to which climate will change and the impact of that change are both unknown. A reduced snowpack, coupled with increased seasonal rainfall and earlier snowmelt may require a change in the operating procedures for existing dams and conveyance facilities. Furthermore, these changes may require more active development of successful conjunctive management programs in which the aquifers are more effectively used as storage facilities. Water managers might want to evaluate their systems to better understand the existing snowpack-surface water-groundwater relationship, and identify opportunities that may exist to optimize groundwater and other storage capability under a new hydrologic regime that may result from climate change. If more water was stored in aquifers or in new or reoperated surface storage, the additional water could be used to meet water demands when the surface water supply was not adequate because of reduced snowmelt.

Recent Groundwater Development Trends

While development of California's surface water storage system has slowed significantly, groundwater development continues at a strong pace. A review of well completion reports submitted to the California Department of Water Resources (DWR) provides data on the number and type of water wells drilled in California since 1987. For the 14-year period, DWR received 127,616 well completion reports for water supply wells that were newly constructed, reconditioned, or deepened—an average of 9,115 annually[1]. Of these, 82 percent were drilled for individual domestic uses; 14 percent for irrigation; and about 4 percent for a combined group of municipal and industrial uses (Figure 5). Although domestic wells predominate, individual domestic use makes up a small proportion of total groundwater use in the State.

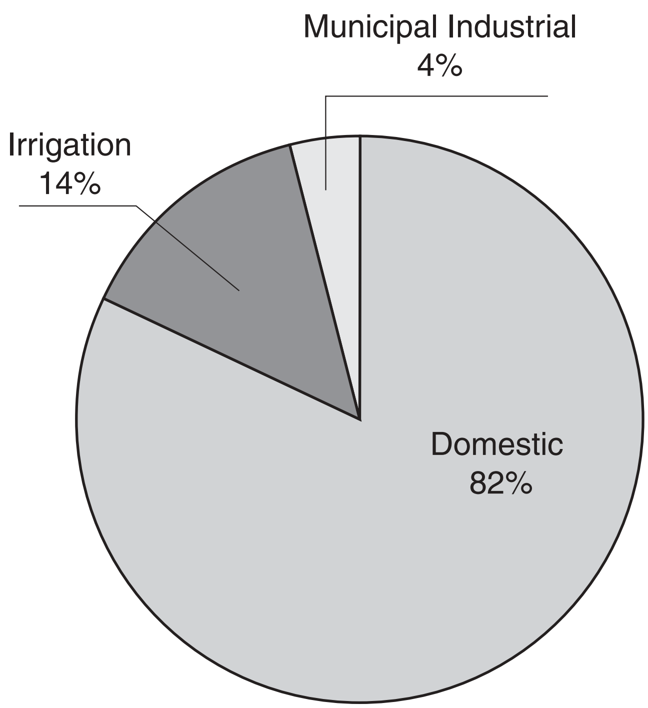

Figure 5 Well completion reports filed with DWR from 1987 through 2000

The most evident influence on the number of wells constructed is hydrologic conditions. The number of wells constructed and modified increases dramatically with drought conditions (Figure 6). The number of wells constructed and modified annually from 1987 through 1992 is more than double the annual totals for 1995 through 2000. Each year from 1987 through 1992 was classified as either dry or critically dry; water years 1995 through 2000 were either above normal or wet, based on measured unimpaired runoff in the Sacramento and San Joaquin valleys. In addition to providing an indication of the growth of groundwater development, well completion reports are a valuable source of information on groundwater basin conditions.

1 DWR also received an average of 4,225 well completion reports for monitoring, which were not included above because they do not extract groundwater for supply purposes.

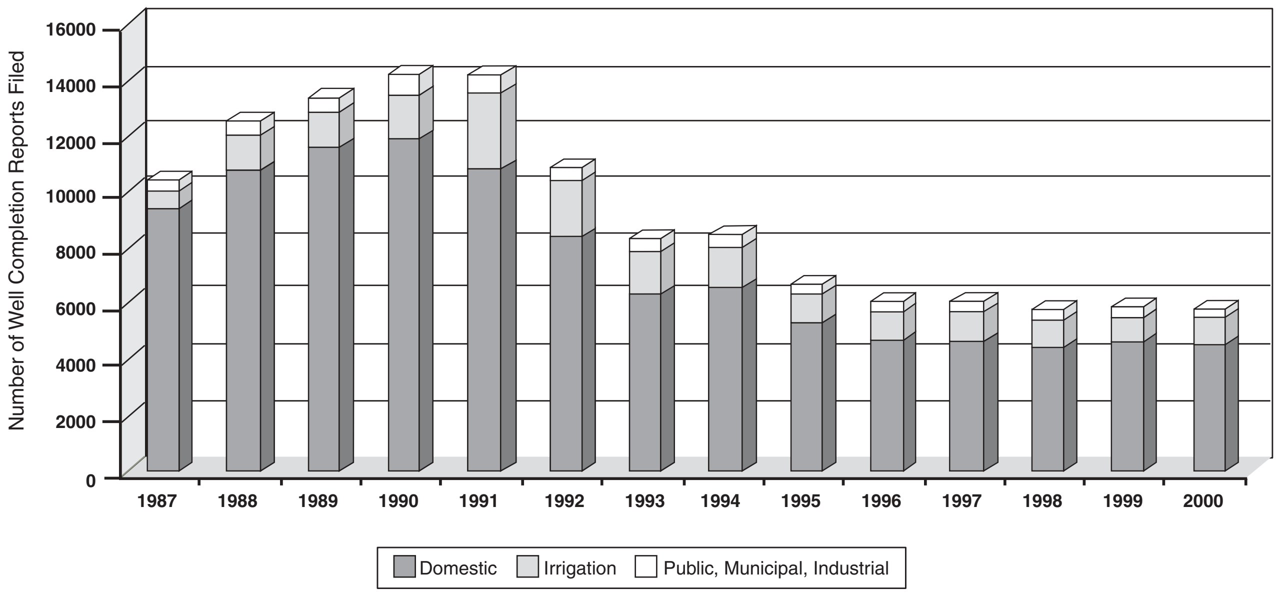

Figure 6 Well completion reports filed annually from 1987 through 2000

The Need for Groundwater Monitoring and Evaluation

Some 34 million people called California their home in the year 2000, and a population of nearly 46 million is expected by 2020. The increased population and associated commercial, industrial, and institutional growth will bring a substantially greater need for water. This need will be met in part by improved water use efficiency, opportunities to reoperate or expand California's surface water system, and increased desalination and recycling of water sources not currently considered usable. This need will also be met by storing and extracting additional groundwater. However, the sustainability of the groundwater resource, both in terms of what is currently used and future increased demand, cannot be achieved without effective groundwater management. In turn, effective groundwater management cannot be achieved without a program of groundwater data collection and evaluation.

Perhaps surprising to many, California does not have a comprehensive monitoring network for evaluating the health of its groundwater resource, including quantity and quality of groundwater. The reasons for this are many with the greatest one being that information on groundwater levels and groundwater quality is primarily obtained by drilling underground, which is relatively expensive. Given that delineated groundwater basins cover about 40 percent of the State's vast area, the cost of a dedicated monitoring network would be prohibitive. The other important reason for the lack of a comprehensive network is that, as will be discussed later in this report, groundwater is a locally controlled resource. State and federal agencies become involved only when a groundwater issue is directly related to the mission of a particular agency or if a local agency requests assistance. For these and other reasons, California lacks a cohesive, dedicated monitoring network.

Box C What about Overdraft?

Overdraft is the condition of a groundwater basin in which the amount of water withdrawn by pumping over the long term exceeds the amount of water that recharges the basin. Overdraft is characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. Overdraft can lead to increased extraction costs, land subsidence, water quality degradation, and environmental impacts.

The California Water Plan Update, Bulletin 160-98 (DWR 1998) estimated that groundwater overdraft in California in 1995 was nearly 1.5 million acre-feet annually, with most of the overdraft occurring in the Tulare Lake, San Joaquin River, and Central Coast hydrologic regions. The regional and statewide estimates of overdraft are currently being revised for the 2003 update of Bulletin 160. While these estimates are useful from a regional and statewide planning perspective, the basin water budgets calculated for this update of Bulletin 118 clearly indicate that information is insufficient in many basins to quantify overdraft that has occurred, project future impacts on groundwater in storage, and effectively manage groundwater. Further technical discussion of overdraft is provided in Chapter 6 of this bulletin.

When DWR and other agencies involved in groundwater began to collect data in the first half of the 20th century, it quickly became evident that there were insufficient funds to install an adequate number of monitoring wells to accurately determine changes in the condition of groundwater basins. Consequently, to create a serviceable monitoring network, the agencies asked owners of irrigation or domestic wells for permission to measure water levels and to a lesser extent to monitor water quality. These have been called "wells of opportunity." In many areas, this approach has led to a network of wells that provide adequate information to gain a general understanding of conditions in the subsurface and to track changes through time. In some areas, groundwater studies were conducted and often included the construction of a monitoring well network. These studies have gradually contributed to a more detailed understanding of some of California's groundwater basins, particularly the most heavily developed basins.

Given the combination of monitoring wells of opportunity and dedicated monitoring wells, it might be assumed that an adequate monitoring network in California will eventually accumulate. However, several factors contribute to reducing the effectiveness of the monitoring network for data collection and evaluation: (1) The funding for data programs in many agencies, which was generally insufficient in the first place, has been reduced significantly. (2) When private properties change ownership, some new owners rescind permission for agency personnel to enter the property and measure the well. (3) The appropriateness of using these private wells is questionable because they are often screened over long intervals encompassing multiple aquifers in the subsurface, and in some cases construction details for the well are unknown. (4) Some wells with long-term records actually reach the end of their usefulness because the casing collapses or something falls into the well, making it unusable. In some cases, groundwater levels may drop below the well depth. (5) As water quality or water quantity conditions change, the monitoring networks may no longer be adequate to provide necessary data to manage groundwater.

The importance of long-term monitoring networks cannot be overstated. Sound groundwater management decisions require observation of trends in groundwater levels and groundwater quality. Only through these long-term evaluations can the question of sustainability of groundwater be answered. For example, this report contains a summary of groundwater contamination in public water supply wells throughout the State collected from 1994 through 2000. While this provides a "snapshot" of the suitability of the groundwater currently developed for public supply needs, it does not address sustainability of groundwater for public uses. Sustainability can only be determined by observing groundwater quality over time. If conditions worsen, local managers will need to take steps to prevent further harm to groundwater quality. Long-term groundwater records require adequate funding and staff to develop groundwater monitoring networks and to collect, summarize, and evaluate the data.

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Chapter 2

Groundwater Management in California

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Chapter 2
Groundwater Management in California

Groundwater management, as defined in this report, is the planned and coordinated monitoring, operation, and administration of a groundwater basin or portion of a groundwater basin with the goal of long-term sustainability of the resource. Throughout the history of water management in California, local agencies have practiced an informal type of groundwater management. For example, since the early 20th century, when excess surface water was available, some agencies intentionally recharged groundwater to augment their total water supply. In 1947, the amount of groundwater used was estimated at 9 million to 10 million acre-feet. By the beginning of the 21st century, the amount of groundwater used had increased to an estimated 15 million acre-feet. Better monitoring would provide more accurate information. This increased demand on California's groundwater resources, when coupled with estimates of population growth, has resulted in a need for more intensive groundwater management.

In 1914, California created a system of appropriating surface water rights through a permitting process (Stats 1913, ch. 586), but groundwater use has never been regulated by the State. Though the regulation of groundwater has been considered on several occasions, the California Legislature has repeatedly held that groundwater management should remain a local responsibility (Sax 2002). Although they are treated differently legally, groundwater and surface water are closely interconnected in the hydrologic cycle. Use of one resource will often affect the other, so that effective groundwater management must consider surface water supplies and uses.

Figure 7 depicts the general process by which groundwater management needs are addressed under existing law. Groundwater management needs are identified at the local water agency level and may be directly resolved at the local level. If groundwater management needs cannot be directly resolved at the local agency level, additional actions such as enactment of ordinances by local governments, passage of laws by the Legislature, or decisions by the courts may be necessary to resolve the issues. Upon implementation, local agencies evaluate program success and identify additional management needs. The State's role is to provide technical and financial assistance to local agencies for their groundwater management efforts, such as through the Local Groundwater Assistance grant program (see Chapter 4, AB 303).

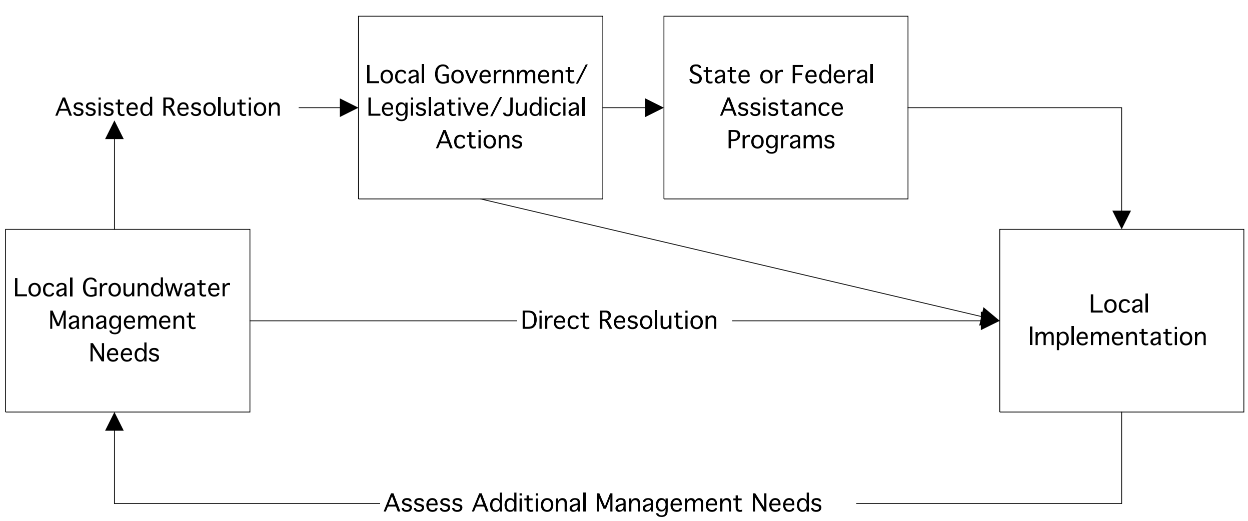

Figure 7 Process of addressing groundwater management needs in California

How Groundwater is Managed in California

There are three basic methods available for managing groundwater resources in California: (1) management by local agencies under authority granted in the California Water Code or other applicable State statutes, (2) local government groundwater ordinances or joint powers agreements, and (3) court adjudications. Table 1 shows how often each of these methods has been used, and each method is discussed briefly below. No law requires that any of these forms of management be applied in a basin. Management is often instituted after local agencies or landowners recognize a specific groundwater problem. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand.

Table 1 Groundwater management methods

Method	Frequency of use[a]
Local water agencies	Undetermined number of agencies with authority to manage some aspect of groundwater under general powers associated with a particular type of district.
	Thirteen agencies with specially legislated authority to limit or regulate extraction.
	Seven agencies with adopted plans under authority from Water Code Section 10750 et seq.[b] (AB 255 of 1991).
	More than 200 agencies with adopted plans under authority from Water Code Section 10750 et seq. (AB 3030 of 1992).
Local groundwater management ordinances	Currently adopted in 27 counties.
Court adjudication	Currently decided in 19 groundwater basins, mostly in Southern California. Three more basins are in court.

a. The numbers for some methods are unknown because reporting to the California Department of Water Resources is not required.
b. Section 10750 *et seq*. was amended in 1992.

Groundwater Management through Authority Granted to Local Water Agencies

More than 20 types of local agencies are authorized by statute to provide water for various beneficial uses. Many of these agencies also have statutory authority to institute some form of groundwater management. For example, a Water Replenishment District (Water Code, § 60000 et seq.) is authorized to establish groundwater replenishment programs and collect fees for that service. A Water Conservation District (Water Code, § 75500 et seq.) can levy groundwater extraction fees. Table 2 lists these and other types of local agencies that deliver water and may have authority to institute some form of groundwater management. Most of these agencies are identified in the Water Code, but their specific authority related to groundwater management varies. The Water Code does not require that the agencies report their activities to the California Department of Water Resources (DWR).

Table 2 Local agencies with authority to deliver water for beneficial uses, which may have authority to institute groundwater management

Local agency	Authority	Number of agencies[a]
Community Services District	Gov. Code § 61000 et seq.	313
County Sanitation District	Health and Safety Code § 4700 et seq.	91
County Service Area	Gov. Code § 25210.1 et seq.	897
County Water Authority	Water Code App. 45.	30
County Water District	Water Code § 30000 et seq.	174
County Waterworks District	Water Code § 55000 et seq.	34
Flood Control and Water Conservation District	Water Code App. 38.	39
Irrigation District	Water Code § 20500 et seq.	97
Metropolitan Water District	Water Code App 109.	1
Municipal Utility District	Pub. Util. Code § 11501 et seq.	5
Municipal Water District	Water Code § 71000 et seq.	40
Public Utility District	Pub. Util. Code § 15501 et seq.	54
Reclamation District	Water Code § 50000 et seq.	152
Recreation and Park District	Pub. Resources Code § 5780 et seq.	110
Resort Improvement District	Pub. Resources Code § 13000 et seq.	-
Resource Conservation District	Pub. Resources Code § 9001 et seq.	99
Water Conservation District	Water Code App. 34; Wat. Code § 74000 et seq.	13
Water District	Water Code § 34000 et seq.	141
Water Replenishment District	Water Code § 60000 et seq.	1
Water Storage District	Water Code § 39000 et seq.	8

a. From State Controller's Office Special Districts Annual Report, 49th Edition.

Greater authority to manage groundwater has been granted to a small number of local agencies or districts created through special acts of the Legislature. For example, the Sierra Valley Groundwater Basin Act of 1980 (Water Code, App. 119) created the first two groundwater management districts in California. Currently, 13 local agencies have specific groundwater management authority as a result of being special act districts. The specific authority of each agency varies, but they can generally be grouped into two categories. Most of the agencies formed since 1980 have the authority to limit export and even control some in-basin extraction upon evidence of overdraft or the threat of overdraft. These agencies can also generally levy fees for groundwater management activities and for water supply replenishment. Agencies formed prior to 1980 do not have authority to limit extraction from a basin. However, the groundwater users in these areas are generally required to report extractions to the agency, and the agency can levy fees for groundwater management or water supply replenishment. Some of these agencies have effectively used a tiered fee structure to discourage excessive groundwater extraction in the basin. Table 3 lists the names of special act districts with legislative authority to manage groundwater.

Table 3 Special act districts with groundwater management authority in California

District or agency	Water Code citation[a]	Year agency established in Code[b]
Desert Water Agency	App. 100	1961
Fox Canyon Groundwater Management Agency	App. 121.	1982
Honey Lake Groundwater Management District	App. 129.	1989
Long Valley Groundwater Management District	App. 119.	1980
Mendocino City Community Services District	Section 10700 et seq.	1987
Mono County Tri-Valley Groundwater Management District	App. 128.	1989
Monterey Peninsula Water Management District	App. 118.	1977
Ojai Groundwater Management Agency	App. 131.	1991
Orange County Water District	App. 40.	1933
Pajaro Valley Water Management Agency	App. 124.	1984
Santa Clara Valley Water District	App. 60.	1951
Sierra Valley Groundwater Management District	App. 119.	1980
Willow Creek Groundwater Management Agency	App. 135.	1993

a. From West's Annotated California Codes (1999 update)
b. This represents the year the agency was established in the Water Code. Specific authorities, such as those for groundwater management activities, may have been granted through later amendments.

In 1991, AB 255 (Stats. 1991, Ch. 903) was enacted authorizing local agencies overlying basins subject to critical conditions of overdraft, as defined in DWR's Bulletin 118-80, to establish programs for groundwater management within their service areas. Water Code section 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality. Seven local agencies adopted plans under this authority.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation was significant in that it greatly increased the number of local agencies authorized to develop a groundwater management plan and set forth a common framework for management by local agencies throughout California. AB 3030, which is codified in Water Code section 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by Bulletin 118-75 (DWR 1975) and updates. Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3). More than 200 agencies have adopted an AB 3030 groundwater management plan. None of these agencies is known to have exercised the authority of a Water Replenishment District.

Water Code section 10755.2 expands groundwater management opportunities by encouraging coordinated plans and by authorizing public agencies to enter into a joint powers agreement or memorandum of understanding with public or private entities that provide water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

Local Groundwater Ordinances

A second general method of managing groundwater in California is through ordinances adopted by local governments such as cities or counties. Twenty-seven counties have adopted groundwater ordinances, and others are being considered (Figure 8). The authority of counties to regulate groundwater has been challenged, but in 1995 the California Supreme Court declined to review an appeal of a lower court decision *Baldwin v. County of Tehama* (1994) that holds that State law does not occupy the field of groundwater management and does not prevent cities and counties from adopting ordinances to manage groundwater under their police powers. However, the precise nature and extent of the police power of cities and counties to regulate groundwater is uncertain.

The Public Policy Institute of California recently performed a study of California's water transfer market, which included a detailed investigation of the nature of groundwater ordinances by counties in California. The report found that 22 counties had adopted ordinances requiring a permit to export groundwater. In all but three cases, restricting out-of-county uses appears to be the only purpose (Hanak 2003). One ordinance, adopted recently in Glenn County (Box D, "Basin Management Objectives for Groundwater Management"), takes a comprehensive approach by establishing management objectives for the county's groundwater basins. Several other counties in Northern California are considering adopting similar management objective based ordinances.

Ordinances are mostly a recent trend in groundwater management, with 24 of the 27 ordinances enacted since 1990. Local ordinances passed during the 1990s have significantly increased the potential role of local governments in groundwater management. The intent of most ordinances has been to hold project proponents accountable for impacts that may occur as a result of proposed export projects. Because adoption of most of these ordinances is recent, their effect on local and regional groundwater management planning efforts is not yet fully known. However, it is likely that future groundwater development will take place within the constraints of local groundwater management ordinances. Table 4 lists counties with groundwater management ordinances and their key elements.

Figure 8 Counties with groundwater ordinances

Box D Basin Management Objectives for Groundwater Management

Most county groundwater management ordinances require that an export proponent prove the project will not deplete groundwater, cause groundwater quality degradation, or result in land subsidence. Although these factors could be part of any groundwater management plan, these ordinances do not require that a groundwater management plan be developed and implemented.

The only ordinance requiring development and adoption of objectives to be accomplished by management of the basin was adopted by the Glenn County Board of Supervisors in 2000. The action came after a citizens committee spent five years working with stakeholders. The process of developing a groundwater management ordinance for Glenn County began in 1995 when local landowners and county residents became concerned about plans to export groundwater or substitute groundwater for exported surface water. Control of exports was the focus of early ordinance discussions.

After long discussions and technical advice from groundwater specialists, the committee realized that goals and objectives must be identified for effective management of groundwater in the county. What did the county want to accomplish by managing groundwater within the county? What did groundwater management really mean?

The concept of establishing basin management objectives emerged (BMOs). BMOs would establish threshold values for groundwater levels, groundwater quality, and land surface subsidence. When a threshold level is reached, the rules and regulations require that groundwater extraction be adjusted or stopped to prevent exceeding the threshold.

The Glenn County Board of Supervisors has adopted BMOs, which were developed by an advisory committee, for groundwater levels throughout the county. While currently there are 17 BMOs representing the 17 management areas in the county, the goal is to begin managing the entire county in a manner that benefits each of the local agencies and their landowners, as well as landowners outside of an agency boundary. The committee is now developing BMOs for groundwater quality and land surface subsidence.

There is no single set of management objectives that will be successful in all areas. Groundwater management must be adapted to an area's political, institutional, legal, and technical constraints and opportunities. Groundwater management must be tailored to each basin or subbasin's conditions and needs. Even within a single basin, the management objectives may change as more is learned about managing the resource within that basin. Flexibility is the key, but that flexibility must operate within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement.

Table 4 Counties with ordinances addressing groundwater management

County	Year enacted	Key elements (refer to ordinances for exemptions and other details)
Butte	1996	Export permit required (extraction & substitute pumping), Water Commission and Technical Advisory Committee, groundwater planning reports (county-wide monitoring program)
Calaveras	2002	Export permit required (extraction & substitute pumping)
Colusa	1998	Export permit required (extraction & substitute pumping)
Fresno	2000	Export permit required (extraction & substitute pumping)
Glenn	1990 rev. 2000	Water Advisory Committee and Technical Advisory Committee, basin management objectives and monitoring network, export permit required (1990)
Imperial	1996	Commission established to manage groundwater, including controlling exports (permit required), overdraft, artificial recharge, and development projects
Inyo	1998	Regulates (1) water transfers pursuant to Water Code Section 1810, (2) sales of water to the City of Los Angeles from within Inyo Co., (3) transfer or transport of water from basins within Inyo County to another basin with the County, and (4) transfers of water from basins within Inyo Co. to any area outside the County.
Kern	1998	Conditional use permit for export to areas both outside county and within watershed area of underlying aquifer in county. Only applies to southeastern drainage of Sierra Nevada and Tehachapi mountains.
Lake	1999	Export permit required (extraction & substitute pumping)
Lassen	1999	Export permit required (extraction & substitute pumping)
Madera	1999	Permit required for export, groundwater banking, and import for groundwater banking purposes to areas outside local water agencies
Mendocino	1995	Mining of groundwater regulated for new developments in Town of Mendocino
Modoc	2000	Export permit required for transfers out of basin
Mono	1988	Permit required for transfers out of basin
Monterey	1993	Water Resources Agency strictly regulates extraction facilities in zones with groundwater problems
Napa	1996	Permits for local groundwater extractions; exemptions for single parcels and agricultural use
Sacramento	1952 rev. 1985	Water Agency established to manage and protect groundwater management zones; replenishment charges
San Benito	1995	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use, injecting imported water; influence of well pumping restrictions
San Bernardino	2002	Permit required for any new groundwater well within the desert region of the county
San Diego	1991	Provides for mapping of groundwater impacted basins (defined); projects within impacted basins require groundwater investigations
San Joaquin	1996	Export permit required (extraction & substitute pumping)
Shasta	1997	Export permit required (extraction & substitute pumping)
Sierra	1998	Export permit required or for off-parcel use
Siskiyou	1998	Permit required for transfers out of basin
Tehama	1992	Mining groundwater (overdraft) for export prohibited; permit required for off-parcel use; influence of well pumping restrictions
Tuolumne	2001	Export permit required (extraction & substitute pumping)
Yolo	1996	Export permit required (extraction & substitute pumping)

Adjudicated Groundwater Basins

A third general form of groundwater management in California is court adjudication. In some California groundwater basins, as the demand for groundwater exceeded supply, landowners and other parties turned to the courts to determine how much groundwater can rightfully be extracted by each user. The courts study available data to arrive at a distribution of the groundwater that is available each year, usually based on the California law of overlying use and appropriation. This court-directed process can be lengthy and costly. As noted in Table 5, the longest adjudication took 24 years. Many of these cases have been resolved with a court-approved negotiated settlement, called a stipulated judgment. Unlike overlying and non-overlying rights to groundwater, such decisions guarantee to each party a proportionate share of the groundwater that is available each year. The intense technical focus on the groundwater supply and restrictions on groundwater extraction for all parties make adjudications one of the strongest forms of groundwater management in California.

There are 19 court adjudications for groundwater basins in California, mostly in Southern California (see Table 5). Eighteen of the adjudications were undertaken in State Superior Court and one in federal court. For each adjudicated groundwater basin, the court usually appoints a watermaster to oversee the court judgment. In 15 of these adjudications, the court judgment limits the amount of groundwater that can be extracted by all parties based on a court-determined safe yield of the basin. The basin boundaries are also defined by the court. The Santa Margarita Basin was adjudicated in federal court. That decision requires water users to report the amount of surface water and groundwater they use, but groundwater extraction is not restricted.

Most basin adjudications have resulted in either a reduction or no increase in the amount of groundwater extracted. As a result, agencies often import surface water to meet increased demand. The original court decisions provided watermasters with the authority to regulate extraction of the quantity of groundwater; however, they omitted authority to regulate extraction to protect water quality or to prevent the spread of contaminants in the groundwater. Because water quantity and water quality are inseparable, watermasters are recognizing that they must also manage groundwater quality.

Box E Adjudication of Groundwater Rights in the Raymond Basin

The first basin-wide adjudication of groundwater rights in California was in the Raymond Basin in Los Angeles County in 1949 (*Pasadena v. Alhambra*). The first water well in Raymond Basin was drilled in 1881; 20 years later, the number of operating wells grew to about 140. Because of this pumping, the City of Pasadena began spreading water in 1914 to replenish the groundwater, and during the next 10 years the city spread more than 20,000 acre-feet.

Pumping during 1930 through 1937 caused water levels to fall 30 to 50 feet in wells in Pasadena. After attempting to negotiate a reduction of pumping on a cooperative basis, the City of Pasadena, on September 23, 1937, filed a complaint in Superior Court against the City of Alhambra and 29 other pumpers to quiet title to the water rights within Raymond Basin. The court ruled that the city must amend its complaint, making defendants of all entities pumping more than 100 acre-feet per year, and that it was not a simple quiet title suit but, a general adjudication of the water rights in the basin.

In February 1939, a court used the reference procedure under the State Water Code to direct the State Division of Water Resources, Department of Public Works (predecessor to the Department of Water Resources) as referee to review all physical facts pertaining to the basin, determine the safe yield, and ascertain whether there was a surplus or an overdraft. The study took 2-1/2 years to complete and cost more than $53,000, which was paid by the parties. The resulting Report of Referee submitted to the court in July 1943 found that the annual safe yield of the basin was 21,900 acre-feet but that the actual pumping and claimed rights were 29,400 acre-feet per year.

Most parties agreed to appoint a committee of seven attorneys and engineers to work out a stipulated agreement. In 1944, the court designated the Division of Water Resources to serve as watermaster for the stipulated agreement, which all but one of the parties supported. On December 23, 1944, the judge signed the judgment that adopted the stipulation.

The stipulation provided that (1) the water was taken by each party openly, notoriously, and under a claim of right, which was asserted to be, and was adverse to each and all other parties; (2) the safe yield would be divided proportionally among the parties; and (3) each party's right to a specified proportion of the safe yield would be declared and protected. It also established an arrangement for the exchange of pumping rights among parties.

Based on the stipulation, the court adopted a program of proportionate reductions. In so doing, the court developed the doctrine of mutual prescription, whereby the rights were essentially based on the highest continual amount of pumping during the five years following the beginning of the overdraft, and under conditions of overdraft, all of the overlying and appropriative water users had acquired prescriptive rights against each other, that is, mutual prescription.*

In 1945, one party appealed the judgment, and in 1947, the District Court of Appeals reversed and remanded *Pasadena v. Alhambra.* However, on June 3, 1949, the State Supreme Court overturned the appellate court's decision and affirmed the original judgment. In 1950, the court granted a motion by the City of Pasadena that there be a review of the determination of safe yield, and in 1955, the safe yield and the total decreed rights were increased to 30,622 acre-feet per year. In 1984, watermaster responsibilities were assigned to the Raymond Basin Management Board.

*In City of Los Angeles v. City of San Fernando (1975) the California Supreme Court rejected the doctrine of mutual prescription and held that a groundwater basin should be adjudicated based on the correlative rights of overlying users and prior appropriation among non-overlying users. For further discussion, see Appendix B.

Table 5 List of adjudicated basins

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
1—Scott River Stream System	Scott River Valley; Siskiyou	1-5	1970	1980	Two local irrigation districts
2—Santa Paula Basin	Subbasin of Santa Clara River; Ventura	4-4	1991	1996	Three-person technical advisory committee from United Water CD, City of Ventura, and Santa Paula Basin Pumpers Association; www.unitedwater.org
3—Central Basin	Northeast part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1962	1965	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
4—West Coast Basin	Southwest part of Coastal Plain of Los Angeles County Basin; Los Angeles	4-11	1946	1961	DWR—Southern District; wwwdpla.water.ca.gov/sd/watermaster/watermaster.html
5—Upper Los Angeles River Area	San Fernando Valley Basin (entire watershed); Los Angeles	4-12	1955	1979	Superior Court appointee
6—Raymond Basin	Northwest part of San Gabriel Valley Basin; Los Angeles	4-13	1937	1944	Raymond Basin Management Board
7—Main San Gabriel Basin	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1968	1973	Water purveyors and water districts elect a nine-member board; www.watermaster.org/
Puente Narrows, *Addendum to Main San Gabriel Basin decision*			1972	1972	Two consulting engineers
8—Puente	San Gabriel Valley Basin, excluding Raymond Basin; Los Angeles	4-13	1985	1985	Three consultants
9—Cummings Basin	Cummings Valley Basin; Kern	5-2	1966	1972	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
10—Tehachapi Basin	Tehachapi Valley West Basin and Tehachapi Valley East Basin; Kern	5-28 6-45	1966	1973	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm
11—Brite Basin	Brite Valley; Kern	5-80	1966	1970	Tehachapi-Cummings County Water District; www.tccwd.com/gwm.htm

Table 5 List of adjudicated basins (continued)

Court name	Relationship to DWR Bulletin 118 basin name; county	Basin No.	Filed in court	Final decision	Watermaster and/or website
12—Mojave Basin Area Adjuducation	Lower, Middle & Upper Mojave River Valley Basins; El Mirage & Lucerne valleys; San Bernardino	6-40, 6-41, 6-42	1990	1996	Mojave Water Agency; www.mojavewater.org/mwa700.htm
13—Warren Valley Basin	Part of Warren Valley Basin; San Bernardino	7-12	1976	1977	Hi-Desert Water District; www.mojavewater.org
14—Chino Basin	Northwest part of Upper Santa Ana Valley Basin; San Bernardino and Riverside	8-2	1978	1978	Nine people, recommended by producers and appointed by the court; www.cbwm.org/
15—Cucamonga Basin	North central part of Upper Santa Ana Valley Basin; San Bernardino	8-2	1975	1978	Not yet appointed, operated as part of Chino Basin
16—San Bernardino Basin Area	Northeast part of Upper Santa Ana Basin; San Bernardino and Riverside	8-2	1963	1969	One representative each from Western Municipal Water District of Riverside County & San Bernardino Valley Municipal Water District
17—Six Basins	Six subbasins in northwest upper Santa Ana Valley; Upper & Lower Claremont Heights, Canyon, Pomona, Live Oak & Ganesha; Los Angeles. Small portions of Upper Claremont Heights and Canyon are in San Bernardino County	4-14, 8-2	1998	1998	Nine-member board representing all parties to the judgment
18—Santa Margarita River watershed	The Santa Margarita River watershed, including 3 groundwater basins: Santa Margarita Valley, Temecula Valley and Cahuilla Valley Basins; San Diego and Riverside.	9-4, 9-5, 9-6	1951	1966	U.S. District Court appointee
19—Goleta	Goleta Central Basin; judgment includes North Basin; Santa Barbara	3-16	1973	1989	No watermaster appointed; the court retains jurisdiction

How Successful Have Groundwater Management Efforts Been?

This chapter describes the opportunities for local agencies to manage their groundwater resources. Many have questioned whether these opportunities have led to an overall successful system of groundwater management throughout California. How successful groundwater management has been throughout the State is a difficult question and cannot be answered at present. While there are many examples of local agency successes (see Box F, "Managing through a Joint Powers Agreement," Box G, "Managing a Basin through Integrated Water Management," and Box H, "Managing Groundwater Using both Physical and Institutional Solutions"), there are neither mandates to prepare groundwater management plans nor reporting requirements when plans are implemented, so a comprehensive assessment of local planning efforts is not possible. Additionally, many plans have been adopted only recently, during a period of several consecutive wet years, so many of the plan components are either untested or not implemented.

At a minimum, successful groundwater management should be defined as maintaining and maximizing long-term reliability of the groundwater resource, focused on preventing significant depletion of groundwater in storage over the long term and preventing significant degradation of groundwater quality. A review of some of the groundwater management plans prepared under AB 3030 reveals that some plans are simply brief recitations about continuing the agency's existing programs. Not all agencies that enacted groundwater management plans under AB 3030 are actively implementing the plan.

Despite this apparent lack of implementation of groundwater management plans prepared under AB 3030, the bill has certainly increased interest in more effective groundwater management. With more than 200 agencies participating in plans and more than 120 of those involved in coordinated plans with other agencies, AB 3030 has resulted in a heightened awareness of groundwater management. Additionally, annual reports published by a few water agencies indicate that they are indeed moving toward better coordination throughout the basin and more effective management of all water supplies. Given the history of groundwater management in California, these seemingly small steps toward better management may actually represent giant strides forward.

More recently, financial incentives have played a large role in driving groundwater management activities. For example, under grant and loan programs resulting from Proposition 13 of 2000 (see description in Chapter 4), local agencies submitted applications proposing a total increase in annual water yield of more than 300,000 acre-feet through groundwater storage projects. Additional projects and programs would be developed with sufficient funding for feasibility and pilot studies. Unfortunately, not enough funding exists for all of the proposed projects, and many other legal and institutional barriers remain (see Box I, "Impediments to Conjunctive Management Programs in California"). It is clear, however, that further incentives would help agencies move ahead more aggressively in their groundwater management planning efforts.

Additional progress in groundwater management is reflected by passage of amendments to the Water Code (§§ 10753.4 and 10795.4 as amended, §§ 10753.7, 10753.8, and 10753.9 as amended and renumbered, and §§ 10753.1 and 10753.7 as added) through SB 1938 of 2002. The amendments require that groundwater management plans include specific components for agencies to be eligible for some public funds for groundwater projects. The provisions of SB 1938 (2001) are fully described in Chapters 3 and 4.

This evaluation of groundwater management success has not really considered ordinances and adjudications. Adjudications have been successful at maintaining the groundwater basin conditions, often restricting pumping for all basin users. In some cases, adjudication provides the necessary framework for more proactive management as well. Ordinances have successfully restricted exports from basins, but have not

Box F Managing through a Joint Powers Agreement

In 1993, representatives from business, environmental, public, and water purveyor interests formed the Sacramento Area Water Forum to develop a plan to protect the region's water resources from the effects of prolonged drought as the demand for water continues to grow. The Water Forum was founded on two co-equal objectives: (1) to provide a reliable and safe water supply for the region's economic health and planned development to the year 2030 and (2) to preserve the fishery, wildlife, recreational and aesthetic values of the lower American River.

After a six-year consensus-based process of education, analysis and negotiation, the participants signed a Water Forum agreement to meet these objectives. The agreement provides a framework for avoiding future water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity.

The Sacramento Groundwater Authority (SGA) was formed to fulfill a key Water Forum goal of protecting and managing the north-area groundwater basin. The SGA is a joint powers authority formed for the purpose of collectively managing the region's groundwater resources. This authority permits SGA to make contractual arrangements required to implement a conjunctive use program, and also provides potential partners with the legal and political certainty for entering into long-term agreements.

SGA's regional banking and exchange program is designed to provide long-term supply benefits for local needs, but also will have the potential to provide broader statewide benefits consistent with American River environmental needs. Water stored in Folsom Lake would be conjunctively used with groundwater in order to reduce surface water diversions in dry years and to achieve in-lieu recharge of the basin in wet years. The conjunctive use program participants include 16 water providers in northern Sacramento and southern Placer counties that serve water to more than half a million people.

Two of three implementation phases of the program are complete. In the first phase, program participants identified long-term water supply needs and conducted an inventory of existing infrastructure that could be used to implement the program. In the second phase, SGA completed two pilot banking and exchange projects, demonstrating the technical, legal, and institutional viability of a regional conjunctive use program. In the first pilot study, water agencies worked with the U.S. Bureau of Reclamation and the Sacramento Area Flood Control Agency to bank 2,100 acre-feet of groundwater, providing additional flood storage capacity in Folsom Lake. In the second pilot study, Citrus Heights and Fair Oaks water districts and the city of Sacramento extracted and used 7,143 acre-feet of groundwater, forgoing a portion of their rights to surface water, making this water available to the Environmental Water Account. The third phase of the SGA program is to further solidify the institutional framework and construct facilities to implement a full-scale regional conjunctive use program. These facilities, that will result in an average annual yield of 21,400 acre-feet, are currently under construction, funded in part by a $21.6 million grant under Proposition 13 of 2000.

Box G Managing a Basin through Integrated Water Management

Orange County Water District (OCWD) was established in 1933 by an uncodified Act (Water Code App. 40) to manage Orange County's groundwater basin and protect the Santa Ana River rights of water users of north-central Orange County. The district manages the groundwater basin, which provides as much as 75 percent of the water supply for its service area. The district strives for a groundwater-based water supply with enough reserves to provide a water supply through drought conditions. An integrated set of water management practices helps achieve this, including the use of recharge, alternative sources, and conservation.

Recharge

The Santa Ana River provides the main natural recharge source for the county's groundwater basin. Increased groundwater use and lower-than-average rainfall during the late 1980s and early 1990s forced the district to rely on an aggressive program to enhance recharge of the groundwater basin. Programs used today to optimize water use and availability include:

- Construction of levees in the river channel to increase infiltration.
- Construction of artificial recharge basins within the forebay.
- Development of an underwater basin cleaning vehicle that removes a clogging layer at the bottom of the recharge basin and extends the time between draining the basin for cleaning by a bulldozer.
- Use of storm water captured behind Prado Dam that would otherwise flow to the ocean.
- Use of imported water from the State Water Project and Colorado River.
- Injection of treated recycled water to form a seawater intrusion barrier.

Alternative Water Use and Conservation

OCWD has successfully used nontraditional sources of water to help satisfy the growing need for water in Orange County. Projects that have added to the effective supply of groundwater are:

- Use of treated recycled water for irrigation and industrial use.
- In-lieu use to reduce groundwater pumping.
- Change to low-flow toilets and showerheads.
- Participation of 70 percent of Orange County hotels and motels in water conservation programs.
- Change to more efficient computerized irrigation.

Since 1975, Water Factory 21 has provided recycled water that meets all primary and secondary drinking water standards set by the California Department of Health Services. OCWD has proposed a larger, more efficient membrane purification project called the Groundwater Replenishment System (GWRS), which is scheduled to begin operating at 70,000 acre-feet per year in 2007. By 2020 the system will annually supply 121,000 acre-feet of high quality water for recharge, for injection into the seawater intrusion barrier, and for direct industrial uses.

This facility will use a lower cost microfiltration and reverse osmosis treatment process that produces water of near distilled quality, which will help reverse the trend of rising total dissolved solids (TDS) in groundwater caused by the recharge of higher TDS-content Santa Ana River and Colorado River waters. The facility will use about half the energy required to import an equivalent amount of water to Orange County from Northern California. The GWRS will be funded, in part, by a $30 million grant under Proposition 13 of 2000.

Source: Orange County Water District

Box H Managing Groundwater using both Physical and Institutional Solutions

Four agencies share responsibility for groundwater management in Ventura County. Coordination and cooperation between these agencies focus on regular meetings, attendance at each other's board meetings, joint projects, watershed committees, and ongoing personal contacts to discuss water-related issues. The agencies and their areas of responsibility are:

- United Water Conservation District – physical solutions, monitoring, modeling, reporting, administering management plans and adjudication;
- Fox Canyon Groundwater Management Agency – pumping allocations, credits and penalties, abandoned well destruction, data for irrigation efficiency;
- County of Ventura – well permits, well construction regulations, tracking abandoned wells; and
- Calleguas Municipal Water District – groundwater storage of imported water.

In Ventura County 75% to 80% of the extracted groundwater is for agriculture; the remainder is for municipal and industrial use. Seawater intrusion into the aquifers was recognized in the 1940s and was the driving force behind a number of groundwater management projects and policies in the county's groundwater basins. As groundwater issues became more complicated at the end of the 20th century, these groundwater management projects and policies were useful in solving a number of problems.

Physical Solutions

Physical solutions substitute supplemental surface water for groundwater pumping near coastal areas, increase basin recharge, and increase the reliability of imported water. Projects include:

- Winter flood-flow storage for dry season release
- Wells and pipelines to move pumping for drinking water away from the coast
- Diversion structures to supply surface water to spreading grounds and irrigation
- Pipelines to convey surface water to coastal areas
- Las Posas Basin Aquifer Storage and Recovery project

Institutional Solutions

Institutional solutions focus on developing and implementing effective groundwater management programs, reducing pumping demands, tracking groundwater levels and water quality, managing groundwater pumping patterns, and destroying abandoned wells to prevent cross-contamination of aquifers. Solutions include:

- Creation of Fox Canyon Groundwater Management Agency (GMA), which represents each major pumping constituency
- Use of irrigation efficiency (agriculture), water conservation, and alternative sources of water (urban) to reduce pumping by 25%
- Manage outside the GMA area through an AB 3030 plan and a court adjudication
- Limit new permits for wells in specific aquifers to avoid seawater intrusion
- Creation of a program to destroy abandoned wells
- Creation of a database of historical groundwater levels and quality information collected since the 1920s
- Development of a regional groundwater flow model and a regional master plan for groundwater projects
- Creation of an irrigation weather station to assist in irrigation efficiency

Implementation of these physical and institutional management tools has resulted in the reversal of seawater intrusion in key coastal monitoring wells. These same tools are being used to mitigate saline intrusion (not seawater) in two inland basins and to reduce seasonal nitrate problems in the recharge area. Work is being expanded to help reduce loading of agricultural pesticides and nutrients. Without close coordination and cooperation of the county's water-related agencies, municipalities, and landowners, it would have been very difficult to implement most of these solutions. Although such coordination takes time, the investment has paid off in solutions that help provide a sustainable water supply for all water users in Ventura County.

Source: United Water Conservation District necessarily improved groundwater management. The primary intent of most ordinances is to ensure that proponents of projects are held accountable for potential impacts of the proposed export projects. As studies lead to a better understanding of local water resources, development of pilot export and transfer projects, with appropriate monitoring, may lead to greater certainty in managing groundwater resources. Areas managed under adjudications and ordinances will continue to develop more active management approaches. Population growth and its accompanying increased demand on the resources is a certainty. Most geographic areas in California are not immune to this growth, so strategies for more than just maintaining existing groundwater supply through extraction or export restrictions need to be implemented.

Box I Impediments to Conjunctive Management Programs in California

In 1998 the National Water Research Institute, in cooperation with the Association of Ground Water Agencies and the Metropolitan Water District of Southern California, conducted a workshop to determine the biggest impediments to implementing a cost-effective conjunctive water management program in California.

Since that time, some steps have been taken to overcome those impediments, but several important barriers remain. Workshop participants identified the 10 most significant obstacles:

1) Inability of local and regional water management governance entities to build trust, resolve differences (internally and externally), and share control.
2) Inability to match benefits and funding burdens in ways that are acceptable to all parties, including third parties.
3) Lack of sufficient federal, State, and regional financial incentives to encourage groundwater conjunctive use to meet statewide water needs.
4) Legal constraints that impede conjunctive use, regarding storage rights, basin judgments, area of origin, water rights, and indemnification.
5) Lack of statewide leadership in the planning and development of conjunctive use programs as part of comprehensive water resources plans, which recognize local, regional, and other stakeholders' interests.
6) Inability to address quality difference in "put" versus "take"; standards for injection, export, and reclaimed water; and unforeseeable future groundwater degradation.
7) Risk that water stored cannot be extracted when needed because of infrastructure, water quality or water level, politics, and institutional or contractual provisions.
8) Lack of assurances to prevent third-party impacts and assurances to increase willingness of local citizens to participate.
9) Lack of creativity in developing lasting "win-win" conjunctive use projects, agreements, and programs.
10) Supplemental suppliers and basin managers have different roles and expectations in relation to conjunctive use.

[**Editor's note**: The California Department of Water Resources' Conjunctive Water Management program has taken significant steps to overcome several of these impediments, using a combination of California Bay-Delta Authority, DWR, Proposition 13, and AB 303 funds to promote locally planned and controlled conjunctive use programs.]

Future Groundwater Management in California

Trying to predict what will happen with groundwater management in California is difficult given that actions by all of the involved groups—landowners, local governments, local, State, and federal agencies, and the courts—will continue to shape groundwater management in the future. However, the increasing population and its demands on California's water supply will accelerate the rate at which groundwater management issues become critical and require resolution. Some general conclusions are:

- Groundwater management will continue to be a local responsibility with increasing emphasis on how actions in one part of a basin impact groundwater resources throughout the basin. Regional cooperation and coordination of groundwater management activities will increase.
- As the State's population continues to grow, the increased reliance on groundwater will keep the topic of groundwater management at the forefront of legislative interest.
- Coordinated management of groundwater and surface water resources, through further development of conjunctive water management programs and projects, will become increasingly important.
- The increased reliance on groundwater in the future will necessitate a more direct link between land use planning, watershed management, floodplain management, and groundwater management plans.
- Current trends indicate that financial incentives in the form of loans and grants are increasing groundwater management planning and implementation at the local level. These successes will only continue at the current pace with increased funding to local agencies.
- Management of groundwater will increasingly include consideration of groundwater quality and groundwater quantity.
- Groundwater will be an important element in the trend toward an integrated water management approach that considers the full range of demand management and supply alternatives.
- Understanding of the relationship of groundwater and surface water and the role of groundwater in the environment will continue to grow.

Box J Managing Groundwater Quantity and Quality

When people hear the words "groundwater monitoring"' they may think either of measuring groundwater levels or of analyzing for groundwater quality. In reality, monitoring and management of groundwater quantity and groundwater quality are inseparable components of a management plan.

Although the primary focus of the California Department of Water Resources (DWR) is on groundwater quantity and the measures taken by local agencies to manage supply, management must also consider groundwater quality. Natural or anthropogenic contamination and pumping patterns that are not managed to protect groundwater quality may limit the quantity of groundwater that is available for use in a basin.

Several State programs provide useful data as well as regulatory direction on groundwater quality that managers can use in managing their groundwater supply. One program is the Drinking Water Source Assessment and Protection Program prepared by the California Department of Health Services in response to 1996 amendments to the federal Safe Drinking Water Act. The DWSAP requires water purveyors to assess sources of drinking water, develop zones indicating time of travel of groundwater, and identify potentially contaminating activities around supply wells. The goal is to ensure that the quality of drinking water sources is maintained and protected. Other useful water quality data for groundwater managers is collected by the agencies within the California Environmental Protection Agency, including the State Water Resources Control Board, Department of Pesticide Regulation and the Department of Toxic Substances Control, which are discussed in more detail in Chapter 5. Each of these agencies has a specific statutory responsibility to collect groundwater quality information and protect water quality.

Protection of Recharge Areas

Groundwater recharge areas, and the human activities that can render them unusable, are an example of the need to coordinate land use activities to protect both groundwater quality and quantity. Protection of recharge areas, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Existing and potential recharge areas must be protected so that they remain functional, that is they continue to provide recharge to the aquifer and they are not contaminated with chemical or microbial constituents. Land-use practices should be implemented so that neither the quantity nor quality of groundwater is reduced. A lack of protection of recharge areas could decrease the availability of usable groundwater and require the substitution of a more expensive water supply.

Many potentially contaminating activities have routinely been practiced in recharge areas, leading to the presence of contaminants in groundwater. In many areas, groundwater obtained from aquifers now requires remediation. Recent studies in some areas show that recharge areas are contaminated, but down-gradient wells are not, indicating that it is only a matter of time before contaminants in wells reach concentrations that require treatment of the groundwater.

In addition to quality impacts, urban development, consisting of pavement and buildings on former agricultural land, lining of flood control channels, and other land use changes have reduced the capacity of recharge areas to replenish groundwater, effectively reducing the safe yield of some basins.

Box J Managing Groundwater Quantity and Quality (continued)

To ensure that recharge areas continue to replenish high quality groundwater, water managers and land use planners should work together to:

- Identify recharge areas so the public and local zoning agencies are aware of the areas that need protection from paving and from contamination;
- Include recharge areas in zoning categories that eliminate the possibility of contaminants entering the subsurface;
- Standardize guidelines for pre-treatment of the recharge water, including recycled water;
- Build monitoring wells to collect data on changes in groundwater quality that may be caused by recharge; and
- Consider the functions of recharge areas in land use and development decisions.

Chapter 3

Groundwater Management Planning and Implementation

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Groundwater Management Planning and Implementation

The 1990s were a very important decade in the history of groundwater management in California. In 1992, the State Legislature provided an opportunity for more formal groundwater management with the passage of AB 3030 (Water Code § 10750 et seq.). More than 200 agencies have adopted an AB 3030 groundwater management plan. Additionally, 24 of the 27 counties with ordinances related to groundwater management adopted those laws during the 1990s. Plans prepared under AB 3030 certainly brought unprecedented numbers of water agencies into the groundwater management arena, and counties are now heavily involved in groundwater management, primarily through ordinances. However, many plans prepared under AB 3030 have had little or no implementation, and many counties focus primarily on limiting exports rather than on a comprehensive management program. As a result, the California Budget Act of 1999 (Stats. 1999, ch. 50), which authorized this update to Bulletin 118, directed the California Department of Water Resources (DWR) to complete several tasks, including developing criteria for evaluating groundwater management plans and developing a model groundwater management ordinance. This chapter presents the results of these directives. The intent is to provide a framework that will assist local agencies in proactively planning and implementing effective groundwater management programs.

Criteria for Evaluating Groundwater Management Plans—Required and Recommended Components

In 2002, the Legislature passed SB 1938 (Stats 2002, ch 603), which amended Water Code section 10750 et seq to require that groundwater management plans adopted by local agencies include certain components to be eligible for public funds administered by DWR for construction of groundwater projects; the statute applies to funds authorized or appropriated after September 1, 2002. In addition to the required components, DWR worked with representatives from local water agencies to develop a list of additional recommended components that are common to effective groundwater management.

Both the "required" and the "recommended" components are tools that local agencies can use either to institute a groundwater management plan for the first time or to update existing groundwater management plans. These components are discussed below and listed in Appendix C, which can be used as a checklist by local agencies to assess whether their groundwater management plans are addressing these issues.

Required Components of Local Groundwater Management Plans

As of January 1, 2003, amendments to Water Code Section 10750 et seq., resulting from the passage of SB 1938, require new groundwater management plans prepared under section 10750, commonly referred to as AB 3030 plans, to include the first component listed below.

Groundwater management plans prepared under any statutory authority must include components 2 through 7 to be eligible for the award of public funds administered by DWR for the construction of groundwater projects or groundwater quality projects. These requirements apply to funds authorized or appropriated after September 1, 2002. Funds appropriated under Water Code section 10795 et seq. (AB 303 – Local Groundwater Assistance Fund) are specifically excluded.

1) Documentation that a written statement was provided to the public "describing the manner in which interested parties may participate in developing the groundwater management plan" (Water Code, § 10753.4 (b)).

2) Basin management objectives (BMOs) for the groundwater basin that is subject to the plan (Water Code, § 10753.7 (a)(1)).
3) Components relating to the monitoring and management of groundwater levels, groundwater quality, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping (Water Code, § 10753.7 (a)(1)).
4) A plan by the managing entity to "involve other agencies that enables the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin" (Water Code, § 10753.7 (a)(2)). A local agency includes "any local public agency that provides water service to all or a portion of its service area" (Water Code, § 10752 (g)).
5) Adoption of monitoring protocols (Water Code, § 10753.7 (a)(4)) for the components in Water Code section 10753.7 (a)(1). Monitoring protocols are not defined in the Water Code, but the section is interpreted to mean developing a monitoring program capable of tracking changes in conditions for the purpose of meeting BMOs.
6) A map showing the area of the groundwater basin as defined by DWR Bulletin 118 with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin in which the agency is developing a groundwater management plan (Water Code, § 10753.7 (a)(3)).
7) For local agencies not overlying groundwater basins, plans shall be prepared including the above listed components and using geologic and hydrologic principles appropriate to those areas (Water Code, § 10753.7 (a)(5)).

Recommended Components of Groundwater Management Plans

Although the seven components listed above are required only under certain conditions, they should always be considered for inclusion in any groundwater management planning process. In addition to the required components of a groundwater management plan resulting from the passage of SB 1938, it is recommended that the components listed below be included in any groundwater management plan adopted and implemented by a local managing entity. These additional components were developed in accord with the Budget Act of 1999 and with the assistance of stakeholder groups. The components should be considered and developed for specific application within the basin, subbasin, or agency service area covered by the plan. Additional components will likely be needed in specific areas. The level of detail for each component will vary from agency to agency. None of the suggested data reporting in the components should be construed to require disclosure of information that is confidential under State law. Local agencies should consider both the benefits of public dissemination of information and water supply security in developing reporting requirements.

Manage with the Guidance of an Advisory Committee

The managing entity should establish an advisory committee of interested parties that will help guide the development and implementation of the plan. The committee can benefit management in several ways. First, the committee can bring a variety of perspectives to the management team. As the intent of local groundwater management is to maintain and expand local benefits from the availability of the resource, it makes sense that the intended beneficiaries are a part of the management process. Second, the committee is free to focus on the specifics of groundwater management without being distracted by the many operational activities that the managing entity (such as a water district) must complete. Third, some parties could be negatively impacted by certain groundwater management decisions, and these actions and potential adverse impacts should be a part of the decision-making process to help reduce future conflicts. Finally, the advisory committee helps the managing entity gain the confidence of the local constituency by providing the opportunity for interested parties to participate in the management process.

Many managing entities have already elected to use advisory committees for implementation of their groundwater management plans. The composition of these committees varies widely. Some groups consist entirely of stakeholders, others add local or State government representatives or academic members as impartial third parties, and some have included consultants as technical advisers. Some plans use multiple advisory committees to manage unique subareas. Some plans appoint advisory committees with different objectives, such as one that deals with technical issues and another that deals with policy issues. There is no formula for the composition of an advisory committee because it should ultimately be based on local management needs and should include representation of diverse local interests.

The Tulare Lake Bed Coordinated Management Plan provides an example of the benefit of an advisory committee. The plan includes nine groups of participants, making coordination and communication a complicated issue. To allow for greater communication, an executive committee was established consisting of one voting member from each public agency participating in the plan and one voting member representing a combined group of private landowner plan participants. The committee administers groundwater management activities and programs for the plan (TLBWSD 2002).

Describe the Area to Be Managed under the Plan

The plan should include a description of the physical setting and characteristics of the aquifer system underlying the plan area in the context of the overall basin. The summary should also include a description of historical data, including data related to groundwater levels, groundwater quality, subsidence, and groundwater-surface water interaction; known issues of concern with respect to the above data; and a general discussion of historical and projected water demands and supplies. All of these data are critical to effective groundwater management because they demonstrate the current understanding of the system to be managed and serve as a point of departure for monitoring activities as part of plan implementation.

Create a Link Between Management Objectives and Goals and Actions of the Plan

The major goal of any groundwater management plan is to maintain a reliable supply of groundwater for long-term beneficial uses of groundwater in the area covered by the plan. The plan should clearly describe how each of the adopted management objectives helps attain that goal. Further, the plan should clearly describe how current and planned actions by the managing entity help meet the adopted management objectives. The plan will have a greater chance of success by developing an understanding of the relationship between each action, management objectives, and the goal of the groundwater management plan.

For example, prevention of contamination of groundwater from the land surface is a management objective that clearly supports the goal of groundwater sustainability. Management actions that could help support this objective include (1) educating the public through outreach programs that explain how activities at the surface ultimately impact groundwater, (2) developing wellhead protection programs or re-evaluating existing programs, (3) working with the local responsible agency to ensure that permitted wells are constructed, abandoned, and destroyed according to State well standards, (4) investigating whether local conditions necessitate higher standards than those adopted by the local permitting agency for the construction, abandonment, or destruction of wells, and (5) working with businesses engaged in practices that might impact groundwater to reduce the risks of contamination.

The concept of having a management objective is certainly not new. While many existing plans do not clearly include management objectives nor specifically identify actions to achieve objectives, some plans indirectly include these components. As an example, Eastern Municipal Water District's (EMWD) Groundwater Management Plan states that its goal includes maximizing "the use of groundwater for all beneficial uses in such a way as to lower the cost of water supply and to improve the reliability of the total water supply for all users." To achieve this goal, EMWD has listed several issues to be addressed. One is the prevention of long-term depletion of groundwater. This can be defined as a management objective even though it is not labeled as such. Where this management objective is currently unmet in the North San Jacinto watershed portion of the plan area, EMWD has identified specific actions to achieve that objective including the reduction of groundwater extraction coupled with pursuing the construction of a pipeline to act as an alternative source of surface water for the impacted area (EMWD 2002).

Describe the Plan Monitoring Program

The groundwater management plan should include a map indicating the locations of any applicable monitoring sites for groundwater levels, groundwater quality, subsidence, stream gaging, and other applicable monitoring. The groundwater management plan should summarize the type of monitoring (for example, groundwater level, groundwater quality, subsidence, streamflow, precipitation, evaporation, tidal influence), type of measurements, and the frequency of monitoring for each location. Site specific monitoring information should be included in each groundwater management plan. The plan should include the well depth, screened interval(s) and aquifer zone(s) monitored and the type of well (public, irrigation, domestic, industrial, monitoring). These components will serve as a tool for the local managing entity to assess the adequacy of the existing monitoring network in tracking the progress of plan activities.

The groundwater management plan developed for the Scotts Valley Water District (SVWD) provides a detailed description of the monitoring program in Santa Cruz County (Todd Engineers 1994) Table 6 is SVWD's monitoring table, which serves as an example of the level of detail that is useful in a plan (Todd Engineers 2003a). Figure 9 shows the locations and types of monitoring points for each monitoring site. The monitoring table specifies in detail the data available and the planned monitoring. These serve as useful tools for SVWD to visualize the types and distribution of data available for their groundwater management activities. In addition to the minimum types of monitoring, SVWD summarizes other types of data that are relevant to their groundwater management effort.

Describe Integrated Water Management Planning Efforts

Water law in California treats groundwater and surface water as two separate resources with the result that they have largely been managed separately. Such management does not represent hydrologic reality. Recently, managers of a number of resources are becoming increasingly aware of how their planning activities could impact or be impacted by the groundwater system. Because of this, the local managing entity should describe any current or planned actions to coordinate with other land use, zoning, or water management planning entities.

Integrated management is addressed in existing groundwater management plans in several ways, including conjunctively managing groundwater with surface water supplies, recharging water from municipal sewage treatment plants, and working with local planning agencies to provide comments when a project is proposed that could impact the groundwater system.

Examples of planning efforts that should be integrated with groundwater management may include watershed management, protection of recharge areas, agricultural water management, urban water management, flood management, drinking water source assessment and protection, public water system emergency and disaster response, general plans, urban development, agricultural land preservation, and environmental habitat protection or restoration. Another example that may appear insignificant is transportation infrastructure. However, local impacts on smaller aquifers could be significant when landscaping of medians and interchanges requires groundwater pumping for irrigation or when paved areas are constructed over highly permeable sediments that act as recharge zones for the underlying aquifer.

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Precipitation	El Pueblo Yard	15-minute recording	Feb-85	Daily/District, Monthly/City	Other historic gages:(1) Blair site on Granite Ck. Rd. (Jan. 1975 - Dec. 1980)
	WWTP	5-minute recording	1990	Daily/City	(2) Hacienda Dr. (Jul. 1974 - Mar. 1979) (3) El Pueblo Yard bucket gage (Jan. 1981 - Jan. 1985)
Evaporation	El Pueblo Yard	Pan	Jan-86	Daily/District	Evaporation pan raw data not compiled after July 1990
Evapotranspiration	De Laveaga Park, Santa Cruz	Automated active weather station	Sep-90	California Irrigation Management Information System/Monthly	Data available on-line through CIMIS
Streamflow	Carbonera Ck at Scotts Valley @ Cabonera Way Bridge (#111613000)	15-minute recording	Jan-85	USGS/ Daily	Other historic gages: (1) Carbonera Ck @ Santa Cruz (#11161400) 150 feet upstream from mouth (1974-1976 partial data)
	Bean Ck near Scotts Valley @ Hermon Crossing (#11160430)	15-minute recording	Dec-88	USGS/ Daily	(2) Bean Ck near Felton (#11160320) (1973-1978 partial data), low flows at same location (1983-1988)
	Eagle Creek In Henry Cowell Redwoods State Park	Bucket-Fall, Flow Meter-Spring	Mar-01	Semi-annually/ Todd Engineers	(3) Carbonera Creek @ Glen Canyon (1990-1994?)
Well Inventory	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36	Over 400 wells: location, log, type, capacity, etc. stored in GIS, and Access database	1950s	Logs from DWR maintained by Todd Engineers	
Groundwater Levels	~34 Santa Magarita aquifer and ~14 Lompico formation wells	Depth to water	1968	Quarterly/ District and cooperators	Data from over 75 wells, as early as 1968, bi-monthly 1983-1989
Pumpage	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14, 23-26, 36 District wells in production and on standby	Metered	1975	Monthly/ Scotts Valley Water District, Mt. Hermon Association, Hanson Aggregates West, San Lorenzo Valley Water District	Other historic pumpage data: Manana Woods (1988-1996 partial data)

Table 6 Scotts Valley Water District's Groundwater Monitoring Plan (continued)

Monitoring type	Location	Measurement type	Date started	Frequency/ maintainer	Notes
Groundwater Quality	T10S/R01E Sections 6-9, 16-20, 30 and T10S/R02E Sections 1,11-14,23-26, 36 District wells in production	Title 22 constituents	1963	At least semi-annual/ District and others	Data from over 80 wells, as early as 1963, monitoring frequency similar to groundwater level program
	North Scotts Valley 3 shallow monitoring wells	Metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Surface Water Quality	4 sites on Carbonera and 3 sites on Bean Creek	Grab samples - metals, nitrogen species, general minerals	Mar-01	Semi-annually/ Todd Engineers	
Wastewater Outflows	City of Scotts Valley WWTP @ Lundy Lane	Wastewater outflow volume and effluent quality	1965	Daily/City of Scotts Valley	Plant operational in 1965 (septic systems pre-1965)
Recycled Water Production	Scotts Valley WWTP	Recycled water quantity and quality	2002	At least quarterly/ WWTP	

Source: Todd Engineering 2003a

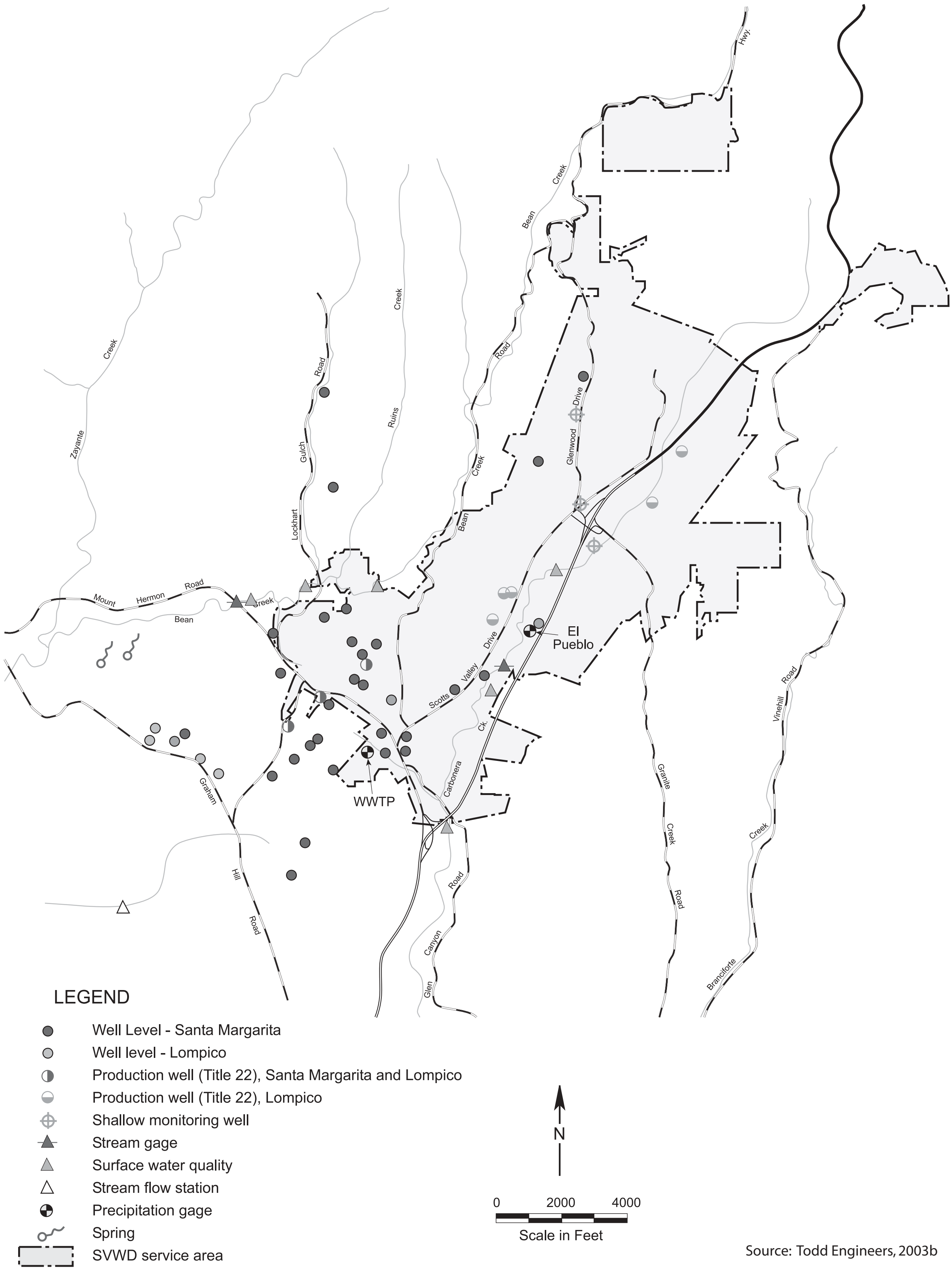

Figure 9 Scotts Valley Water District's Groundwater Management Plan monitoring locations

Box K What are Management Objectives?

Management objectives are the local managing entity's way of identifying the most important issues in meeting local resource needs; they can be seen as establishing a "value system" for the plan area. There is no fixed set of management objectives for any given plan area. Some of the more commonly recognized management objectives include the monitoring and managing of groundwater levels, groundwater quality, inelastic land subsidence, and changes in streamflow and surface water quality where they impact or are impacted by groundwater pumping. Management objectives may range from being entirely qualitative to strictly quantified.

Each management objective would have a locally determined threshold value associated with it, which can vary greatly. For example, in establishing a management objective for groundwater quality, one area may simply choose to establish an average value of total dissolved solids as the indicator of whether a management objective is met, while another agency may choose to have no constituents exceeding the maximum contaminant level for public drinking water standards. While there is great latitude in establishing management objectives, local managers should remember that the objectives should serve to support the goal of a sustainable supply for the beneficial use of the water in their particular area.

An example of an alternative management objective is Orange County Water District's (OCWD) objective of maintaining available storage space in its management area at 200,000 acre-feet. The objective does not require that groundwater elevations be fixed at any particular location, although managing to this objective would likely have the net benefit of stabilizing water levels. Groundwater storage is a dynamic value, so attempting to meet this management objective is an ongoing challenge. OCWD has implemented many management actions directly aimed at managing the basin to meet this objective.

The Deer Creek and Tule River Authority provides an excellent example of how groundwater management activities can be coordinated with other resources. The authority, in conjunction with the U.S. Bureau of Reclamation, has constructed more than 200 acres of recharge basins as part of its Deer Creek Recharge-Wildlife Enhancement Project. When available, the project takes surplus water during winter months and delivers it to the basins, which serve as winter habitat for migrating waterfowl, creating a significant environmental benefit. Most of the water also recharges into the underlying aquifer, thereby benefiting the local groundwater system.

Report on Implementation of the Plan

The managing entity should produce periodic reports—annually or at other frequencies determined by the local managing entity—summarizing groundwater basin conditions and groundwater management activities. For the period since the previous update, the reports should include:

- A summary of monitoring results, including historical trends,
- A summary of actual management actions,
- A summary, supported by monitoring results, of whether management actions are achieving progress in meeting management objectives,
- A summary of proposed management actions, and
- A summary of any plan component changes, including addition or modification of management objectives.

Unfortunately, many plans were prepared in the mid-1990s with little or no follow-up documentation of whether the plan is actually being implemented. This makes it difficult to determine what progress has been achieved in managing the groundwater resource. Periodic reports will serve as a tool for the managing entity to organize its many activities to implement the plan, act as a driving force for plan implementation, and help interested parties understand the progress made by local entities in managing their groundwater resource.

Progress reports on SVWD (Todd Engineers 2002) and EMWD (2002) groundwater management plans serve as excellent examples of the value of such an exercise. Both reports effectively portray the results of management actions: progress toward achieving objectives and specific recommendations for future management actions. An example of reporting on the modification of a management objective for water quality can be found in EMWD's 2000 Annual Report (EMWD 2001). A task force of more than 20 water suppliers and wastewater agencies, including EMWD, worked to update the Regional Water Quality Control Board's Region 5 Basin Plan objectives for nitrogen and total dissolved solids in water, effectively changing EMWD's management objectives for those constituents.

Evaluate the Plan Periodically

The managing entity and advisory committee should re-evaluate the entire plan. Periodic evaluation of the entire management plan is essential to define successes and failures under the plan and identify changes that may be needed. Additionally, re-evaluation of the plan should include assessment of changing conditions in the basin that may warrant modification of the plan or management objectives. Adjustment of components in the plan should occur on an ongoing basis if necessary. The re-evaluation of the plan should focus on determining whether the actions under the plan are meeting the management objectives and whether the management objectives are meeting the goal of sustaining the resource.

While there are several examples of existing groundwater management plans that demonstrate ongoing changes to plan activities, there are no known examples of such an approach to entirely re-evaluate an existing plan. This is likely due in part to the occurrence of several consecutive wet years in the mid- and late-1990s. The abundant surface water supplies reduced the need to actively manage groundwater supplies in many cases. More recent dry conditions and the recent passage of SB 1938 will create an excellent opportunity for managing entities to begin a re-evaluation of existing plans.

Model Groundwater Management Ordinance

As discussed in the previous chapter, ordinances are groundwater management mechanisms enacted by local governments through exercise of their police powers to protect the health and safety of their citizens. In Baldwin v. Tehama County (1994), the appellate court declared that State law does not preempt the field of groundwater management.

In the mid- to late-1990s, many counties adopted ordinances that effectively prevented export of groundwater from the county, even though none specifically prohibited export. The intent of each of these ordinances is to sustain groundwater as a viable local resource. To ensure that goal, an export project proponent is required by most of the ordinances to show that the proposed project will not cause depletion of the groundwater, degradation of groundwater quality, or subsidence before a permit to export groundwater can be issued. Although these ordinances do not specifically require threshold limits for each of these potential negative impacts, a project proponent can really only show that these negative effects will not occur if the proponent develops a groundwater management plan.

Many of these ordinances were developed in response to the plans of some agencies or landowners to export groundwater or develop a groundwater substitution project where surface water is exported and groundwater is substituted for local use. In some cases, short-term export actually took place, leading to a number of claims of negative third party impacts. Residents of some counties became concerned because no one knew how much groundwater was available for local use and how much groundwater was available for export. In short, details of the hydrology of the basin, including surface water and groundwater availability, water quality, and the interaction of surface water and groundwater were not known. This lack of detailed knowledge about the operating potential of their groundwater resources led counties to take what they viewed as protective action, which consisted of requiring a permit before anyone could export groundwater from the county.

From the perspective of DWR, groundwater should be managed in a manner that ensures long-term sustainability of the resource for beneficial uses. Those beneficial uses are to be decided by the local stakeholders within the basin. In some areas, there may be an ample supply of water, so groundwater exports or substitution projects are feasible while local beneficial uses of the water supply are maintained. In other areas, limiting exports may be necessary to maintain local beneficial uses. Such determinations can be made only after the data are collected and evaluated and the results are used to develop management objectives for the basin.

While developing both the criteria for evaluating groundwater management plans and the model groundwater management ordinance, DWR staff has borne two principles in mind. First, the goal of groundwater management, whether accomplished by a plan or by an ordinance, is to sustain and often expand a groundwater resource. Second, groundwater management, whether accomplished by a plan or by an ordinance, requires that local agencies address and resolve the same or similar issues within the boundaries of the agencies. To say it in different words, whether it is a plan or an ordinance, good groundwater management should address the same issues and problems and arrive at the same conclusions and solutions to satisfy the needs of the local area. While some areas may allow or promote exports, others may not.

As stated above, the Legislature required a model ordinance as one of the elements of this update of Bulletin 118. The model ordinance is included as Appendix D and can be used by local governments that have identified a need to adopt a groundwater management ordinance. The model is an example of what a local ordinance might include. Local conditions will require some additions, modifications, or deletions. The variety of political, institutional, legal, technical, and economic opportunities and constraints throughout California guarantees that there will be differences to which the model will have to be adapted. Local governments interested in adopting a groundwater management ordinance are encouraged to consider all components included in the model.

Water Code section 10753.7(b)(1)(A) allows an agency to participate in or consent to be subject to a groundwater management plan, a basin-wide management plan, or other integrated regional water management plan in order to meet the funding eligibility requirements that resulted from passage of SB 1938 (2001). A local government that adopts an ordinance should consider whether or not it will have local agencies that do not have their own groundwater management plan, but consent to be managed under the ordinance. If this situation is anticipated, the ordinance should include the required components described in the Water Code so State funding can be pursued.

Chapter 4

Recent Actions Related to Groundwater Management

Chapter 4
Recent Actions Related to Groundwater Management

The past few years have seen significant actions that impact groundwater management in California. Below are several examples of recent actions including legislation, ballot measures, and executive orders that show the State Legislature and the citizens of California clearly recognize the importance of groundwater and its appropriate management in meeting the present and future water supply needs of the State.

Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)

On March 7, 2000, California voters approved a $1.97-billion general obligation bond known as the Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13). Of the nearly $2 billion, $230 million was earmarked for groundwater programs. The act authorizes $200 million for grants for feasibility studies, project design, and construction of conjunctive use facilities (Water Code, § 79170 et seq.) and $30 million in loans for local agency acquisition and construction of groundwater recharge facilities and feasibility study grants for projects potentially eligible for the loan program (Water Code, § 79161 et seq.). More than $120 million have been awarded in grants and loans to local agencies in the first two years of implementation of these programs.

California Bay-Delta Record of Decision

The goal of the California Bay-Delta (formerly CALFED) program is to restore ecosystem health and improve water management in the Bay-Delta system. The program has four primary objectives:

- Provide good water quality for all beneficial uses,
- Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species,
- Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system, and
- Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

The Record of Decision (ROD), released in August 2000, sets forth a 30-year plan to address ecosystem health and water supply reliability problems in the Bay-Delta system. The ROD lays out specific actions and investments over the first seven years to meet program goals. Most important, with respect to groundwater is the California Bay-Delta program's commitment to local groundwater management. The ROD states, "CALFED will work with local governments and affected stakeholders to develop legislation to strengthen AB 3030 and provide technical and financial incentives to encourage more effective basin-wide groundwater management plans…" (CALFED 2000). The ROD encourages basin management that is developed at the subbasin level so that it addresses local needs, but is coordinated at the basin-wide level so that it considers impacts to other users in the basin. The ROD also commits Bay-Delta agencies to "facilitate and fund locally supported, managed, and controlled groundwater and conjunctive use projects with a total of 500,000 acre-feet to 1 million acre-feet (maf) of additional storage capacity by 2007" (CALFED 2000).

Local Groundwater Management Assistance Act of 2000
(AB 303, Water Code Section 10795 et seq.)

The goal of the Local Groundwater Management Assistance Act is to help local agencies better understand how to manage groundwater resources effectively to ensure the safe production, quality, and proper storage of groundwater in the State. The act created the Local Groundwater Assistance Fund, which must be appropriated annually. In three years, more than $15 million in grants were awarded for 71 projects. Grants went to local agencies for groundwater studies and projects that contribute to basin and subbasin management objectives, including but not limited to groundwater monitoring and groundwater basin management. Grants are available to all geographic areas of the State. This act serves to emphasize that groundwater is recognized as an important local resource and, to the extent that groundwater is properly managed at the local level, serves to benefit all Californians.

Groundwater Quality Monitoring Act of 2001
(AB 599, Water Code Section 10780 et seq.)

Assembly Bill 599, known as the Groundwater Quality Monitoring Act of 2001, set a goal to establish comprehensive groundwater monitoring and increase the availability of information about groundwater quality to the public. The objective of the program is to highlight those basins in which contamination has occurred or is likely to occur and provide information that will allow local managers to develop programs to curtail, treat, or avoid additional contamination. The act required the State Water Resources Control Board (SWRCB), in coordination with an Interagency Task Force (ITF) and a Public Advisory Committee (PAC), to integrate existing monitoring programs and design new program elements, as necessary, to establish a comprehensive statewide groundwater quality monitoring program.

Through the ITF and PAC, the Comprehensive Groundwater Quality Monitoring Program was developed. The program will seek to:

- Accelerate the monitoring and assessment program already established by the SWRCB,
- Implement monitoring and assessment in accordance with a prioritization of basins/subbasins,
- Increase coordination and data sharing among groundwater agencies, and
- Maintain groundwater data in a single repository to provide useful access by the public while maintaining appropriate security measures.

The Comprehensive Groundwater Quality Monitoring Program is expected to provide the following key benefits:

- A common base communications medium for agencies to utilize and supply groundwater quality data at multiple levels,
- A mechanism to unite local, regional and statewide groundwater programs in a common effort,
- Better understanding of local, regional and statewide water quality issues and concerns that in turn can provide agencies at all levels with better information to deal with the concerns of consumers and consumer advocate groups,
- Trend and long-term forecasting information for groundwater agencies, which is essential for groundwater management plan preparation and implementation, and
- The motivation for small- and medium-sized agencies to begin or improve their own groundwater monitoring and management programs.

Water Supply Planning

Three bills enacted by the Legislature to improve water supply planning processes at the local level became effective January 1, 2002. In general, the new laws are intended to improve the assessment of water supplies during the local planning process before land use projects that depend on water are approved. The new laws require the verification of sufficient water supplies as a condition for approving developments, and they compel urban water suppliers to provide more information on the reliability of groundwater if used as a supply.

SB 221 (Bus. and Prof. Code, § 11010 as amended; Gov. Code, § 65867.5 as amended; Gov. Code, §§ 66455.3 and 66473.7) prohibits approval of subdivisions consisting of more than 500 dwelling units unless there is verification of sufficient water supplies for the project from the applicable water supplier(s). This requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 service connections. The law defines criteria for determining "sufficient water supply," such as using normal, single-dry, and multiple-dry year hydrology and identifying the amount of water that the supplier can reasonably rely on to meet existing and future planned uses. Rights to extract additional groundwater must be substantiated if used for the project.

SB 610 (Water Code, §§ 10631, 10656, 10910, 10911, 10912, and 10915 as amended; Pub. Resources Code, § 21151.9 as amended) and AB 901 (Water Code, §§ 10610.2 and 10631 as amended; Water Code § 10634) make changes to the Urban Water Management Planning Act to require additional information in Urban Water Management Plans (UWMP) if groundwater is identified as a source available to the supplier. Required information includes a copy of any groundwater management plan adopted by the supplier, proof that the developer or agency has rights to the groundwater, a copy of the adjudication order or decree for adjudicated basins, and if not adjudicated, whether the basin has been identified as being overdrafted or projected to be overdrafted in the most current DWR publication on the basin. If the basin is in overdraft, the UWMP must include current efforts to eliminate any long-term overdraft. A key provision in SB 610 requires that any project subject to the California Environmental Quality Act supplied with water from a public water system must provide a water supply assessment, except as specified in the law. AB 901 requires the plan to include information relating to the quality of existing sources of water available to an urban water supplier over given periods and include the manner in which water quality affects water management strategies and supply reliability.

Emergency Assistance to the Klamath Basin

On May 4, 2001, the Governor proclaimed a State of Emergency in the Klamath Basin in Siskiyou and Modoc counties. The proclamation included disaster assistance of up to $5 million under authority of the State Natural Disaster Assistance Act. This assistance went directly into constructing wells to extract groundwater for use on cover crops to avoid loss of critical topsoil. The Governor's proclamation also included $1 million for a study of the Klamath River Basin to determine the long-term water supply in the California portion of the basin.

Governor's Drought Panel

The Governor's Advisory Drought Planning Panel was formed in 2000 to develop a contingency plan to address the impacts of critical water shortages in California. The panel formed with the recognition that critical water shortages may severely impact the health, welfare, and economy of California. Panel recommendations included securing funding for the Local Groundwater Management Assistance Act (described above), continued support of critical groundwater monitoring in basins with inadequate data, and the formation of a technical assistance and education program for "rural homeowners and small domestic water systems relying on self-supplied groundwater" (GADPP 2000).

Sacramento Valley Water Management Agreement

On May 22, 1995, SWRCB adopted the "Water Quality Control Plan for the San Francisco Bay/Sacramento San Joaquin Delta Estuary" (the 1995 WQCP). Following this action, SWRCB initiated a water rights hearing process with the intent of allocating responsibility for meeting the standards of the 1995 WQCP among water right holders in areas tributary to the Delta. The water rights hearing was conducted in phases with all phases being resolved with the exception of Phase 8, which involved water rights holders in the Sacramento Valley.

Proceeding with Phase 8 may have involved litigation and judicial review for years. That extended process could have resulted in adverse impacts to the environment and undermined progress on other statewide water management initiatives. To avoid the consequences of delay, the Sacramento Valley Water Users, DWR, the U.S. Bureau of Reclamation (USBR), and export water users developed the Sacramento Valley Water Management Agreement. The agreement became effective April 20, 2001. At that time, SWRCB issued an order staying the Phase 8 hearing for 18 months. The parties negotiated a short-term settlement agreement that obligated DWR and USBR to continue to fully meet the Bay-Delta water quality standards while providing for the development of conjunctive use and system improvement projects by participating upstream water rights holders that would make water available to help meet water quality standards while improving the reliability of local water supplies. SWRCB has subsequently dismissed the Phase 8 proceedings, and work is being undertaken on both short-term and long-term activities included in the Sacramento Valley Water Management Agreement.

Groundwater Management Water Code Amendments

In September 2002, SB 1938 (Water Code, § 10753.4 and § 10795.4 as amended; Water Code, § 10753.7, § 10753.8 and § 10753.9 as amended and renumbered; Water Code, § 10753.1 and § 10753.7 as added) was signed into law. The act amends existing law related to groundwater management by local agencies. The law requires any public agency seeking State funds administered through DWR for the construction of groundwater projects or groundwater quality projects to prepare and implement a groundwater management plan with certain specified components. Prior to this, there were no required plan components. New requirements include establishing basin management objectives, preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management. The requirements apply to agencies that have already adopted groundwater management plans as well as agencies that do not overlie groundwater basins identified in Bulletin 118 and its updates when these agencies apply for state funds. The requirements do not apply to funds administered through the AB 303-Local Groundwater Management Assistance Act (Water Code, § 10795 et seq.) or to funds authorized or appropriated prior to September 1, 2002. Further discussion of the requirements is included in Chapter 3 and Appendix C.

Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)

California voters approved the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50; Water Code, § 79500 et seq.) in the November 2002 elections. The initiative provides for more than $3.4 billion of funding, subject to appropriation by the Legislature, for a number of land protection and water management activities.

Several chapters of Proposition 50 allocate funds for specified water supply and water quality projects, including:

- Chapter 3 Water Security. Provides $50 million to protect State, local, and regional drinking water systems from terrorist attack or deliberate acts of destruction or degradation.

- Chapter 4 Safe Drinking Water. Provides $435 million for grants and loans for infrastructure improvements to meet safe drinking water standards.
- Chapter 5 Clean Water and Water Quality. Provides $390 million for a number of water quality and environmental improvements.
- Chapter 6 Contaminant and Salt Removal Technologies. Provides $100 million for desalination of ocean or brackish waters as well as treatment and removal of contaminants.
- Chapter 7 California Bay-Delta program. Provides $825 million for continuing implementation of all elements of the program.
- Chapter 8 Integrated Regional Water Management. Provides $500 million for many categories of water management projects that will protect communities from drought, protect and improve water quality, and reduce dependence on imported water supplies.
- Chapter 9 Colorado River. Provides $70 million for canal-lining projects necessary to reduce water use and to meet commitments related to California's allocation of water from the Colorado River.

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Chapter 5

The Roles of State and Federal Agencies in California Groundwater Management

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Chapter 5
The Roles of State and Federal Agencies in California Groundwater Management

Even though groundwater management is a local responsibility and mostly voluntary, several State and federal agencies have key roles in California groundwater management. Some of these roles may not be immediately recognized, but because they work toward the goal of maintaining a reliable groundwater supply, they are closely related to groundwater management. Some of the programs available through the California Department of Water Resources (DWR) and other agencies that assist local agencies in managing groundwater resources are described below.

Local Groundwater Management Assistance from DWR

DWR's role in groundwater management begins with the fundamental understanding that groundwater management is locally driven and management programs should respond to local needs and concerns. DWR recognizes that when groundwater is effectively managed at the local level, benefits are realized at a statewide level.

DWR has historically maintained many programs that directly benefit local groundwater management efforts including:

- Providing assistance to local agencies to assess basin hydrogeologic characteristics,
- Assisting local agencies to identify opportunities to develop additional groundwater supply,
- Monitoring groundwater levels and quality,
- Providing watermaster services for court-adjudicated basins,
- Providing standards for well construction and destruction,
- Managing the State's extensive collection of well completion reports, and
- Reviewing proposals and distributing grant funds and low-interest loans for conjunctive use projects, as well as local groundwater management and monitoring programs.

Conjunctive Water Management Program

DWR's Conjunctive Water Management Program consists of a number of integrated efforts to assist local agencies in improving groundwater management and increasing water supply reliability.

One goal of the Integrated Storage Investigations (ISI) Program, an element of the Bay-Delta program, is to increase water supply reliability statewide through the planned, coordinated management and use of groundwater and surface water resources. The effort emphasizes forming working partnerships with local agencies and stakeholders to share technical data and costs for planning and developing locally controlled and managed conjunctive water management projects.

Toward that end, the Conjunctive Water Management Program has:

- Developed a vision in which DWR would assist local agencies throughout the State so that these agencies can effectively manage groundwater resources,
- Adopted a set of working principles to ensure local planning; local control, operation, and management of conjunctive use projects; voluntary implementation of projects; and local benefits from the proposed projects,
- Executed to date memoranda of understanding with 37 local agency partners and provided technical and financial assistance to study groundwater basins and assess opportunities for conjunctive water management,

- Provided technical assistance in the form of groundwater monitoring, groundwater modeling, and local water management planning, as well as a review of numerous regional and statewide planning efforts on a variety of water issues, and
- Provided facilitation assistance to promote broad stakeholder involvement in regional water management planning processes.

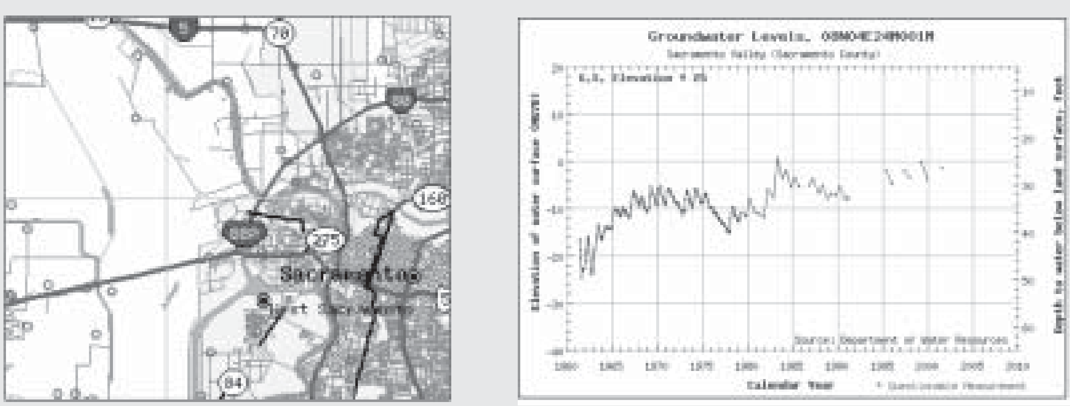
DWR staff review proposals and distribute grants pursuant to the Local Groundwater Management Assistance Act of 2000 (AB 303). To date, DWR has awarded more than $15 million to local agencies to fund 71 projects dealing with groundwater investigation, monitoring, or management.

With funds provided under Proposition 13, DWR has awarded more than $170 million in loans and grants for groundwater recharge and storage studies and projects to local agencies throughout the State. Applicant estimates of the water supply reliability increases that will be realized from these projects exceeds 150 thousand acre-feet annually. Recipients of loans and grants must provide progress reports to allow an evaluation of the successes of the various programs. Figure 10 shows the distribution of loan and grant awardees throughout the State.

Both grant programs have active outreach efforts to inform and to assist agencies in preparation of applications. Selection of projects for funding relies in part on input from advisory committees composed of stakeholders from throughout the State.

Box L Providing Data:
The Internet Makes Groundwater Elevation Data Readily Accessible to the Public

In 1996, the California Department of Water Resources (DWR) began providing Internet access to groundwater level data and hydrographs for wells in groundwater basins throughout California. The website provides historical data for more than 35,000 wells monitored by DWR and its many cooperators and has proven very popular, with more than 60,000 visits to date. Options include a form or map interface to locate wells with water level data and the ability to download long-term water levels for specific wells or seasonal measurements for specific areas to create groundwater contour maps. The accessibility of this data makes it a significant resource for local agencies in making sound groundwater management decisions. The address of the site is http://wdl.water.ca.gov/.



Wells can be located with a map interface. By clicking on a well, a hydrograph with the latest data available is automatically generated.

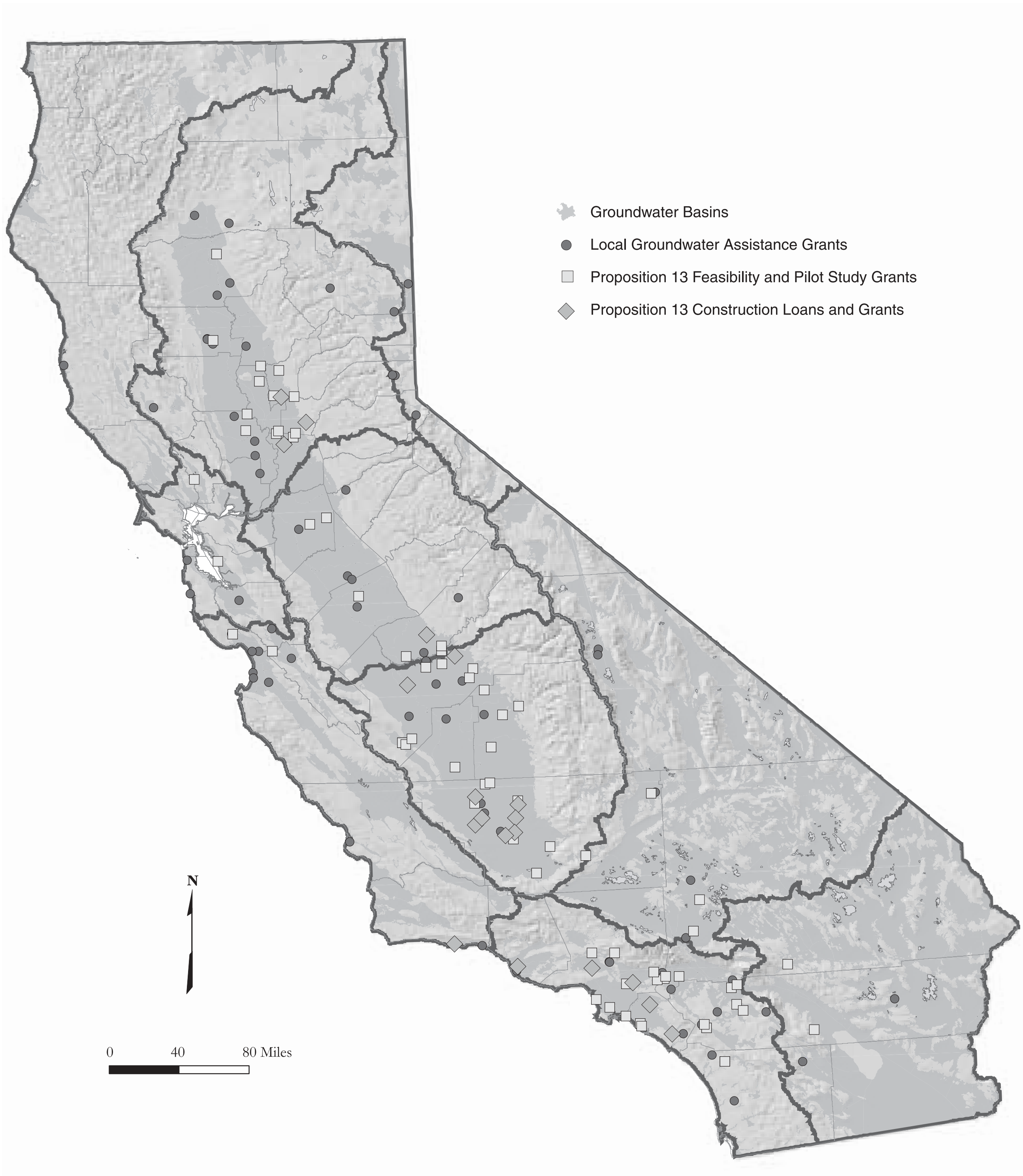


Figure 10 Broad distribution of grant and loan awardees for 2001 through 2003

Assistance from Other State and Federal Agencies

Many other State and federal agencies provide groundwater management assistance to local agencies. Some of those roles are described below. For more information on the roles of various agencies in protecting the groundwater resource, see the California Department of Health Services' Drinking Water Source Assessment and Protection Program Document (DHS 2000), California Groundwater Management (Bachman and others 1997), or the individual agency websites.

State Water Resources Control Board and Regional Water Quality Control Boards

http://www.swrcb.ca.gov The mission of the State Water Resources Control Board (SWRCB) is to ensure the highest reasonable quality of waters of the State, while allocating those waters to achieve the optimum balance of beneficial uses. In turn, the nine Regional Water Quality Control Boards (RWQCB) develop and enforce water quality objectives and implement plans to protect the beneficial uses of the State's waters, recognizing differences in climate, topography, geology, and hydrology.

SWRCB has many responsibilities regarding the protection of the groundwater resource. One of the more notable is the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA is a recently enacted program that will provide a comprehensive assessment of water quality in water wells throughout the state. GAMA has two main components: the California Aquifer Susceptibility (CAS) Assessment and the Voluntary Domestic Well Assessment Project.

The CAS combines age dating of water and sampling for low-level volatile organic compounds (VOCs), such as methyl tertiary-butyl ether (MTBE), to assess the relative susceptibility of all of approximately 16,000 public supply wells throughout the State. Age dating provides a general assessment of how quickly groundwater is moving through the system, while the sampling of low-level VOCs allows greater reaction time for potential remediation strategies before contaminants reach action levels. Sampling is being conducted by staff from the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The CAS Assessment was developed cooperatively with DHS and DWR.

The Voluntary Domestic Well Assessment Project will provide a previously unavailable sampling of water quality in domestic wells, which will assist in assessing the relative susceptibility of California's groundwater. Because water quality in individual domestic wells is unregulated, the program is voluntary and will focus, as resources permit, on specific areas of the state. Constituents to be analyzed include nitrate, total and fecal coliform bacteria, MTBE, and minerals. Additional constituents will be added in areas with known water quality problems.

Other SWRCB/RWQCB activities related to groundwater protection include developing basin plans that identify existing and potential beneficial uses of marine water, groundwater, and surface waters; regulating the discharge of waste that may affect water quality in California; monitoring of landfills and hazardous waste facilities; establishing standards for the construction and monitoring of underground storage tanks; establishing management plans for control of nonpoint source pollutants; and issuing cleanup and abatement orders that require corrective actions by the responsible party for a surface water or groundwater pollution problem or nuisance.

The Groundwater Quality Monitoring Act of 2001 (AB599, Water Code, § 10780 et seq.) required the SWRCB to develop a comprehensive monitoring program in a report to the Legislature. See Chapter 4 for details.

California Department of Health Services

http://www.dhs.ca.gov/ps/ddwem The DHS Drinking Water Program, part of the Division of Drinking Water and Environmental Management, is responsible for DHS implementation of the federal Safe Drinking Water Act, as well as California statutes and regulations related to drinking water. As part of this responsibility, DHS inspects and provides regulatory oversight of approximately 8,500 public water systems (and approximately 16,000 drinking water wells) to assure delivery of safe drinking water to all California consumers.

Public water system operators are required to regularly monitor their drinking water sources for microbiological, chemical and radiological contaminants to show that drinking water supplies meet regulatory requirements (called primary maximum contaminant levels–MCLs). Among these contaminants are approximately 80 specific inorganic and organic chemical contaminants and six radiological contaminants that reflect the natural environment as well as human activities.

Public water system operators also monitor their water for a number of other contaminants and characteristics that deal with the aesthetic properties of drinking water (known as secondary MCLs). They are also required by regulation to analyze for certain unregulated contaminants (to allow DHS to collect information on emerging contaminants, for example), and to report findings of other contaminants that may be detected during routine monitoring. The DHS water quality monitoring database contains the results of analyses since 1984. These data, collected for purposes of regulatory compliance with drinking water laws, also provide an extensive body of information on the quality of groundwater throughout the State.

California Department of Pesticide Regulation

http://www.cdpr.ca.gov/dprprograms.htm The California Department of Pesticide Regulation (DPR) protects human health and the environment by regulating pesticide sales and use and by promoting reduced-risk pest management. DPR plays a significant role in monitoring for the presence of pesticides and in preventing further contamination of the groundwater resource.

DPR conducts six types of groundwater monitoring:

1) Monitoring for pesticides on a DPR-determined Ground Water Protection List, which lists pesticides with the potential to pollute groundwater;
2) Four-section survey monitoring to verify a reported detection and to help determine if a detected pesticide resulted from legal agricultural use;
3) Areal extent monitoring to identify the extent of contaminated wells;
4) Adjacent section monitoring to identify additional areas sensitive to pesticide movement to groundwater;
5) Monitoring to repeatedly sample a network of wells to determine whether pesticide residues are declining; and
6) Special project monitoring.

When pesticides are found in groundwater, they are normally regulated in one-square mile areas identified in regulation as sensitive to groundwater pollution. These pesticides are subject to permitting by the county agricultural commissioner and to use restrictions specified in regulation. DPR maintains an extensive database of pesticide sampling in groundwater and reports a summary of annual sampling and detections to the State Legislature.

California Department of Toxic Substances Control

http://www.dtsc.ca.gov The California Department of Toxic Substances Control (DTSC) has two programs related to groundwater resources protection: the Hazardous Waste Management Program and the Site Mitigation Program. These programs are authorized under Division 20 of the California Health and Safety Code, and implementing regulations are codified in Title 22 of the California Code of Regulations.

A critical element of both programs is maintaining environmental quality and economic vitality through the protection of groundwater resources. This is accomplished through hazardous waste facility permitting and design; oversight of hazardous waste handling, removal, and disposal; oversight of remediation of hazardous substances releases; funding of emergency removal actions involving hazardous substances, including the cleanup of illegal drug labs; cleanup of abandoned hazardous waste sites; oversight of the closure of military bases; and pollution prevention.

If groundwater is threatened or impacted by a hazardous substance release, DTSC provides technical oversight for the characterization and remediation of soil and groundwater contamination. DTSC and the nine RWQCBs coordinate regulatory oversight of groundwater remediation. To ensure site-specific groundwater quality objectives are met, DTSC consults with RWQCB staff and appropriate groundwater basin plans.

Box M Improving Coordination of Groundwater Information

California's groundwater resources are addressed by an array of different State and federal agencies. Each agency approaches groundwater from a unique perspective, based on its individual statutory mandate. As a result, each agency collects different types of groundwater data and information. To facilitate the effective and efficient exchange of groundwater resource information, the State Water Resources Control Board (SWRCB) is coordinating the Groundwater Resources Information Sharing Team (GRIST), which is composed of representatives from various groundwater agencies. Agencies currently participating in GRIST are:

- State Water Resources Control Board
- Department of Health Services
- Department of Water Resources
- Department of Pesticide Regulation
- Lawrence Livermore National Laboratory
- U.S. Geological Survey

One of the tasks of the GRIST is to identify data relevant to California groundwater resources. A listing of the data, along with the appropriate agency contacts and Internet links, will be maintained by SWRCB on the Groundwater Resources Information Database. In addition, to facilitate effective information sharing and communication among stakeholders, groundwater data will be made available on the SWRCB GeoTracker system. GeoTracker is a geographic information system that provides Internet access to environmental data. The centralization of environmental data through GeoTracker will enable more in-depth geospatial and statistical analyses of groundwater data in the future. For more information about GeoTracker, visit the GeoTracker Internet site at http://geotracker.arsenautlegg.com.

California Bay-Delta Authority

http://calwater.ca.gov The California Bay-Delta program was initiated in 1994 to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Sacramento-San Joaquin Bay-Delta System. The partnership currently consists of more than 20 State and federal agencies. An important element of the program is to increase storage by developing an additional 500,000 acre-feet to 1.0 million acre-feet of groundwater storage capacity by the year 2007 (CALFED 2000).

Effective January 1, 2003, a newly formed State agency assumed responsibility for overseeing implementation of the Bay-Delta program. The California Bay-Delta Authority provides a permanent governance structure for the collaborative state-federal effort. The authority was established by enactment of Senate Bill 1653 in 2002. The legislation calls for the authority to sunset on January 1, 2006, unless federal legislation has been enacted authorizing the participation of appropriate federal agencies in the authority.

U.S. Environmental Protection Agency

http://www.epa.gov/safewater The U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water, together with states, tribes, and many partners, protects public health by ensuring safe drinking water and protecting groundwater. The EPA's role in California groundwater is primarily related to protection of the resource and comes in the form of administering several federal programs in close coordination with State agencies such as SWRCB, DHS, and DTSC.

U.S. Geological Survey

http://ca.water.usgs.gov USGS has published results of many studies of California groundwater basins. USGS maintains an extensive groundwater level and groundwater quality monitoring network and has compiled this data in a database. The California District is working on cooperative programs with local, State, and other federal agencies. The most notable programs include three regional studies of the San Joaquin-Tulare Basin, the Sacramento River Basin, and the Santa Ana River basin under the National Water Quality Assessment Program. Results were published for the San Joaquin-Tulare Basin in 1995 and the Sacramento River Basin in 2000. The Santa Ana River basin study is in progress.

U.S. Bureau of Reclamation

http://www.usbr.gov The U.S. Bureau of Reclamation (USBR) operates the Central Valley Project (CVP), an extensive network of dams, canals, and related facilities that delivers about 7 maf during normal years for agricultural, urban, and wildlife use. USBR's role with respect to groundwater is generally limited to monitoring for impacts to the groundwater systems adjacent to its CVP facilities. Through the cooperative efforts of USBR, DWR, irrigation districts, farmers, and other local entities, groundwater level data have been collected continuously since project conception in the 1930s and 1940s.

In addition to CVP monitoring, USBR monitors groundwater levels to identify potential impacts as a result of two other projects in California. That monitoring includes the Santa Ynez basin as part of the Cachuma Project on the central coast, and the Putah Creek Cone as part of the Solano Project in the southwest Sacramento Valley. Both monitoring efforts are required as part of permitting for the projects.

USBR is planning to implement a groundwater information system to collect and distribute to the public the large volume of historical groundwater level data associated with its projects.

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Chapter 6

Basic Groundwater Concepts

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Chapter 6
Basic Groundwater Concepts

This chapter presents general concepts relating to the origin, occurrence, movement, quantity, and quality of groundwater. The concepts will be useful in providing the nontechnical reader with a basic understanding of groundwater. For more experienced readers, many topics are discussed specifically as they apply to California or as the terms are used in this report. A glossary of terms is included at the end of this report. For additional reading on basic groundwater concepts see *Basic Ground-Water Hydrology* (Heath 1983).

Origin of Groundwater

Groundwater is a component of the hydrologic cycle (Figure 11), which describes locations where water may occur and the processes by which it moves or is transformed to a different phase. In simple terms, water or one of its forms—water vapor and ice—can be found at the earth's surface, in the atmosphere, or beneath the earth's surface. The hydrologic cycle is a continuum, with no beginning or end; however, it is often thought of as beginning in the oceans. Water evaporates from a surface water source such as an ocean, lake, or through transpiration from plants. The water vapor may move over the land and condense to form clouds, allowing the water to return to the earth's surface as precipitation (rain or snow). Some of the snow will end up in polar ice caps or in glaciers. Most of the rain and snowmelt will either become overland flow in channels or will infiltrate into the subsurface. Some of the infiltrated water will be transpired by plants and returned to the atmosphere, while some will cling to particles surrounding the pore spaces in the subsurface, remaining in the vadose (unsaturated) zone. The rest of the infiltrated water will move gradually under the influence of gravity into the saturated zone of the subsurface, becoming groundwater. From here, groundwater will flow toward points of discharge such as rivers, lakes, or the ocean to begin the cycle anew. This flow from recharge areas to discharge areas describes the groundwater portion of the hydrologic cycle.

The importance of groundwater in the hydrologic cycle is illustrated by considering the distribution of the world's water supply. More than 97 percent of all earth's water occurs as saline water in the oceans (Fetter 1988). Of the world's fresh water, almost 75 percent is in polar ice caps and glaciers, which leaves a very small amount of fresh water readily available for use. Groundwater accounts for nearly all of the remaining fresh water (Alley and others 1999). All of the fresh water stored in the world's rivers and lakes accounts for less than 1 percent of the world's fresh water.

Occurrence of Groundwater

Groundwater is the water occurring beneath the earth's surface that completely fills (saturates) the void space of rocks or sediment. Given that all rock has some open space (voids), groundwater can be found underlying nearly any location in the State. Several key properties help determine whether the subsurface environment will provide a significant, usable groundwater resource. Most of California's groundwater occurs in material deposited by streams, called alluvium. Alluvium consists of coarse deposits, such as sand and gravel, and finer-grained deposits such as clay and silt. The coarse and fine materials are usually coalesced in thin lenses and beds in an alluvial environment. In this environment, coarse materials such as sand and gravel deposits usually provide the best source of water and are termed aquifers; whereas, the finer-grained clay and silt deposits are relatively poor sources of water and are referred to as aquitards. California's groundwater basins usually include one or a series of alluvial aquifers with intermingled aquitards. Less frequently, groundwater basins include aquifers composed of unconsolidated marine sediments that have been flushed by fresh water. The marine-deposited aquifers are included in the discussion of alluvial aquifers in this bulletin.

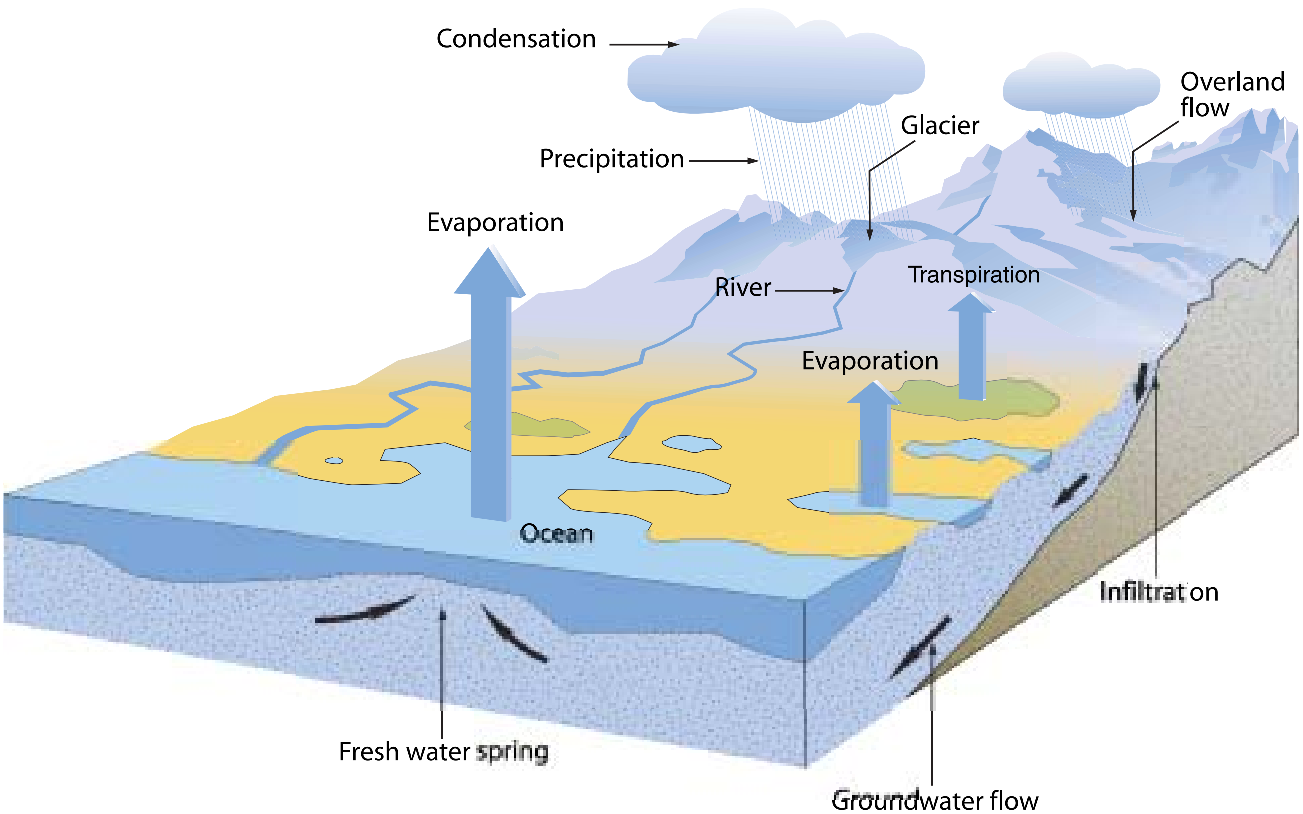

Figure 11 The Hydrologic Cycle

Although alluvial aquifers are most common in California, other groundwater development occurs in fractured crystalline rocks, fractured volcanics, and limestones. For this report, these nonalluvial areas that provide groundwater are referred to as "groundwater source areas," while the alluvial aquifers are called groundwater basins. Each of these concepts is discussed more fully below.

Groundwater and Surface Water Interconnection

Groundwater and surface water bodies are connected physically in the hydrologic cycle. For example, at some locations or at certain times of the year, water will infiltrate the bed of a stream to recharge groundwater. At other times or places, groundwater may discharge, contributing to the base flow of a stream. Changes in either the surface water or groundwater system will affect the other, so effective management requires consideration of both resources. Although this physical interconnection is well understood in general terms, details of the physical and chemical relationships are the topic of considerable research.

These details are the subject of significant recent investigations into the hyporheic zone, the zone of sand and gravel that forms the channel of a stream. As surface water flows downstream it may enter the gravels in the

Box N One Resource, Two Systems of Law

In California, two distinct legal regimes govern the appropriation of surface water and subterranean streams, and percolating groundwater. The California Water Code requires that water users taking water for beneficial use from surface watercourses and "subterranean streams flowing through known and definite channels" obtain water right permits or licenses from the State Water Resources Control Board (SWRCB) (Water Code § 1200 et seq.). Groundwater classified as percolating groundwater is not subject to the Water Code provisions concerning the appropriation of water, and a water user can take percolating groundwater without having a State-issued water right permit or license. Current Water Code section 1200 is derived from a provision in the Water Commission Act of 1913, which became effective on December 19, 1914.

The SWRCB developed a test to identify groundwater that is in a subterranean stream flowing through a known and definite channel and is therefore subject to the SWRCB's permitting authority. The physical conditions that must be present in a subterranean stream flowing in a known and definite channel are: (1) a subsurface channel must be present; (2) the channel must have relatively impermeable bed and banks; (3) the course of the channel must be known or capable of being determined by reasonable inference; and (4) groundwater must be flowing in the channel. Whether groundwater is subject to the SWRCB's permitting authority under this test is a factual determination. Water that does not fit this test is "percolating groundwater" and is not subject to the SWRCB's permitting authority.

The SWRCB has issued decisions that find that groundwater under the following streams constitutes a "subterranean stream flowing through known and definite channels" and is therefore subject to the SWRCB's permitting authority (Murphey 2003 pers com):

Los Angeles River in Los Angeles County
Sheep Creek in San Bernardino County
Mission Basin of the San Luis Rey River in San Diego County
Bonsall Basin of the San Luis Rey River in San Diego County
Pala Basin of the San Luis Rey River in San Diego County
Carmel River in Monterey County
Garrapata Creek in Monterey County
Big Sur River in Monterey County
Russian River
Chorro Creek in San Luis Obispo County
Morro Creek in San Luis Obispo County
North Fork Gualala River in Mendocino County

Contact the SWRCB, Division of Water Rights for specific stream reaches and other details of these decisions.

hyporheic zone, mix with groundwater, and re-enter the surface water in the stream channel. The effects of this interchange between surface water and groundwater can change the dissolved oxygen content, temperature, and mineral concentrations of the water. These changes may have a significant effect on aquatic and riparian biota.

Significantly, the physical and chemical interconnection of groundwater and surface water is not well represented in California's water rights system (see Box N "One Resource, Two Systems of Law").

Physical Properties That Affect Groundwater

The degree to which a body of rock or sediments will function as a groundwater resource depends on many properties, some of which are discussed here. Two of the more important physical properties to consider are porosity and hydraulic conductivity. Transmissivity is another important concept to understand when considering an aquifer's overall ability to yield significant groundwater. Throughout the discussion of these properties, keep in mind that sediment size in alluvial environments can change significantly over short distances, with a corresponding change in physical properties. Thus, while these properties are often presented as average values for a large area, one might encounter different conditions on a more localized level. Determination of these properties for a given aquifer may be based on lithologic or geophysical observations, laboratory testing, or aquifer tests with varying degrees of accuracy.

Porosity

The ratio of voids in a rock or sediment to the total volume of material is referred to as porosity and is a measure of the amount of groundwater that may be stored in the material. Figure 12 gives several examples of the types of porosity encountered in sediments and rocks. Porosity is usually expressed as a percentage and can be classified as either primary or secondary. Primary porosity refers to the voids present when the sediment or rock was initially formed. Secondary porosity refers to voids formed through fracturing or weathering of a rock or sediment after it was formed. In sediments, porosity is a function of the uniformity of grain size (sorting) and shape. Finer-grained sediments tend to have a higher porosity than coarser sediments because the finer-grained sediments generally have greater uniformity of size and because of the tabular shape and surface chemistry properties of clay particles. In crystalline rocks, porosity becomes greater with a higher degree of fracturing or weathering. As alluvial sediments become consolidated, primary porosity generally decreases due to compaction and cementation, and secondary porosity may increase as the consolidated rock is subjected to stresses that cause fracturing.

Porosity does not tell the entire story about the availability of groundwater in the subsurface. The pore spaces must also interconnect and be large enough so that water can move through the ground to be extracted from a well or discharged to a water body. The term "effective porosity" refers to the degree of interconnectedness of pore spaces. For coarse sediments, such as the sand and gravel encountered in California's alluvial groundwater basins, the effective porosity is often nearly equal to the overall porosity. In finer sediments, effective porosity may be low due to water that is tightly held in small pores. Effective porosity is generally very low in crystalline rocks that are not highly fractured or weathered.

While porosity measures the total amount of water that may be contained in void spaces, there are two related properties that are important to consider: specific yield and specific retention. Specific yield is the fractional amount of water that would drain freely from rocks or sediments due to gravity and describes the portion of the groundwater that could actually be available for extraction. The portion of groundwater that is retained either as a film on grains or in small pore spaces is called specific retention. Specific yield and specific retention of the aquifer material together equal porosity. Specific retention increases with decreasing grain size. Table 7 shows that clays, while having among the highest porosities, make poor sources of groundwater because they yield very little water. Sand and gravel, having much lower porosity than clay, make excellent sources of groundwater because of the high specific yield, which allows the groundwater to flow to wells. Rocks such as limestone and basalt yield significant quantities of groundwater if they are well-weathered and highly fractured.

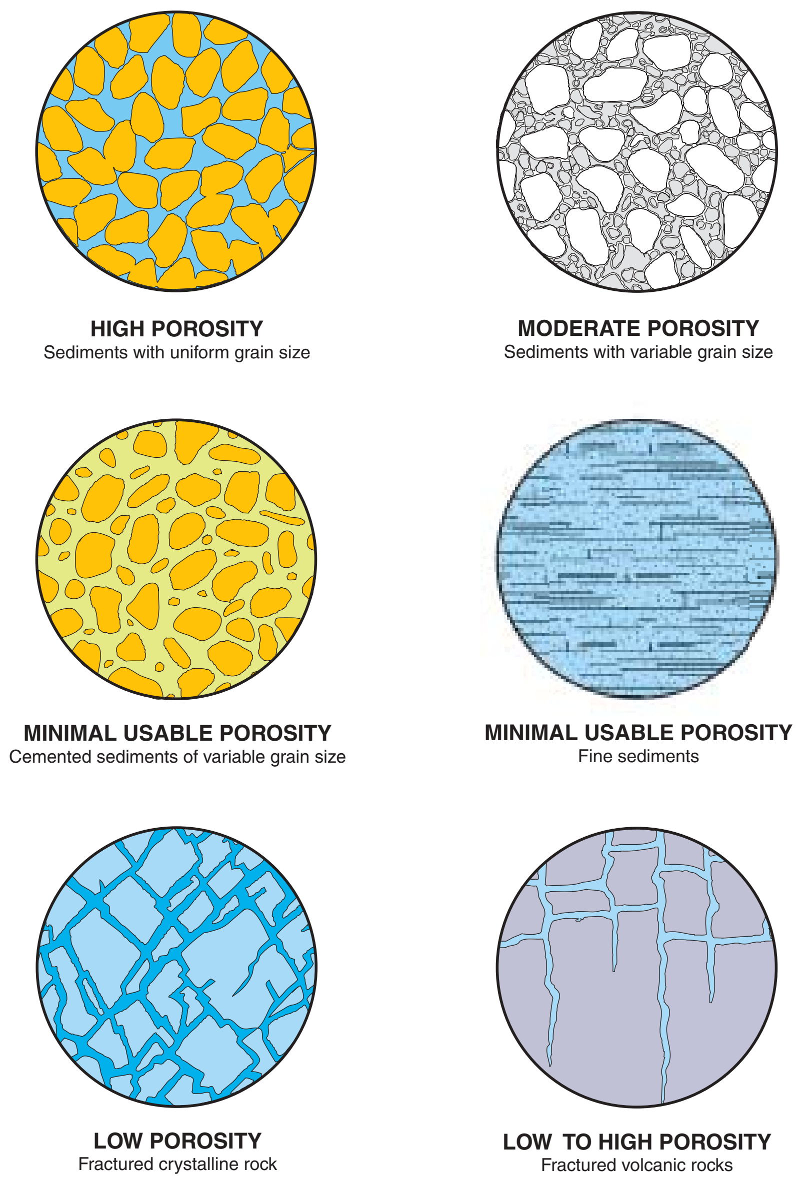

Figure 12 Examples of porosity in sediments and rocks

Table 7 Porosity (in percent) of soil and rock types

Material	Porosity	Specific yield	Specific retention
Clay	50	2	48
Sand	25	22	2
Gravel	20	19	1
Limestone	20	18	2
Sandstone (semiconsolidated)	11	6	5
Granite	0.1	0.09	0.01
Basalt (young)	11	8	3

Modified from Heath (1983)

Hydraulic Conductivity

Another major property related to understanding water movement in the subsurface is hydraulic conductivity. Hydraulic conductivity is a measure of a rock or sediment's ability to transmit water and is often used interchangeably with the term permeability. The size, shape, and interconnectedness of pore spaces affect hydraulic conductivity (Driscoll 1986).

Hydraulic conductivity is usually expressed in units of length/time: feet/day, meters/day, or gallons/day/square-foot. Hydraulic conductivity values in rocks range over many orders of magnitude from a low permeability unfractured crystalline rock at about 10^{-8} feet/day to a highly permeable well-sorted gravel at greater than 10^{4} feet/day (Heath 1983). Clays have low permeability, ranging from about 10^{-3} to 10^{-7} feet/day (Heath 1983). Figure 13 shows hydraulic conductivity ranges of selected rocks and sediments.

Transmissivity

Transmissivity is a measure of the aquifer's ability to transmit groundwater through its entire saturated thickness and relates closely to the potential yield of wells. Transmissivity is defined as the product of the hydraulic conductivity and the saturated thickness of the aquifer. It is an important property to understand because a given area could have a high value of hydraulic conductivity but a small saturated thickness, resulting in limited overall yield of groundwater.

Aquifer

An aquifer is a body of rock or sediment that yields significant amounts of groundwater to wells or springs. In many definitions, the word "significant" is replaced by "economic." Of course, either term is a matter of perspective, which has led to disagreement about what constitutes an aquifer. As discussed previously, coarse-grained sediments such as sands and gravels deposited in alluvial or marine environments tend to function as the primary aquifers in California. These alluvial aquifers are the focus of this report. Other aquifers, such as those found in volcanics, igneous intrusive rocks, and carbonate rocks are described briefly in the section Groundwater Source Areas.

Aquitard

An aquitard is a body of rock or sediment that is typically capable of storing groundwater but does not yield it in significant or economic quantities. Fine-grained sediments with low hydraulic conductivity, such as clays and silts, often function as aquitards. Aquitards are often referred to as confining layers because they retard the vertical movement of groundwater and under the right hydrogeologic conditions confine groundwater that is under pressure. Aquitards are capable of transmitting enough water to allow some flow between adjacent aquifers, and depending on the magnitude of this transfer of water, may be referred to as leaky aquitards.

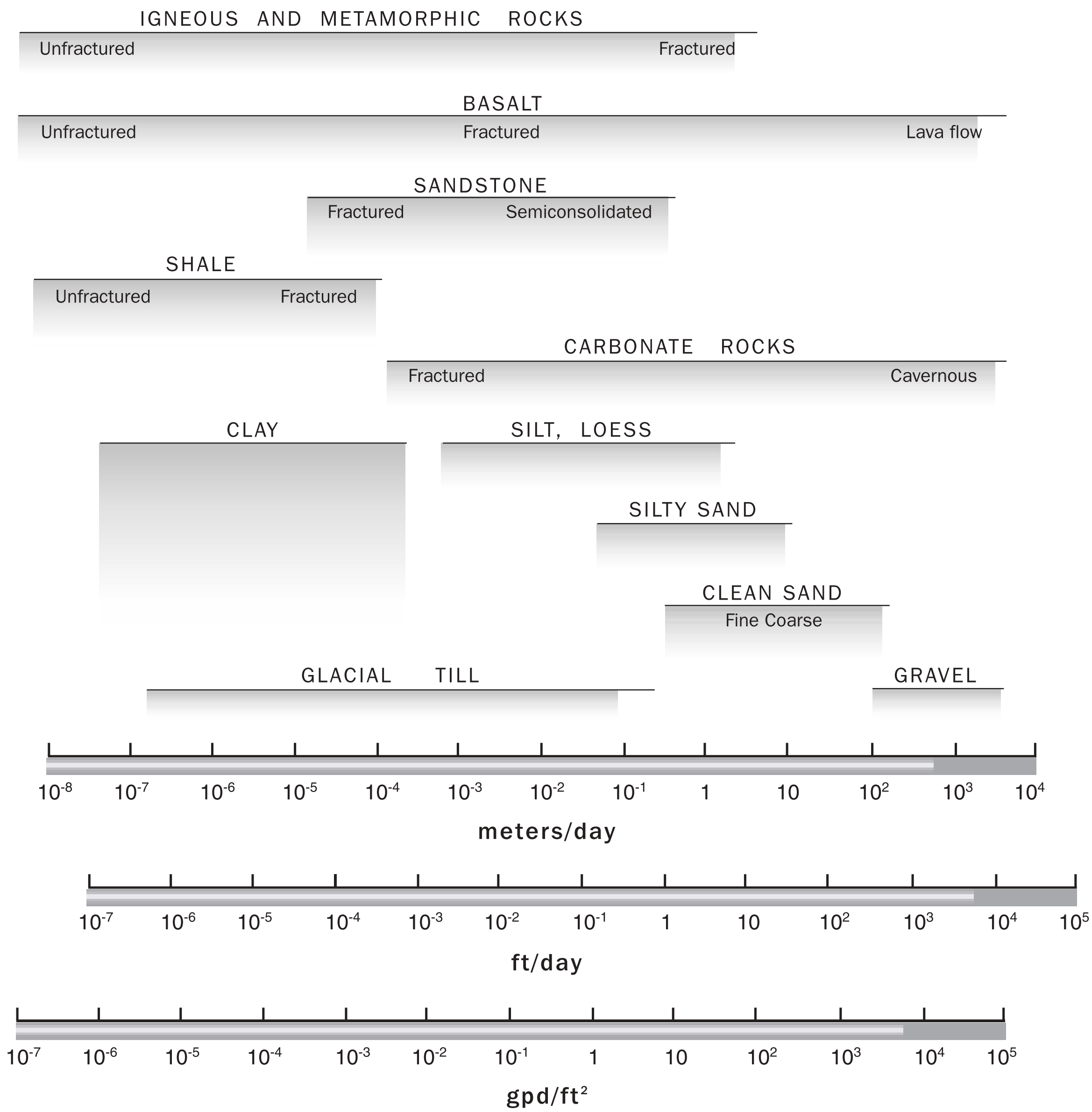

Figure 13 Hydraulic conductivity ranges of selected rocks and sediments

Unconfined and Confined Aquifers

In most depositional environments, coarser-grained deposits are interbedded with finer-grained deposits creating a series of aquifers and aquitards. When a saturated aquifer is bounded on top by an aquitard (also known as a confining layer), the aquifer is called a confined aquifer (Figure 14). Under these conditions, the water is under pressure so that it will rise above the top of the aquifer if the aquitard is penetrated by a well. The elevation to which the water rises is known as the potentiometric surface. Where an aquifer is not bounded on top by an aquitard, the aquifer is said to be unconfined. In an unconfined aquifer, the pressure on the top surface of the groundwater is equal to that of the atmosphere. This surface is known as the water table, so unconfined aquifers are often referred to as water table aquifers. The arrangement of aquifers and aquitards in the subsurface is referred to as hydrostratigraphy.

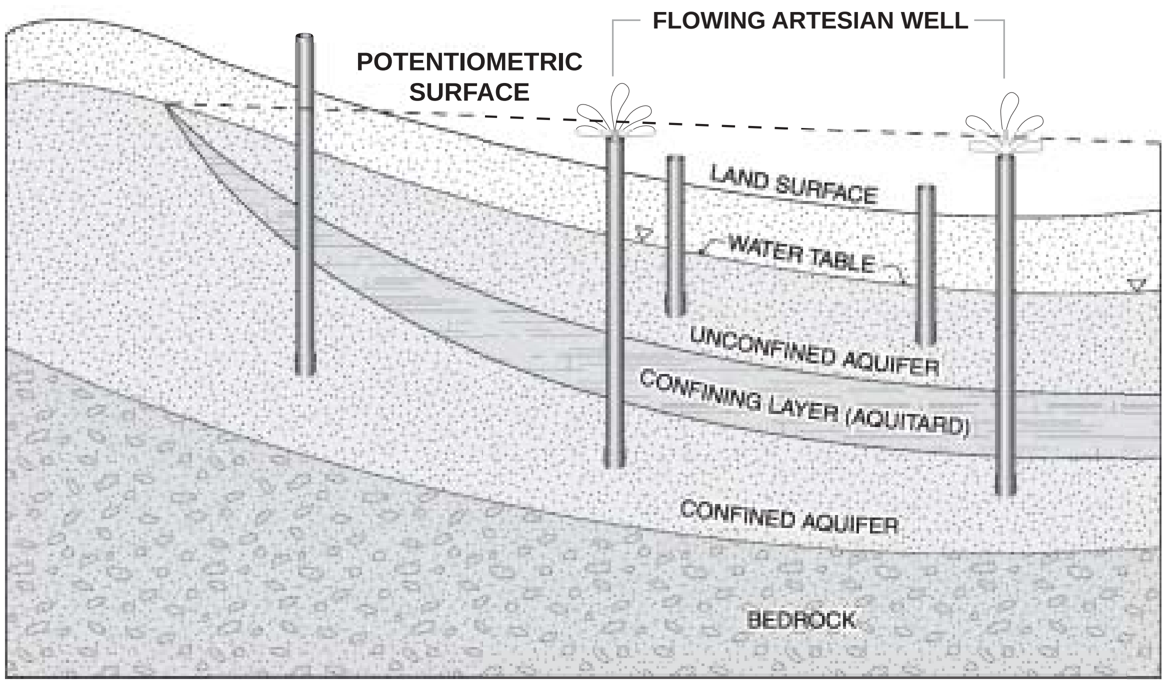

Figure 14 Interbedded aquifers with confined and unconfined conditions

With the notable exception of the Corcoran Clay of the Tulare Formation in the San Joaquin Valley and the aquitard in West Coast Basin in Los Angeles County, there are no clearly recognizable regional aquitards in California alluvial basins. Instead, due to the complexity of alluvial environments, it is the cumulative effect of multiple thin lenses of fine-grained sediments that causes increasing confinement of groundwater with increasing depth, creating what is often referred to as a semiconfined aquifer.

In some confined aquifers groundwater appears to defy gravity, but that is not the case. When a well penetrates a confined aquifer with a potentiometric surface that is higher than land surface, water will flow naturally to the surface. This is known as artesian flow, and results from pressure within the aquifer. The pressure results when the recharge area for the aquifer is at a higher elevation than the point at which discharge is occurring (Figure 14). The confining layer prevents the groundwater from returning to the surface until the confining layer is penetrated by a well. Artesian flow will discontinue as pressure in the aquifer is reduced and the potentiometric surface drops below the land surface elevation.

Groundwater Basin

A groundwater basin is defined as an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Lateral boundaries are features that significantly impede groundwater flow, such as rock or sediments with very low permeability or a geologic structure such as a fault. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin. In some cases, such as in the San Joaquin and Sacramento Valleys, the base of fresh water is considered the bottom of the groundwater basin. Table 8 is a generalized list of basin types and the features that define the basin boundaries.

Table 8 Types and boundary characteristics of groundwater basins

Characteristics of groundwater basins	
Groundwater basin	An aquifer or an aquifer system that is bounded laterally and at depth by one or more of the following features that affect groundwater flow: • Rocks or sediments of lower permeability • A geologic structure, such as a fault • Hydrologic features, such as a stream, lake, ocean, or groundwater divide
Types of basins and their boundaries	
Single simple basin	Basin surrounded on all sides by less permeable rock. Higher permeability near the periphery. Clays near the center. Unconfined around the periphery. Confined near the center. May have artesian flow near the center.
Basin open at one or more places to other basins	Many desert basins. Merged alluvial fans. Topographic ridges on fans. Includes some fault-bounded basins.
Basin open to Pacific Ocean	260 basins along the coast. Water-bearing materials extend offshore. May be in contact with sea water. Vulnerable to seawater intrusion.
Single complex basin	Basin underlain or surrounded by older water-bearing materials and water-bearing volcanics. Quantification is difficult because of unknown contacts between different rock types within the basin.
Groundwater in areas of volcanic rocks	Basin concept is less applicable in volcanic rocks. Volcanic rocks are highly variable in permeability.
Groundwater in weathered crystalline rocks (fractured hard rock)—not considered a basin	Small quantities of groundwater. Low yielding wells. Most wells are completed in the crystalline rock and rely on fractures to obtain groundwater.
Political boundaries or management area boundaries	Usually not related to hydrogeologic boundaries. Formed for convenience, usually to manage surface water storage and delivery.

Although only the upper surface of a groundwater basin can be shown on a map, the basin is three-dimensional and includes all subsurface fresh water-bearing material. These boundaries often do not extend straight down, but are dependent on the spatial distribution of geologic materials in the subsurface. In fact, in a few cases near California's coastal areas, aquifers in the subsurface are known to extend beyond the mapped surface of the basin and may actually be exposed under the ocean. Under natural conditions, fresh water flows from these aquifers into the ocean. If groundwater levels are lowered, sea water may flow into the aquifer. This has occurred in Los Angeles, Orange, Ventura, Santa Cruz and Monterey Counties, and some areas around San Francisco Bay. Depiction of a groundwater basin in three dimensions requires extensive subsurface investigation and data evaluation to delineate the basin geometry. Figure 15 is a cross-section showing how a coastal basin might appear in the subsurface.

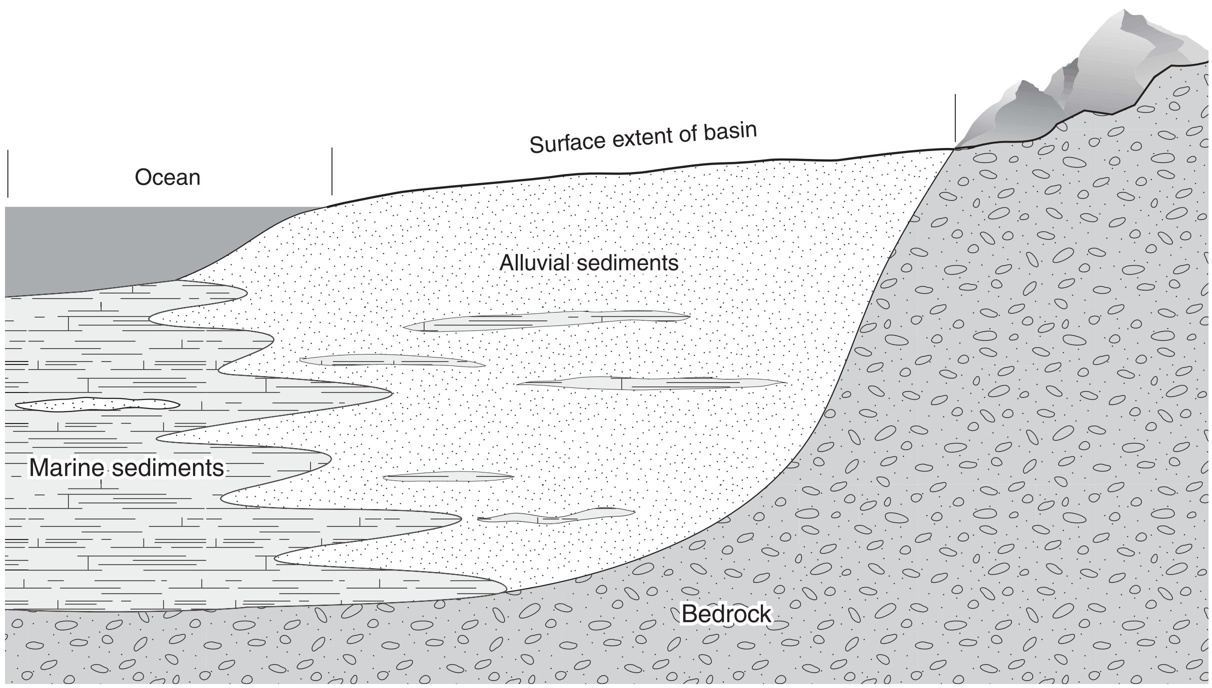

Figure 15 Groundwater basin near the coast with the aquifer extending beyond the surface basin boundary

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated. In many other basins where much less is known and understood about the basin, boundaries will probably change as a better understanding of the basin is developed. A procedure for collecting information from all the stakeholders should be developed for use statewide so that agreement on basin boundaries can be achieved.

Groundwater Subbasin

A subbasin is created by dividing a groundwater basin into smaller units using geologic and hydrologic barriers or, more commonly, institutional boundaries (see Table 8). These subbasins are created for the purpose of collecting and analyzing data, managing water resources, and managing adjudicated basins. As the definition implies, the designation of a subbasin boundary is flexible and could change in the future. The limiting rule for a subbasin is that it should not cross over a groundwater basin boundary.

An example of a hydrologic subbasin boundary would be a river or stream that creates a groundwater divide. While hydrologic boundaries may limit groundwater flow in the shallow subsurface, data indicate significant groundwater flow may occur across the boundary at greater depths. In addition, the location of the boundary may change over time if pumping or recharge patterns change. Institutional subbasin boundaries could be based on a political boundary, such as a county line or a water agency service area, or a legally mandated boundary, such as a court adjudicated basin.

Groundwater Source Areas

Groundwater in California is also found outside of alluvial groundwater basins. Igneous extrusive (volcanic), igneous intrusive, metamorphic, and sedimentary rocks are all potential sources of groundwater. These rocks often supply enough water for domestic use, but in some cases can also yield substantial quantities. In this report, the term groundwater source area is used for rocks that are significant in terms of being a local groundwater source, but do not fit the category of basin or subbasin. The term is not intended to imply that groundwater actually originates in these rocks, but that it is withdrawn from rocks underlying a generally definable area. Because of the increased difficulty in defining and understanding the hydrogeologic properties of these rocks, the limited data available for the areas in which these rocks occur, and the relatively small, though rapidly growing, segment of the population served by these water supplies, they are discussed separately from groundwater basins.

Volcanics

Groundwater in volcanics can occur in fractures that result from cooling or changes in stress in the crust of the Earth, lava tubes, tree molds, weathering surfaces, and porous tuff beds. Additionally, the volcanics could overlie other deposits from an alluvial environment. Flow in the fractures may approach the same velocities as that of surface water, but there is often very limited storage potential for groundwater. The tuff beds can act similarly to alluvial aquifers.

Some of the most productive volcanic rocks in the State include the Modoc Plateau volcanics in the northeast and the Napa-Sonoma volcanics northeast of San Francisco Bay (Figure 16). Wells in Modoc Plateau volcanics are commonly reported to yield between 100 and 1,000 gallons per minute, with some yields of 4,000 gpm (Planert and Williams 1995). Bulletin 118-75 assigned identification numbers to these volcanic rocks throughout the State (for example, Modoc Plateau Recent Volcanic Areas, 1-23). The numbers led some to interpret them as being groundwater basins. In this update, the numbers corresponding to the volcanics are retired to eliminate this confusion.

Figure 16 Significant volcanic groundwater source areas

Igneous Intrusive, Metamorphic, and Sedimentary Rocks

Groundwater in igneous intrusive, metamorphic, and consolidated sedimentary rocks occurs in fractures resulting from tectonism and expansion of the rock as overburden pressures are relieved. Groundwater is extracted from fractured rock in many of the mountainous areas of the State, such as the Sierra Nevada, the Peninsular Range, and the Coast Ranges. Rocks in these areas often yield only enough supply for individual domestic wells, stock water wells, or small community water systems. Availability of groundwater in such formations can vary widely, even over a distance of a few yards. Areas of groundwater production from consolidated rocks were not defined in previous versions of Bulletin 118 and are not included in this update.

As population grows in areas underlain by these rocks, such as the foothills of the Sierra Nevada and southern California mountains, many new wells are being built in fractured rock. However, groundwater data are often insufficient to accurately estimate the long term reliability of groundwater supplies in these areas. Additional investigation, data evaluation, and management will be needed to ensure future sustainable supplies. The Legislature recognized both the complexity of these areas and the need for management in SB 1938 (2002), which amended the Water Code to require groundwater management plans with specific components be adopted for agencies to be eligible for certain funding administered by DWR for construction of groundwater projects. Water Code section 10753.7(a)(5) states:

> Local agencies that are located in areas outside the groundwater basins delineated on the latest edition of the department's groundwater basin and subbasin map shall prepare groundwater management plans incorporating the components in this subdivision, and shall use geologic and hydrologic principles appropriate to those areas.

In carbonate sedimentary rocks such as limestone, groundwater occurs in fractures and cavities formed as a result of dissolution of the rock. Flow in the largest fractures may approach the velocities of surface water, but where these rocks occur in California there is limited storage potential for groundwater. Carbonate rocks occur mostly in Inyo County near the Nevada border (USGS 1995), in the Sierra Nevada foothills, and in some parts of the Sacramento River drainage north of Redding. The carbonates near the Nevada state border in Inyo County are part of a regional aquifer that extends northeastward into Nevada. Springs in Nevada and in the Death Valley region in California are dependent on groundwater flow in this regional aquifer. In other parts of the country, such as Florida, carbonate rocks constitute significant sources of groundwater.

Movement of Groundwater

The movement of groundwater in the subsurface is quite complex, but in simple terms it can be described as being driven by potential energy. At any point in the saturated subsurface, groundwater has a hydraulic head value that describes its potential energy, which is the combination of its elevation and pressure. In an unconfined aquifer, the water table elevation represents the hydraulic head, while in a confined aquifer the potentiometric surface represents the hydraulic head (Figure 14). Water moves in response to the difference in hydraulic head from the point of highest energy toward the lowest. On a regional scale, this results in flow of groundwater from recharge areas to discharge areas. In California, pumping depressions around extraction wells often create the discharge points to which groundwater flows. Groundwater may naturally exit the subsurface by flowing into a stream, lake, or ocean, by flowing to the surface as a spring or seep, or by being transpired by plants.

The rate at which groundwater flows is dependent on the hydraulic conductivity and the rate of change of hydraulic head over some distance. In the mid-19th century, Henry Darcy found through his experiments on sand filters that the amount of flow through a porous medium is directly proportional to the difference between hydraulic head values and inversely proportional to the horizontal distance between them (Fetter 1988). His conclusions extend to flow through aquifer materials. The difference between hydraulic heads divided by the distance between them is referred to as the hydraulic gradient. When combined with the hydraulic conductivity of the porous medium and the cross-sectional area through which the groundwater flows, Darcy's law states:

$$Q = KA(dh/dl) \quad \text{(volume/time)}$$

Where:

Q = flow discharging through a porous medium
K = hydraulic conductivity (length/time)
A = cross-sectional area ($length^2$)
dh = change in hydraulic head between two points (length)
dl = distance between two points (length)

This version of Darcy's law provides a volumetric flow rate. To calculate the average linear velocity at which the water flows, the result is divided by the effective porosity. The rate of movement of groundwater is very slow, usually less than 1,000 feet per year because of the great amount of friction resulting from movement through the spaces between grains of sand and gravel.

Quantity of Groundwater

Because groundwater is a precious resource, the questions of how much there is and how more can be made available are important. There are many terms and concepts associated with the quantity of groundwater available in a basin, and some controversy surrounding their definition. Some of these include groundwater storage capacity, usable storage capacity, groundwater budget, change in storage, overdraft, and safe yield. This section discusses some of the more common terms used to represent groundwater quantity in California.

Groundwater Storage Capacity

The groundwater storage capacity of an individual basin or within the entire State is one of the questions most frequently asked by private citizens, water resource planners, and politicians alike. Total storage capacity seems easy to understand. It can be seen as how much physical space is available for storing groundwater. The computation of groundwater storage capacity is quite simple if data are available: capacity is determined by multiplying the total volume of a basin by the average specific yield. The total storage capacity is constant and is dependent on the geometry and hydrogeologic characteristics of the aquifer(s) (Figure 17).

Estimates of total groundwater storage capacity in California are staggering. Previous estimates of total storage range from 850 million acre-feet (maf) to 1.3 billion acre-feet (DWR 1975, DWR 1994). However, due to incomplete information about many of the groundwater basins, there has never been an accurately quantified calculation of total storage capacity statewide. Even if such a calculation were possible, the utility of such a number is questionable because total storage capacity might lead to overly optimistic estimates of how much additional groundwater development can contribute to meeting future demands.

Total groundwater storage capacity is misleading because it only takes into account one aspect of the physical character of the basin. Many other factors limit the ultimate development potential of a groundwater basin. These limiting factors may be physical, chemical, economic, environmental, legal, and institutional (Table 9). Some of these factors, such as the economic and institutional ones, can change with time. However, there may remain significant physical and chemical constraints that will limit groundwater development.

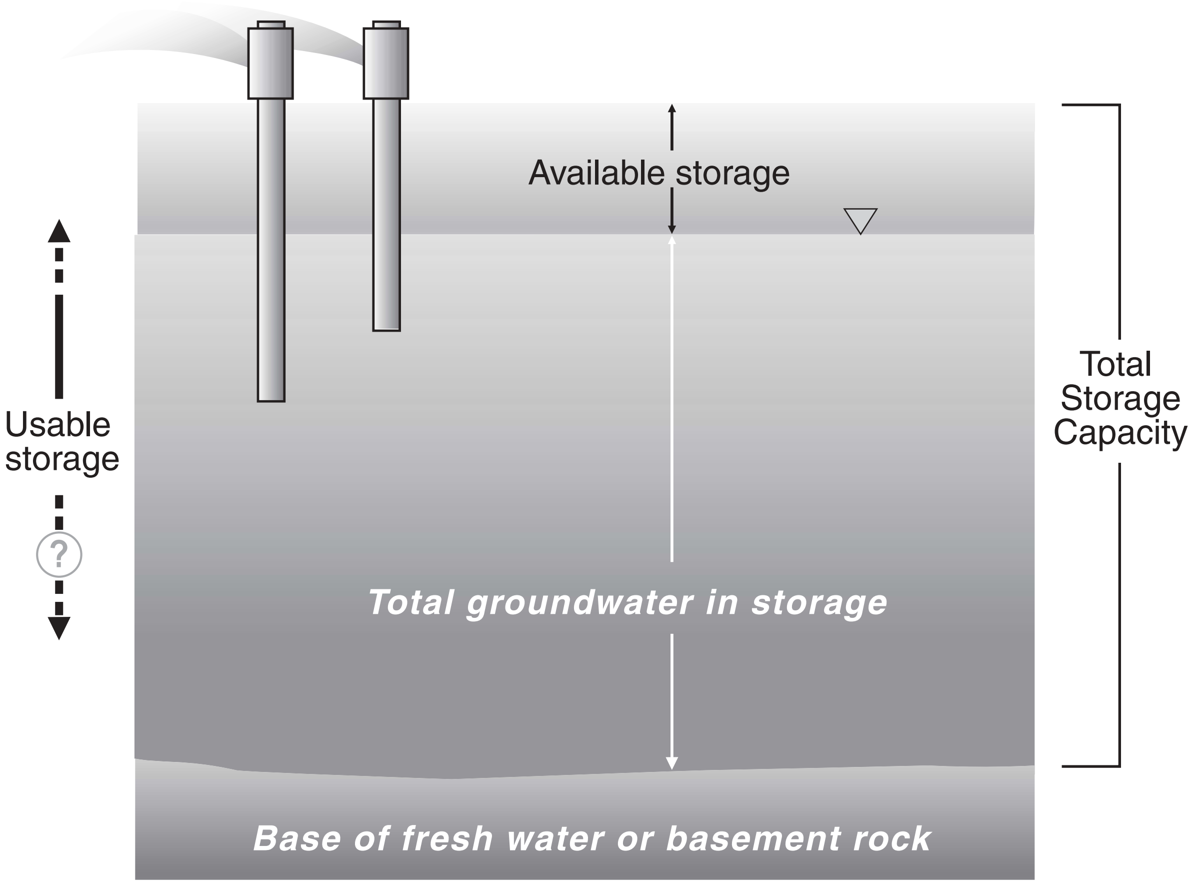

Figure 17 Schematic of total, usable, and available groundwater storage capacity

Table 9 Examples of factors that limit development of a groundwater basin

Limiting factor	Examples
Physical	Basin recharge area not adequate to sustain development; pumping too concentrated in a portion of basin; well yields too low for intended use.
Quality	Water quality not suitable for intended use; increased potential for seawater intrusion in coastal areas; upwelling of poorer quality water in deeper parts of basin.
Economic	Excessive costs associated with increased pump lifts and deepening of wells; cost of treating water if it does meet requirements for intended use.
Environmental	Need to maintain groundwater levels for wetlands, stream base flow, or other habitat.
Institutional	Local groundwater management plans or ordinances restricting use; basin adjudication; impacts on surface water rights of others.

Usable Groundwater Storage Capacity

Usable storage capacity is defined as the amount of groundwater of suitable quality that can be economically withdrawn from storage. It is typically computed as the product of the volume of the basin to some basin-specific depth that is considered economically available and the average specific yield of the basin (see Figure 17).

As more groundwater is extracted, groundwater levels may fall below some existing wells, which may then require replacement or deepening. This may be a consideration in management of the basin and will depend on the cost of replacement, the cost of pumping the water from deeper zones, and whether managers are willing to pay that cost. Other impacts that may increase the cost include subsidence and groundwater quality degradation. The usable storage may change because of changes in economic conditions.

Estimates of usable storage represent only the total volume of groundwater assumed to be usable in storage, not what would be available for sustained use on an annual basis. Previous estimates of usable groundwater storage capacity range from 143 to 450 maf (DWR 1975, DWR 1994). Unfortunately, the term "usable storage" is often used to indicate the amount of water that can be used from a basin as a source of long-term annual supply. However, the many limitations associated with total groundwater storage capacity discussed above may also apply to usable storage.

Available Groundwater Storage Capacity

Available storage capacity is defined as the volume of a basin that is unsaturated and capable of storing additional groundwater. It is typically computed as the product of the empty volume of the basin and the average specific yield of the unsaturated part of the basin (see Figure 17). The available storage capacity does not include the uppermost portion of the unsaturated zone in which saturation could cause problems such as crop root damage or increased liquefaction potential. The available storage will vary depending on the amount of groundwater taken out of storage and the recharge. The total groundwater in storage will change inversely as the available storage changes.

Available storage has often been used as a number to represent the potential for additional yield from a particular basin. Unfortunately, many of the limitations that exist in developing existing supply discussed above also limit taking advantage of available storage. Although limitations exist, looking only at available groundwater storage capacity may underestimate the potential for groundwater development. Opportunities to use groundwater already in storage and create additional storage space would be overlooked by this approach.

Groundwater Budget

A groundwater budget is an analysis of a groundwater basin's inflows and outflows to determine the change in groundwater storage. Alternatively, if the change in storage is known, the value of one of the inflows or outflows could be determined. The basic equation can be expressed as:

INFLOWS – OUTFLOWS = CHANGE IN STORAGE

Typical inflows include:

- natural recharge from precipitation;
- seepage from surface water channels;
- intentional recharge via ponds, ditches, and injection wells;
- net recharge of applied water for agricultural and other irrigation uses;
- unintentional recharge from leaky conveyance pipelines; and
- subsurface inflows from outside basin boundaries.

Outflows include:

- groundwater extraction by wells;
- groundwater discharge to surface water bodies and springs;
- evapotranspiration; and
- subsurface outflow across basin or subbasin boundaries.

Groundwater budgets can be useful tools to understand a basin, but detailed budgets are not available for most groundwater basins in California. A detailed knowledge of each budget component is necessary to obtain a good approximation of the change in storage. Absence or inaccuracy of one or more parameters can lead to an analysis that varies widely from a positive to a negative change in storage or vice versa. Since much of the data needed requires subsurface exploration and monitoring over a series of years, the collection of detailed field data is time-consuming and expensive. A management plan should develop a monitoring program as soon as possible.

Change in Groundwater Storage

As stated above, a groundwater budget is one potential way of estimating the change in storage in a basin, although it is limited by the accuracy and availability of data. There is a simpler way—by determining the average change in groundwater elevation over the basin, multiplied by the area overlying the basin and the average specific yield (or storativity in the case of a confined aquifer). The time interval over which the groundwater elevation change is determined is study specific, but annual spring-to-spring changes are commonly used. A change in storage calculation does not attempt to determine the volume of water in storage at any time interval, but rather the change from a previous period or baseline condition.

A change in storage calculation is a relatively quick way to represent trends in a basin over time. If change in storage is negligible over a representative period, the basin is in equilibrium under current use. Changes in storage calculations are more often available for a groundwater basin than groundwater budgets because water level measurements are available in many basins. Specific yield and storativity are readily estimated based on knowledge of the hydrogeologic setting and geologic materials or through aquifer pumping tests. Although simple, change in storage calculations have potential sources of error, so it is important to treat change in storage as just one of many tools in determining conditions in a groundwater basin. Well data sets must be carefully evaluated before use in these calculations. Mixing of wells constructed in confined and unconfined portions of the basin and measurement of different well sets over time can result in significant errors.

Although the change in storage calculation is a relatively quick and inexpensive method of observing changes in the groundwater system, the full groundwater budget is preferable. A detailed budget describes an understanding of the physical processes affecting storage in the basin, which the simple change in storage calculation does not. For example, the budget takes into account the relationship between the surface water and the groundwater system. If additional groundwater extraction induced additional infiltration of surface water, the calculated change in storage could be minimal. However, if the surface water is used as a source of supply downstream, the impact of reduced flows could be significant.

Overdraft

Groundwater overdraft is defined as the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions (DWR 1998). Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues for a number of years, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts.

Despite its common usage, the term overdraft has been the subject of debate for many years. Groundwater management is a local responsibility, therefore, the decision whether a basin is in a condition of overdraft is the responsibility of the local groundwater or water management agency. In some cases, local agencies may choose to deliberately extract groundwater in excess of recharge in a basin (known as "groundwater mining") as part of an overall management strategy. An independent analysis of water levels in such a basin might conclude that the basin is in overdraft. In other cases, where basin management is less active or nonexistent, declining groundwater levels are not considered a problem until levels drop below the depth of many wells in the basin. As a result, overdraft may not be reported for many years after the condition began.

Water quality changes and subsidence may also indicate that a basin has been overdrafted. For example, when groundwater levels decline in coastal aquifers, seawater fills the pore spaces in the aquifer that are vacated by the groundwater, indicating that the basin is being overdrafted. Overdraft has historically led to as much as 30 feet of land subsidence in one area of the State and lesser amounts in other areas.

The word "overdraft" has been used to designate two unrelated types of water shortages. The first is "historical overdraft" similar to the type illustrated in Figure 18, which shows that ground water levels began to decline in the mid 1950s and then leveled off in the mid 1980s, indicating less groundwater extraction or more recharge. The second type of shortage is "projected overdraft" as used in the *California Water Plan Update* (DWR 1998). In reality, this is an estimate of future water shortages based on an assumed management program within the basin, including projected supply and projected demand. If water management practices change in those basins in which a water shortage is projected, the amount of projected shortage will change.

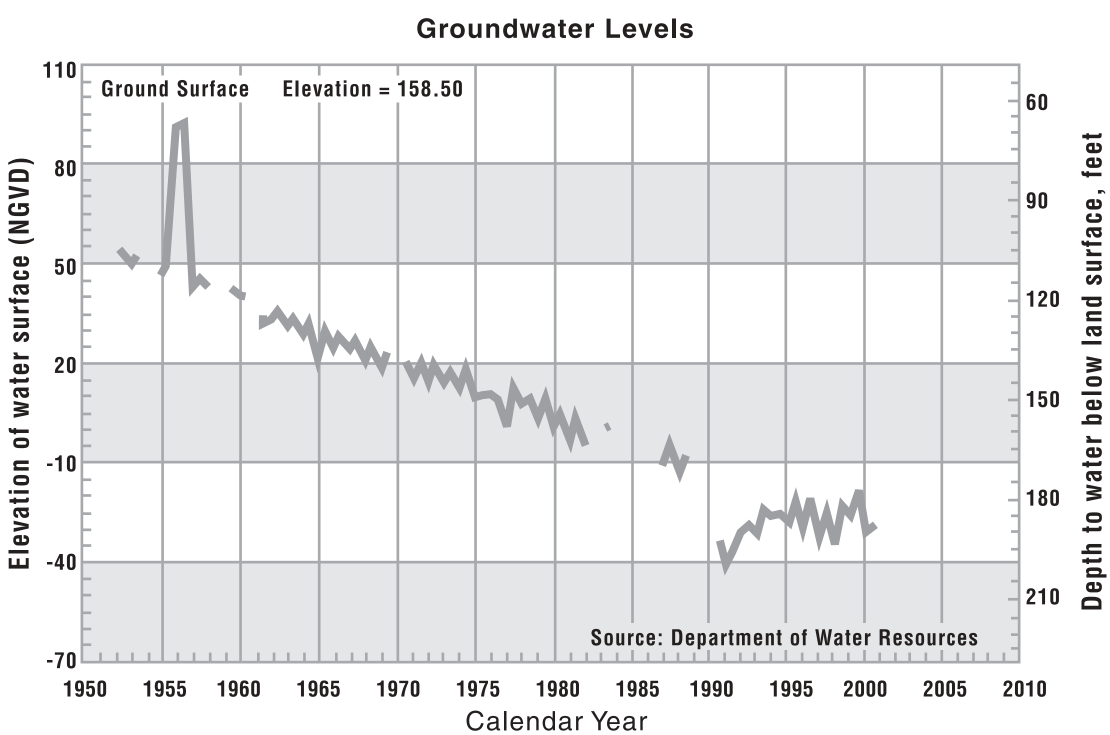

Figure 18 Hydrograph indicating overdraft

In some basins or subbasins, groundwater levels declined steadily over a number of years as agricultural or urban use of groundwater increased. In response, managing agencies developed surface water import projects to provide expanded water supplies to alleviate the declining groundwater levels. Increasing groundwater levels, or refilling of the aquifer, demonstrate the effectiveness of this approach in long-term water supply planning. In some areas of the State, the past overdraft is now being used to advantage. When the groundwater storage capacity that is created through historical overdraft is used in coordination with surface water supplies in a conjunctive management program, local and regional water supplies can be augmented.

In 1978, DWR was directed by the legislature to develop a definition of critical overdraft and to identify basins that were in a condition of critical overdraft (Water Code § 12924). The process that was followed and the basins that were deemed to be in a condition of critical overdraft are discussed in Box O, "Critical Conditions of Overdraft." This update to Bulletin 118 did not include similar direction from the legislature, nor funding to undertake evaluation of the State's groundwater basins to determine whether they are in a state of overdraft.

Box O Critical Conditions of Overdraft

In 1978, DWR was directed by the legislature to develop a definition of critical overdraft and to identify those basins in a critical condition of overdraft (Water Code §12924). DWR held public workshops around the state to obtain public and water managers' input on what the definition should include, and which basins were critically overdrafted. Bulletin 118-80, *Ground Water Basins in California* was published in 1980 with the results of that local input. The definition of critical overdraft is:

> *A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts.*

No time is specified in the definition. Definition of the time frame is the responsibility of the local water managers, as is the definition of significant adverse impacts, which would be related to the local agency's management objectives.

Eleven basins were identified as being in a critical condition of overdraft. They are:

- Pajaro Basin
- Ventura Central Basin
- Chowchilla Basin
- Kings Basin
- Tulare Lake Basin
- Kern County Basin
- Cuyama Valley Basin
- Eastern San Joaquin County Basin
- Madera Basin
- Kaweah Basin
- Tule Basin

The task was not identified by the Legislature, nor was the funding for this update (2003) sufficient to consult with local water managers and fully re-evaluate the conditions of the 11 critically overdrafted basins. Funding and duration were not sufficient to evaluate additional basins with respect to conditions of critical overdraft.

If a basin lacks existing information, the cost of a thorough evaluation of overdraft conditions in a single basin could exceed $1 million. In this update of Bulletin 118, DWR has included groundwater budget information for each basin description, where available. In most cases, however, sufficient quantitative information is not available, so conditions of overdraft or critical overdraft were not reported.

While this bulletin does not specifically identify overdrafted basins (other than the 11 basins from Bulletin 118-80), the negative effects of overdraft are occurring or may occur in the future in many basins throughout the State. Declining water levels, diminishing water quality, and subsidence threaten the availability of groundwater to meet current and future demands. A thorough understanding of overdraft can help local groundwater managers minimize the impacts and take advantage of the opportunity created by available groundwater storage capacity. Local groundwater managers and DWR should seek funding and work cooperatively to evaluate the groundwater basins of the State with respect to overdraft and its potential impacts. Beginning with the most heavily used basins and relying to the extent possible on available data collected by DWR and through local groundwater management programs, current or projected conditions of critical overdraft should be identified. If local agencies take the lead in collecting and analyzing data to fully understand groundwater basin conditions, DWR can use the information to update the designations of critically overdrafted basins. This can be a cost effective approach since much of the data needed to update the overdraft designations are the same data that agencies need to effectively manage groundwater.

Safe Yield

Safe yield is defined as the amount of groundwater that can be continuously withdrawn from a basin without adverse impact. Safe yield is commonly expressed in terms of acre-feet per year. Depending on how it is applied, safe yield may be an annual average value or may be calculated based on changed conditions each year. Although safe yield may be indicated by stable groundwater levels measured over a period of years, a detailed groundwater budget is needed to accurately estimate safe yield. Safe yield has commonly been determined in groundwater basin adjudications.

Proper application of the safe yield concept requires that the value be modified through time to reflect changing practices within the basin. One of the common misconceptions is that safe yield is a static number. That is, once it has been calculated, the amount of water can be extracted annually from the basin without any adverse impacts. An example of a situation in which this assumption could be problematic is when land use changes. In some areas, where urban development has replaced agriculture, surface pavement, storm drains, and sewers have increased runoff and dramatically reduced recharge into the basin. If extraction continued at the predetermined safe yield of the basin, water level decline and other negative impacts could occur.

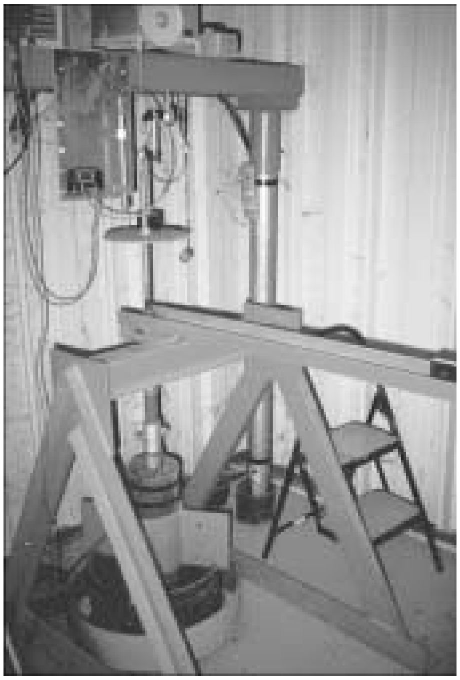

Figure 19 Photograph of extensometer

An extensometer is a well with a concrete bench mark at the bottom. A pipe extends from the concrete to the land surface. If compaction of the finer sediments occurs, leading to land surface subsidence, the pipe in the well will appear to rise out of the well casing. When this movement is recorded, the data show how much the land surface has subsided.

Subsidence

When groundwater is extracted from some aquifers in sufficient quantity, compaction of the fine-grained sediments can cause subsidence of the land surface. As the groundwater level is lowered, water pressure decreases and more of the weight of the overlying sediments is supported by the sediment grains within the aquifer. If these sediments have not previously been surcharged with an equivalent load, the overlying load will compact them. Compaction decreases the porosity of the sediments and decreases the overall volume of the finer grain sediments, leading to subsidence at the land surface. While the finer sediments within the aquifer system are compacted, the usable storage capacity of the aquifer is not greatly decreased.

Data from extensometers (Figure 19) show that as groundwater levels decline in an aquifer, the land surface falls slightly. As groundwater levels rise, the land surface also rises to its original position. This component of subsidence is called elastic subsidence because it recovers. Inelastic subsidence, the second component of subsidence, is what occurs when groundwater levels decline to the point that the finer sediments are compacted. This compaction is not recoverable.

Conjunctive Management

Conjunctive management in its broadest definition is the coordinated and combined use of surface water and groundwater to increase the overall water supply of a region and improve the reliability of that supply. Conjunctive management may be implemented to meet other objectives as well, including reducing groundwater overdraft and land subsidence, protecting water quality, and improving environmental conditions. Although surface water and groundwater are sometimes considered to be separate resources, they are connected in the hydrologic cycle. By using or storing additional surface water when it is plentiful, and relying more heavily on groundwater during dry periods, conjunctive management can change the timing and location of water so it can be used more efficiently.

Although a specific project or program may be extremely complex, there are several components common to conjunctive management projects. The first is to recharge surplus surface water when it is available to increase groundwater in storage. Recharge may occur through surface spreading, by injection wells, or by reducing groundwater use by substituting surface water. The surplus surface water used for recharge may be local runoff, imported water, stored surface water, or recycled water. The second component is to reduce surface water use in dry years or dry seasons by switching to groundwater. This use of the stored groundwater may take place through direct extraction and use, pumping back to a conveyance facility, or through exchange of another water supply. A final component that should be included is an ongoing monitoring program to evaluate operations and allow water managers to respond to changes in groundwater, surface water, or environmental conditions that could violate management objectives or impact other water users.

Quality of Groundwater

All water contains dissolved constituents. Even rainwater, often described as being naturally pure, contains measurable dissolved minerals and gases. As it moves through the hydrologic cycle, water dissolves and incorporates many constituents. These include naturally occurring and man-made constituents.

Most natural minerals are harmless up to certain levels. In some cases, higher mineral content is preferable to consumers for taste. For example, minerals are added to many bottled drinking waters after going through a filtration process. At some level, however, most naturally occurring constituents, along with those introduced by human activities, are considered contaminants. The point at which a given constituent is considered a contaminant varies depending on the intended use of the groundwater and the toxicity level of the constituents.

Beneficial Uses

For this report, water quality is a measure of the suitability of water for its intended use, with respect to dissolved solids and gases and suspended material. An assessment of water quality should include the investigation of the presence and concentration of any individual constituent that may limit the water's suitability for an intended use.

The SWRCB has identified 23 categories of water uses, referred to as beneficial uses. The beneficial use categories and a brief description of each are presented in Appendix E. The actual criteria that are used to evaluate water quality for each of the beneficial uses are determined by the nine Regional Water Quality Control Boards, resulting in a range of criteria for some of the uses. These criteria are published in each of the Regional Boards' Water Quality Control Plans (Basin Plans)[1].

A summary of water quality for all of the beneficial uses of groundwater is beyond the scope of this report. Instead, water quality criteria for two of the most common uses—municipal supply (referred to as public drinking water supply in this report) and agricultural supply—are described below.

Public Drinking Water Supply

Standards for maximum contaminant levels (MCLs) of constituents in drinking water are required under the federal Safe Drinking Water Act of 1974 and its updates. There are primary and secondary standards. Primary standards are developed to protect public health and are legally enforceable. Secondary standards are generally for the protection of aesthetic qualities such as taste, odor, and appearance, and cosmetic qualities, such as skin or tooth discoloration, and are generally non-enforceable guidelines. However, in California secondary standards are legally enforceable for all new drinking water systems and new sources developed by existing public water suppliers (DWR 1997). Under these primary and secondary standards, the U.S. Environmental Protection Agency regulates more than 90 contaminants, and the California Department of Health Services regulates about 100. Federal and State primary MCLs are listed in Appendix F.

Agricultural Supply

An assessment of the suitability of groundwater as a source of agricultural supply is much less straightforward than that for public water supply. An evaluation of water supply suitability for use in agriculture is difficult because the impact of an individual constituent can vary depending on many factors, including soil chemical and physical properties, crop type, drainage, and irrigation method. Elevated levels of constituents usually do not result in an area being taken entirely out of production, but may lower crop yields. Management decisions will determine appropriate land use and irrigation methods.

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[1] Digital versions of these plans are available online at http://www.swrcb.ca.gov/plnspols/index.html

There are no regulatory standards for water applied on agriculture. Criteria for crop water have been provided as guidelines. Many constituents have the potential to negatively impact agriculture, including more than a dozen trace elements (Ayers and Westcot 1985). Two constituents that are commonly considered with respect to agricultural water quality are salinity—expressed as total dissolved solids (TDS)—and boron concentrations.

Increasing salinity in irrigation water inhibits plant growth by reducing a plant's ability to absorb water through its roots (Pratt and Suarez 1996). While the impact will depend on crop type and soil conditions, it is useful to look at the TDS of the applied water as a general assessment tool. A range of values for TDS with their estimated suitability for agricultural uses is presented in Table 10. These ranges are modified from criteria developed for use in the San Joaquin Valley by the San Joaquin Valley Drainage Program. However, they are similar to values presented in Ayers and Westcot (1985).

Table 10 Range of TDS values with estimated suitability for agricultural uses

Range of TDS (mg/L)	Suitability
<500	Generally no restrictions on use
500 – 1,250	Generally slight restrictions on use
1,250 – 2,500	Generally moderate restrictions on use
>2,500	Generally severe restrictions on use

Modified from SJVDP (1990)
TDS = total dissolved solids

High levels of boron can present toxicity problems in plants by damaging leaves. The boron is absorbed through the root system and transported to the leaves. Boron then accumulates during plant transpiration, resulting in leaf burn (Ayers and Westcot 1985). Boron toxicity is highly dependent on a crop's sensitivity to the constituent. A range of values of dissolved boron in irrigation water, with their estimated suitability on various crops is presented in Table 11. These ranges are modified from Ayers and Westcot (1985).

Table 11 Range of boron concentrations with estimated suitability on various crops

Range of dissolved boron (mg/L)	Suitability
<0.5	Suitable on all but most highly boron sensitive crops
0.5 – 1.0	Suitable on most boron sensitive crops
1.0 – 2.0	Suitable on most moderately boron sensitive crops
>2.0	Suitable for only moderately to highly boron tolerant crops

Source: Modified from Ayers and Westcot 1985

Contaminant Groups

Because there are so many potential individual constituents to evaluate, researchers have often summarized contaminants into groups depending on the purpose of the study. Recognizing that there are exceptions to any classification scheme, this update considered groups according to their common sources of contamination—those naturally occurring and those caused by human activities (anthropogenic). Each of these sources includes more than one contaminant group. A listing of the contaminant groups and the individual constituents belonging to those groups, summarized in this report, is included in Appendix F.

Naturally Occurring Sources

In this report, naturally occurring sources include three primary groups: (1) inorganic constituents with primary MCLs, (2) inorganic constituents with secondary MCLs, and (3) radiological constituents. Inorganics primarily include naturally occurring minerals such as arsenic or mercury, although human activities may certainly contribute to observed concentrations. Radiological constituents include primarily naturally occurring constituents such as radon, gross alpha, and uranium. Although radioactivity is not considered a significant contaminant statewide, it can be locally important, particularly in communities in the Sierra Nevada.

Anthropogenic Sources

Anthropogenic contaminants include pesticides, volatile organic compounds (VOCs), and nitrates. Pesticides and VOCs are often grouped together into an organic contaminant group. However, separating the two gives a general idea of which contaminants are primarily from agricultural activities (pesticides) and which are primarily from industrial activities (VOCs). One notable exception to the groupings is dibromochloropropane (DBCP). Even though this compound is a VOC, DBCP is a soil fumigant and is included with pesticides. Nitrates are a surprising anthropogenic class to some observers. Nitrogen is certainly a naturally occurring inorganic constituent. However, because most nitrates are associated with agriculture (see Box P, "Focused on Nitrates: Detailed Study of a Contaminant") and nitrates are among California's leading contaminants, it is appropriate to consider them separately from inorganics.

Box P Focused on Nitrates: Detailed Study of a Contaminant

Because water has so many potential uses, the study of water quality means different things to different people. Thomas Harter, a professor at the University of California at Davis, has chosen to focus on nitrates as one of his research interests. Harter's monitoring network consists of 79 wells on 5 dairies in the San Joaquin Valley.

A common result of dairy activities is the release of nitrogen into the surroundings, which changes to nitrate in groundwater. Nitrates are notorious for their role in interfering with oxygen transport in babies, a condition commonly referred to as "blue baby syndrome." Nitrates are also of interest because more public supply wells have been closed due to nitrate contamination than from any other contaminant (Bachman and others 1997).

Harter's study has focused on two primary activities. The first is a meticulous examination of nitrogen at the surface and nitrates in the uppermost 25 feet of the subsurface. This monitoring has been ongoing since 1993, and has shown that a significant amount of nitrate can reach shallow groundwater. The second focus of the study has been to change management practices to reduce the amount of nitrogen available to reach groundwater, along with continued monitoring. This has occurred since 1998. Results of the study are better management practices that significantly reduce the amount of nitrogen available to groundwater. This will help minimize the potential adverse impacts to groundwater quality from nitrates.

Chapter 7

Inventory of California's Groundwater Information

Chapter 7
Inventory of California's Groundwater Information

The groundwater information in this chapter summarizes the available information on statewide and regional groundwater issues. For more detailed information on specific groundwater basins see the supplement to this report that is available on the California Department of Water Resources (DWR) website, http://www.waterplan.water.ca.gov/groundwater/118index.htm. See Appendix A for information on accessing individual basin descriptions and the map delineating California's groundwater basins.

Statewide Groundwater Information

There is a large amount of data available for many of the State's most heavily developed groundwater basins. Conversely, there is relatively little data available on groundwater in the undeveloped areas. The information in this report is generally limited to a compilation of the information readily available to DWR staff and may not include the most up-to-date data generated by studies that have been completed recently by water management agencies. For this reason, the collection of additional, more recent data on groundwater basins should be continued and integrated into the basin descriptions. Statewide summaries are included below.

Groundwater Basins

There are currently 431 groundwater basins delineated, underlying about 40 percent of the surface area of the State. Of those, 24 basins are subdivided into a total of 108 subbasins, giving a total of 515 distinct groundwater systems described in this report (Figure 20). Basin delineation methods are described in Appendix G. Additionally, many of the subbasin boundaries were developed or modified with public input, but little physical data. These boundaries should not be considered as precisely defining a groundwater basin boundary; the determination of whether any particular area lies within a groundwater basin boundary should be determined only after detailed local study.

Groundwater basin and subbasin boundaries shown on the map included with this bulletin are based on evaluation of the best available information. In basins where many studies have been completed and the basin has been operated for a number of years, the basin response is fairly well understood and the boundaries are fairly well defined. Even in these basins, however, there are many unknowns and changes in boundaries may result as more information about the basin is collected and evaluated.

Groundwater Budgets

Rather than simply providing all groundwater budget data collected during this update, the budget information was classified into one of three categories indicating the relative level of detail of information available. These categories, types A, B, and C, are discussed in Box R, "Explanation of Groundwater Data Tables." A type A budget indicates that much of the information needed to characterize the groundwater budget for the basin or subbasin was available. DWR staff did not verify these type A budgets, so DWR cannot address the accuracy of the data provided by them. Type B indicates that enough data are available to estimate the groundwater extraction to meet local water use needs. This is useful in understanding the reliance of a particular area on groundwater. Type C indicates a low level of knowledge of any of the budget components for the area.

Figure 21 depicts where these type A, B, and C budgets occur. In general, there is a greater level of understanding (type A or B) in the more heavily developed areas in terms of groundwater use. These include the Central Valley and South Coast. The lowest level of knowledge of groundwater budget data is in the southeast desert area. A discussion of groundwater use in each region is included below.

Box Q How Does the Information in This Report Relate to the Recently Enacted Laws Senate Bill 221 and Senate Bill 610 (2002)?

Recently enacted legislation requires developers of certain new housing projects to demonstrate an available water supply for that development. If a part of that proposed water supply is groundwater, urban water suppliers must provide additional information on the availability of an adequate supply of groundwater to meet the projected demand and show that they have the legal right to extract that amount of groundwater. SB 610 (2002) amended the Water Code to require, among other things, the following information (Section 10631(b)(2)):

> *For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.*

The hydrogeologic information contained in the basin descriptions that supplement this update of Bulletin 118 includes only the information that was available in California Department of Water Resources (DWR) files through reference searches and through limited contact with local agencies. Local agencies may have conducted more recent studies that have generated additional information about water budgets and aquifer characteristics. Unless the agency notified DWR, or provided a copy of the recent reports to DWR staff, that recent information has not been included in the basin descriptions. Therefore, although SB 610 refers to groundwater basins identified as overdrafted in Bulletin 118, it would be prudent for local water suppliers to evaluate the potential for overdraft of any basin included as a part of a water supply assessment.

Persons interested in collecting groundwater information in accordance with the Water Code as amended by SB 221 and SB 610 may start with the information in Bulletin 118, but should follow up by consulting the references listed for each basin and contacting local water agencies to obtain any new information that is available. Otherwise, evaluation of available groundwater resources as mandated by SB 221 and SB 610 may not be using the most complete and recent information about water budgets and aquifer characteristics.

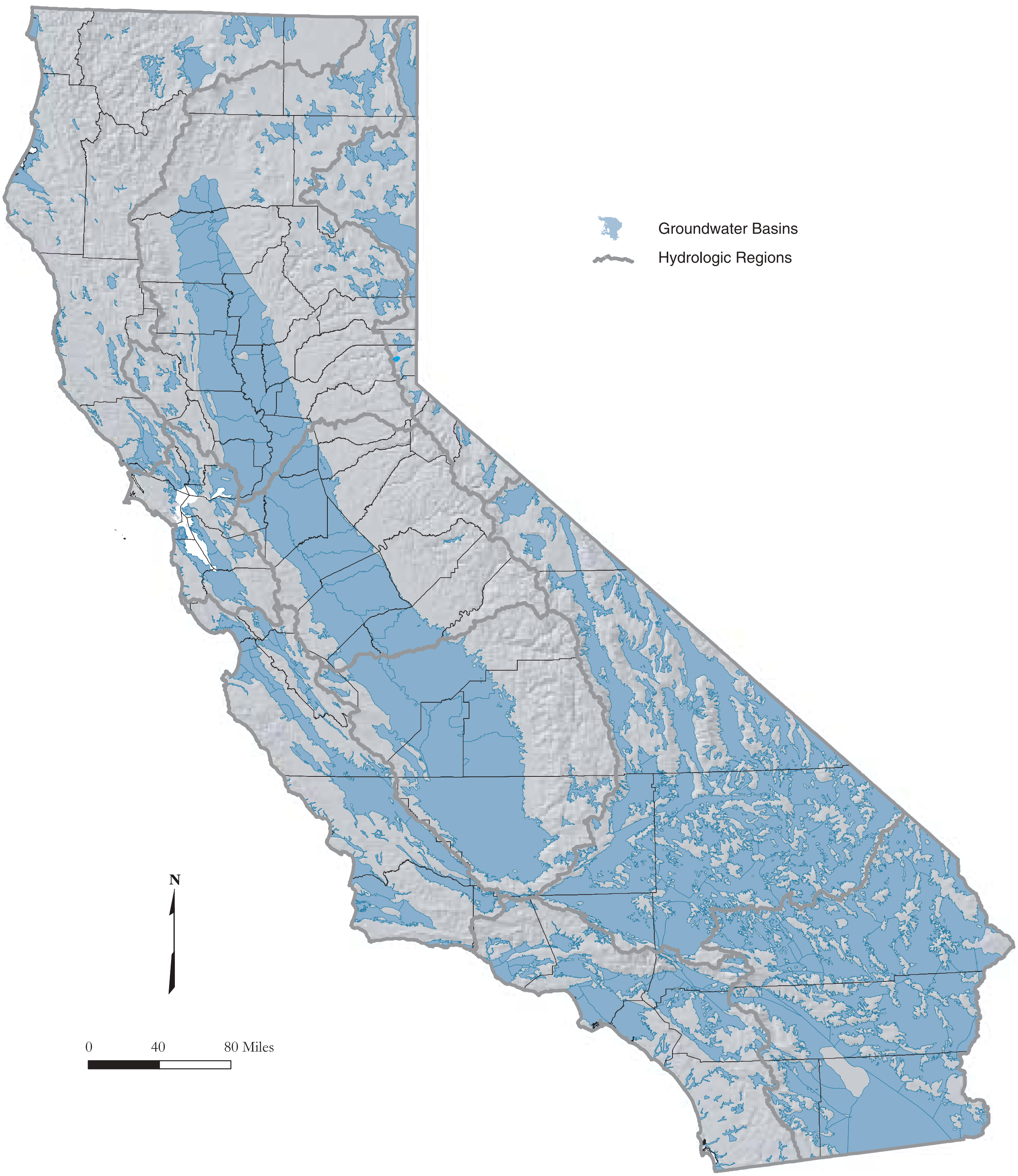

Figure 20 Groundwater basins and subbasins

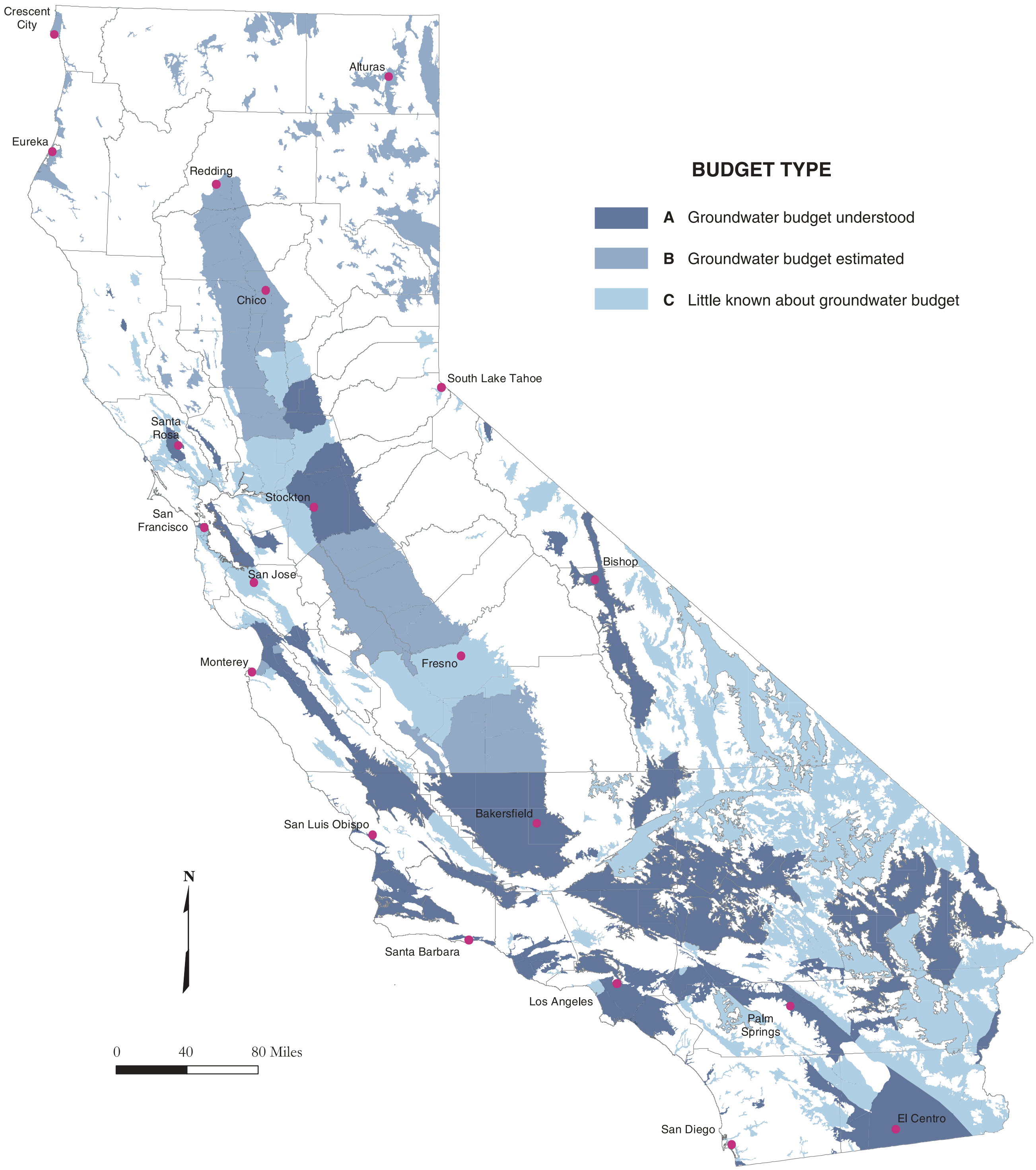

Figure 21 Basin and subbasin groundwater budget types

Box R Explanation of Groundwater Data Tables

A groundwater data table for each hydrologic region is included at the end of each hydrologic region section in Chapter 7. The tables include the following information:

Basin/Subbasin Number. The basin numbering format is x-xxx.xx. The first number in the sequence assigns the basin to one of the nine Regional Water Quality Control Board boundaries. The second number is the groundwater basin number. Any number following the decimal identifies that the groundwater basin has been further divided into subbasins. Reevaluation of available hydrogeologic information resulted in the deletion of some basins and subbasins identified in Bulletins 118-75 and 118-80. Because of this, there are some gaps in the sequence of basin numbers in this report. The methods used for developing the current groundwater basin maps are discussed in Appendix H. The names and numbers of the basins deleted, along with any comments related to their elimination are included in the appropriate region in Chapter 7. Previously unidentified groundwater basins or subbasins that were delineated during this update are assigned new identification numbers that sequentially follow the last number used in Bulletin 118-80 for groundwater basins or subbasins.

Basin or Subbasin Name. Basin names are based on published and unpublished reports, topographic maps, and local terminology. Names of more recently delineated basins or subbasins are based on the principal geographic feature, which in most cases corresponds to the name of a valley. In the case of a subbasin, its formal name should include the name of the basin (for example, Sacramento Valley Groundwater Basin, North American Subbasin). However, both locally and informally, the term subbasin is used interchangeably with basin (for example, North American Basin).

Area. The area for each basin or subbasin is presented in acres rounded to three significant figures (for example, 147,148 acres was rounded to 147,000 acres). The area describes only the upper surface or map view of a basin. The basin underlies the area and may extend beyond the surface expression (discussed in Chapter 6).

Groundwater Budget Type. The type of groundwater budget information available was classified as Type A, B, or C based on the following criteria:

Type A – indicates one of the following: (1) a groundwater budget exists for the basin or enough components from separate studies could be combined to give a general indication of the basin's groundwater budget, (2) a groundwater model exists for the basin that can be used to calculate a groundwater budget, or (3) actual groundwater extraction data exist for the basin.

Type B – indicates that a use-based estimate of groundwater extraction is calculated for the basin. The use-based estimate is determined by calculating the overall use from California Department of Water Resources land use and urban water use surveys. Known surface water supplies are then subtracted from the total demand leaving the rest of the use to be met by groundwater extraction.

Type C – indicates that there are not enough data to provide either an estimate of the basin's groundwater budget or groundwater extraction from the basin.

Well Yields. Maximum and average well yields in gallons per minute (gpm) are reported for municipal supply and agricultural wells where available. Most of the values reported are from initial tests reported during construction of the well, which may not be an accurate indication of the long-term production capacity of the wells.

Box R continued on next page

Box R Explanation of Groundwater Data Tables (continued)

Types of Monitoring. This includes monitoring of both groundwater levels and quality. "Levels" indicate the number of wells actively monitored without consideration of frequency. Most wells are monitored semi-annually, but many are monitored monthly. "Quality" indicates the number of wells monitored for various constituents; these could range from a grab sample taken for a field specific conductance measurement to a full analysis of organic and inorganic constituents. "Title 22" indicates the number of public water system wells that are actively sampled and monitored under the direction of California Department of Health Services (DHS) Title 22 Program.

Total Dissolved Solids. This category includes range and average values of total dissolved solids (TDS). This data primarily represents data from published reports. In some cases, a range of average TDS values is presented.

Active Monitoring

The summary of active monitoring includes wells that are monitored for groundwater elevation or groundwater quality within the delineated groundwater basins as of 1999. Groundwater elevation data collected by DWR and cooperators are available online at http://wdl.water.ca.gov. Most of the water quality data are for public supply wells and were provided by the California Department of Health Services (DHS). Other groundwater level and water quality monitoring activities were reported by local agencies during this update. The summary indicates that there are nearly 14,000 wells monitored for groundwater levels, 10,700[1] wells monitored under DHS water quality monitoring program, and 4,700 wells monitored for miscellaneous water quality by other agencies.

[1] These numbers include the wells in basins and subbasins only; throughout the entire state, DHS has responsibility for more than 16,000 public supply wells.

Box S What Happens When an MCL Exceedance Occurs?

All suppliers of domestic water to the public are subject to regulations adopted by the U.S. Environmental Protection Agency under the Safe Drinking Water Act (42 U.S.C. 300f et seq.) as well as by the California Department of Health Services under the California Safe Drinking Water Plan Act (Health and Safety Code §§ 116270-116750).

These regulations include primary drinking water standards that establish maximum contaminant levels (MCLs) for inorganic and organic chemicals and radioactivity. MCLs are based on health protection, technical feasibility, and economic factors.

California requires public water systems to sample their drinking water sources, analyze for regulated contaminants, and determine compliance with the MCLs on a regular basis. Sampling frequency depends on the contaminant, type of water source, and previous sampling results; frequency can range from monthly to once every nine years, or none at all if sampling is waived because the source is not vulnerable to the contaminant.

Primary MCLs are enforceable standards. In California, compliance is usually determined at the wellhead or the surface water intake. To meet water quality standards and comply with regulations, a water system with a contaminant exceeding an MCL must notify the public and remove the source from service or initiate a process and schedule to install treatment for removing the contaminant.

Notification requirements reflect the severity of the associated health risks; immediate health concerns prompt immediate notice to consumers. Violations that do not pose a significant health concern may use a less immediate notification process. In addition to consumer notification, a water system is required by statute to notify the local governing body (for example, city council or county board of supervisors) whenever a drinking water well exceeds an MCL, even if the well is taken out of service.

Detections of regulated contaminants (and certain unregulated contaminants) must also be reported to consumers in the water system's annual Consumer Confidence Report.

Groundwater Quality

The summary of water quality relied heavily on data from the DHS Title 22 water quality monitoring program. The assessment consisted of querying the DHS database for active wells that have constituents exceeding the maximum contaminant level (MCL) for drinking water. Summaries of this assessment for each of the State's hydrologic regions (HRs) are discussed in this chapter.

DHS data are the most comprehensive statewide water quality data set available, but this data set should not be used as a sole indicator of the groundwater quality in California. Data from these wells are not necessarily representative of any given basin; it only represents the quality of groundwater where a public water supply is extracted.

The Natural Resources Defense Council (NRDC 2001) issued a report that concludes California's groundwater resources face a serious long-term threat from contamination. Despite heavy reliance on groundwater, no comprehensive statewide assessments of groundwater quality were available. In response to the NRDC report, the State Water Resources Control Board (SWRCB) is planning a comprehensive assessment of the State's groundwater quality. This program is discussed in Chapter 4, in the section titled "Groundwater Quality Monitoring Act of 2001 (AB 599)."

Regional Groundwater Use

The importance of groundwater as a resource varies regionally throughout the State. For planning purposes, DWR divides California into 10 hydrologic regions (HRs), which correspond to the State's major drainage areas. HR boundaries are shown in Figure 22. A review of average water year supplies from the California Water Plan (DWR 1998) shows the importance of groundwater as a local supply for agricultural and municipal use throughout the State and in each of California's 10 HRs (Table 12 and Figure 23).

Table 12 Annual agricultural and municipal water demands met by groundwater

Hydrologic region	Total Demand Volume (TAF)	Demand met by Groundwater (TAF)	Demand met by Groundwater (%)
North Coast	1063	263	25
San Francisco Bay	1353	68	5
Central Coast	1263	1045	83
South Coast	5124	1177	23
Sacramento River	8720	2672	31
San Joaquin River	7361	2195	30
Tulare Lake	10556	4340	41
North Lahontan	568	157	28
South Lahontan	480	239	50
Colorado River	4467	337	8

Source: DWR 1998

With more than 80 percent of demand met by groundwater, the Central Coast HR is heavily reliant on groundwater to meet its local needs. The Tulare Lake and South Lahontan HRs meet more than 40 percent of their local demand from groundwater. The South Coast, North Coast, North Lahontan, San Joaquin River, and Sacramento River HRs take between 20 and 40 percent of their supply from groundwater. Groundwater is a relatively minor source of supply in the San Francisco Bay and Colorado River HRs.

Of all the groundwater extracted annually in the state, an estimated 35 percent is produced from the Tulare Lake HR. More than 70 percent of groundwater extraction occurs in the Central Valley (Tulare Lake, San Joaquin River, and Sacramento River HRs combined). Nearly 20 percent is extracted in the highly urbanized South Coast and Central Coast HRs, while less than 10 percent is extracted in the remaining five HRs combined.

Figure 22 California's 10 hydrologic regions

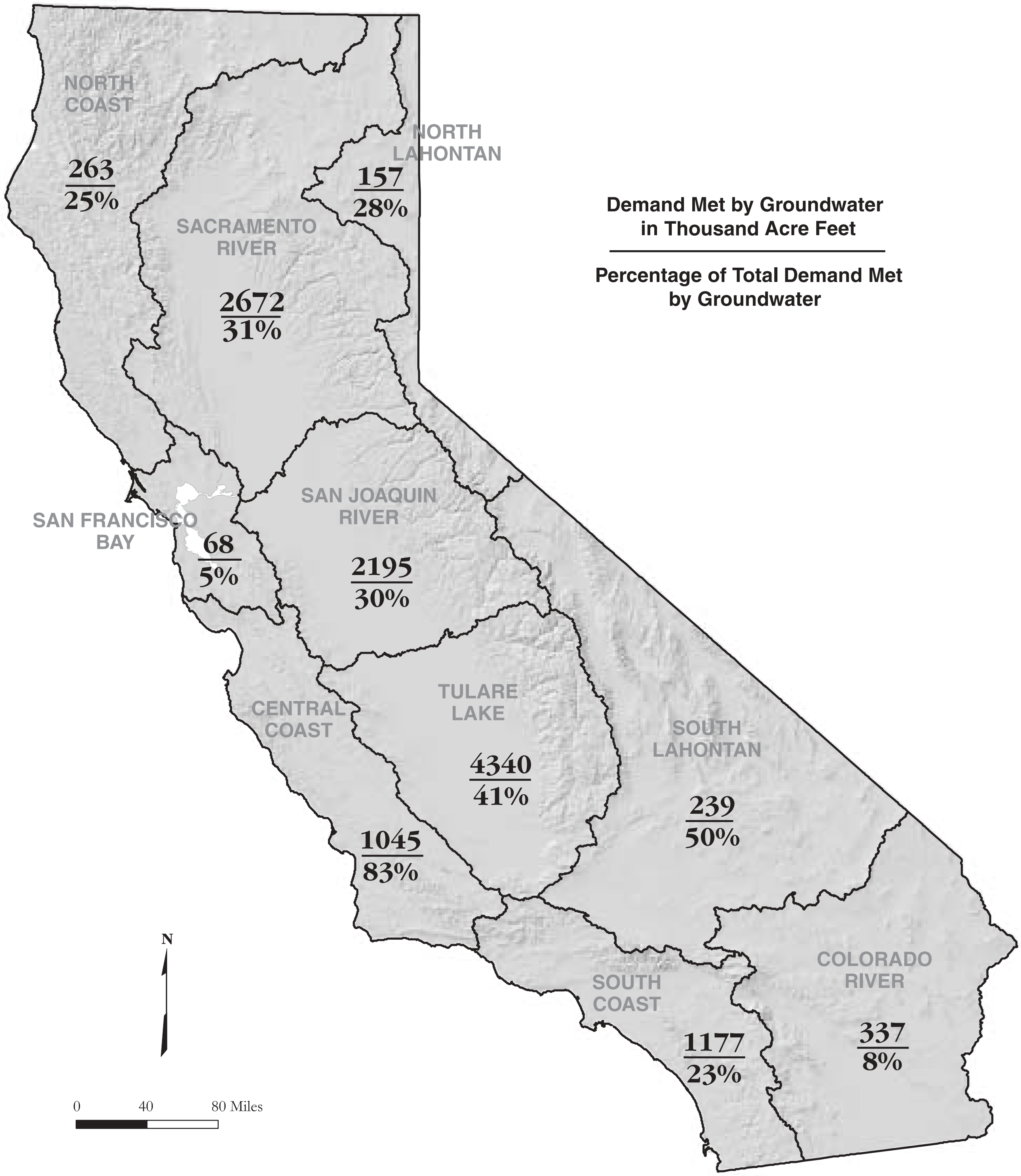

Figure 23 Agricultural and urban demand supplied by groundwater in each hydrologic region

The remainder of this chapter provides a summary of each of the 10 HRs. A basin location map for each HR is followed by a brief discussion of groundwater occurrence and groundwater conditions. A summary tabulation of groundwater information for each groundwater basin within the HR is provided. Greater detail for the data presented in these tables, including a bibliography, is provided in the individual basin/subbasin descriptions in the supplemental report (see Appendix A). Because the groundwater basin numbers are based on the boundaries of the State's nine Regional Water Quality Control Boards (RWQCB), Figure 24 shows the relationship between the Regional Board boundaries and DWR's HR boundaries.

The groundwater basin tabulations give an overview of available data. Where a basin is divided into subbasins, only the information for the subbasins is provided. The data for each subbasin generally come from different sources, so it is inappropriate to sum the data into a larger basin summary. An explanation of each of the data items presented in the summary table is provided in Box R.

Figure 24 Regional Water Quality Control Board regions and Department of Water Resources hydrologic regions

North Coast Hydrologic Region

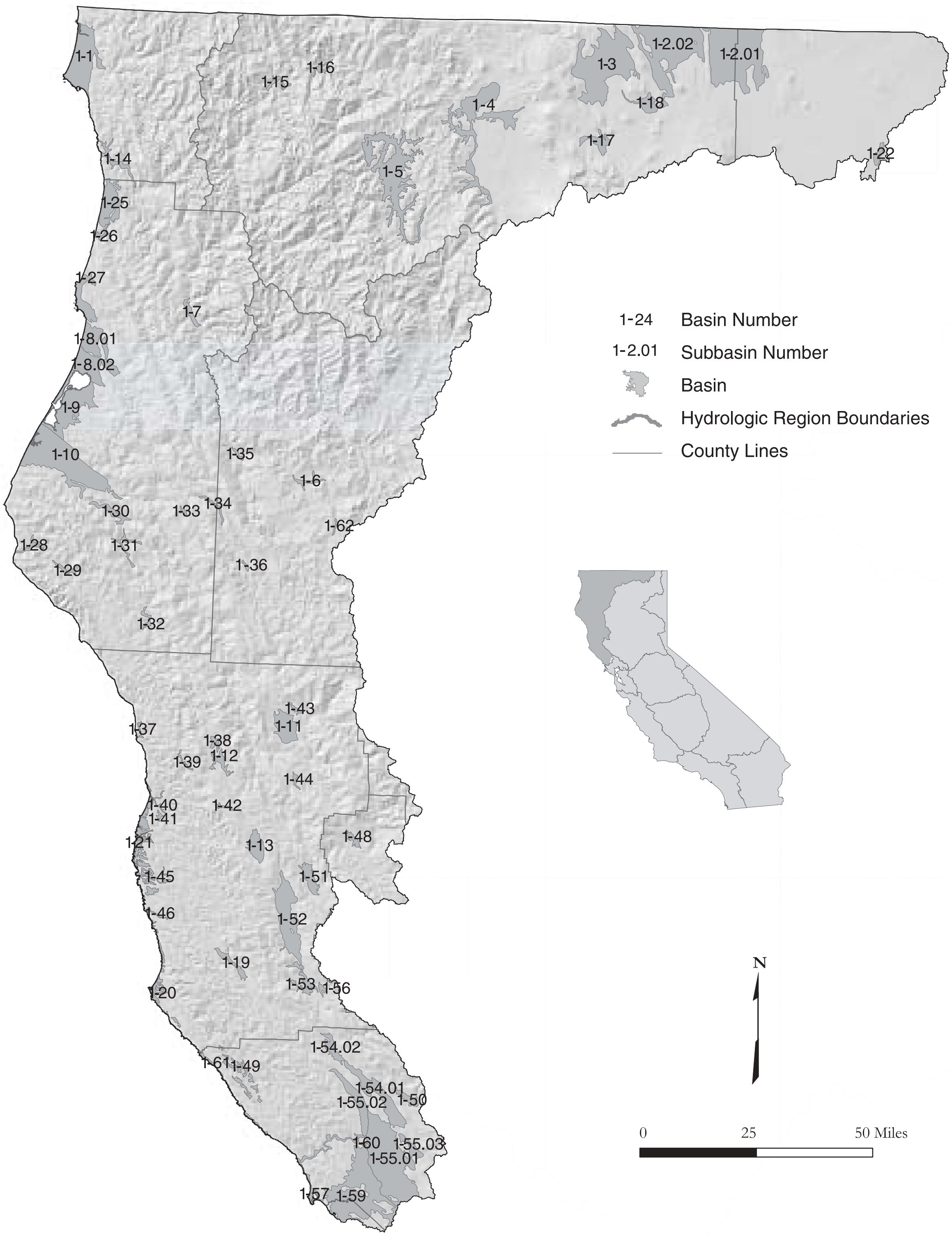

Figure 25 North Coast Hydrologic Region

Basins and Subbasins of the North Coast Hydrologic Region

Basin/subbasin	Basin name
1-1	Smith River Plain
1-2	Klamath River Valley
1-2.01	Tule Lake
1-2.02	Lower Klamath
1-3	Butte Valley
1-4	Shasta Valley
1-5	Scott River Valley
1-6	Hayfork Valley
1-7	Hoopa Valley
1-8	Mad River Valley
1-8.01	Mad River Lowland
1-8.02	Dows Prairie School Area
1-9	Eureka Plain
1-10	Eel River Valley
1-11	Covelo Round Valley
1-12	Laytonville Valley
1-13	Little Lake Valley
1-14	Lower Klamath River Valley
1-15	Happy Camp Town Area
1-16	Seiad Valley
1-17	Bray Town Area
1-18	Red Rock Valley
1-19	Anderson Valley
1-20	Garcia River Valley
1-21	Fort Bragg Terrace Area
1-22	Fairchild Swamp Valley
1-25	Prairie Creek Area
1-26	Redwood Creek Area
1-27	Big Lagoon Area
1-28	Mattole River Valley
1-29	Honeydew Town Area
1-30	Pepperwood Town Area
1-31	Weott Town Area
1-32	Garberville Town Area
1-33	Larabee Valley
1-34	Dinsmores Town Area
1-35	Hyampom Valley
1-36	Hettenshaw Valley
1-37	Cottoneva Creek Valley
1-38	Lower Laytonville Valley
1-39	Branscomb Town Area
1-40	Ten Mile River Valley
1-41	Little Valley

Basin/subbasin	Basin name
1-42	Sherwood Valley
1-43	Williams Valley
1-44	Eden Valley
1-45	Big River Valley
1-46	Navarro River Valley
1-48	Gravelley Valley
1-49	Annapolis Ohlson Ranch Formation Highlands
1-50	Knights Valley
1-51	Potter Valley
1-52	Ukiah Valley
1-53	Sanel Valley
1-54	Alexander Valley
1-54.01	Alexander Area
1-54.02	Cloverdale Area
1-55	Santa Rosa Valley
1-55.01	Santa Rosa Plain
1-55.02	Healdsburg Area
1-55.03	Rincon Valley
1-56	McDowell Valley
1-57	Bodega Bay Area
1-59	Wilson Grove Formation Highlands
1-60	Lower Russian River Valley
1-61	Fort Ross Terrace Deposits
1-62	Wilson Point Area

Description of the Region

The North Coast HR covers approximately 12.46 million acres (19,470 square miles) and includes all or portions of Modoc, Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Lake, and Sonoma counties (Figure 25). Small areas of Shasta, Tehama, Glenn, Colusa, and Marin counties are also within the region. Extending from the Oregon border south to Tomales Bay, the region includes portions of four geomorphic provinces. The northern Coast Range forms the portion of the region extending from the southern boundary north to the Mad River drainage and the fault contact with the metamorphic rocks of the Klamath Mountains, which continue north into Oregon. East of the Klamath terrane along the State border are the volcanic terranes of the Cascades and the Modoc Plateau. In the coastal mountains, most of the basins are along the narrow coastal strip between the Pacific Ocean and the rugged Coast Range and Klamath Mountains and along inland river valleys; alluviated basin areas are very sparse in the steep Klamath Mountains. In the volcanic terrane to the east, most of the basins are in block faulted valleys that once held Pleistocene-age lakes. The North Coast HR corresponds to the boundary of RWQCB 1. Significant geographic features include basin areas such as the Klamath River Basin, the Eureka/Arcata area, Hoopa Valley, Anderson Valley, and the Santa Rosa Plain. Other significant features include Mount Shasta, forming the southern border of Shasta Valley, and the rugged north coastal shoreline. The 1995 population of the entire region was about 606,000, with most being centered along the Pacific Coast and in the inland valleys north of the San Francisco Bay Area.

The northern mountainous portion of the region is rural and sparsely populated, primarily because of the rugged terrain. Most of the area is heavily forested. Some irrigated agriculture occurs in the narrow river valleys, but most occurs in the broader valleys on the Modoc Plateau where pasture, grain and alfalfa predominate. In the southern portion of the region, closer to urban centers, crops like wine grapes, nursery stock, orchards, and truck crops are common.

A majority of the surface water in the North Coast HR goes to environmental uses because of the “wild and scenic” designation of most of the region’s rivers. Average annual precipitation ranges from 100 inches in the Smith River drainage to 29 inches in the Santa Rosa area and about 10 inches in the Klamath drainage; as a result, drought is likely to affect the Klamath Basin more than other portions of the region. Communities that are not served by the area’s surface water projects also tend to experience shortages. Surface water development in the region includes the U.S. Bureau of Reclamation (USBR) Klamath Project, Humboldt Bay Municipal Water District’s Ruth Lake, and U.S. Army Corps of Engineer’s Russian River Project. An important factor concerning water demand in the Klamath Project area is water allocation for endangered fish species in the upper and lower basin. Surface water deliveries for agriculture in 2001, a severe drought year, were only about 20 percent of normal.

Groundwater Development

Groundwater development in the North Coast HR occurs along the coast, near the mouths of some of the region’s major rivers, on the adjacent narrow marine terraces, or in the inland river valleys and basins. Reliability of these supplies varies significantly from area to area. There are 63 groundwater basins/subbasins delineated in the region, two of which are shared with Oregon. These basins underlie approximately 1.022 million acres (1,600 square miles).

Along the coast, most groundwater is developed from shallow wells installed in the sand and gravel beds of several of the region’s rivers. Under California law, the water produced in these areas is considered surface water underflow. Water from Ranney collectors installed in the Klamath River, Rowdy Creek, the Smith

River, and the Mad River supply the towns of Klamath, Smith River and Crescent City in Del Norte County and most of the Humboldt Bay area in Humboldt County. Except on the Mad River, which has continuous supply via releases from Ruth Reservoir, these supplies are dependent on adequate precipitation and flows throughout the season. In drought years when streamflows are low, seawater intrusion can occur causing brackish or saline water to enter these systems. This has been a problem in the town of Klamath, which in 1995 had to obtain community water from a private well source. Toward the southern portion of the region, along the Mendocino coast, the Town of Mendocino typifies the problems related to groundwater development in the shallow marine terrace aquifers. Groundwater supply is limited by the aquifer storage capacity, and surveys done in the Town of Mendocino in the mid-1980s indicate that about 10 percent of wells go dry every year and up to 40 percent go dry during drought years.

Groundwater development in the inland coastal valleys north of the divide between the Russian and Eel Rivers is generally of limited extent. Most problems stemming from reliance on groundwater in these areas is a lack of alluvial aquifer storage capacity. Many groundwater wells rely on hydrologic connection to the rivers and streams of the valleys. The City of Rio Dell has experienced water supply problems in community wells and, as a result, recently developed plans to install a Ranney collector near the Eel River. South of the divide, in the Russian River drainage, a significant amount of groundwater development has occurred on the Santa Rosa Plain and surrounding areas. The groundwater supplies augment surface supplies from the Russian River Project.

In the north-central part of the North Coast HR, the major groundwater basins include the Klamath River Valley, Shasta Valley, Scott River Valley, and Butte Valley. The Klamath River Valley is shared with Oregon. Of these groundwater basins, Butte Valley has the most stable water supply conditions. The historical annual agricultural surface water supply has been about 20,000 acre-feet. As farming in the valley expanded from the early 1950s to the early 1990s, bringing nearly all the arable land in the valley into production, groundwater was developed to farm the additional acres. It has been estimated that current, fully developed demands are only about 80 percent of the available groundwater supply. By contrast, water supply issues in the other three basins are contingent upon pending management decisions regarding restoration of fish populations in the Klamath River and the Upper Klamath Basin system. The Endangered Species Act (ESA) fishery issues include lake level requirements for two sucker fish species and in-stream flow requirements for coho salmon and steelhead trout. Since about 1905, the Klamath Project has provided surface water to the agricultural community, which in turn has provided water to the wildlife refuges. Since the early 1990s, it has been recognized that surface water in the Klamath Project is over-allocated, but very little groundwater development had occurred. In 2001, which was a severe drought year, USBR delivered a total of about 75,000 acre-feet of water to agriculture in California, about 20 percent of normal. In the Klamath River Groundwater Basin this translated to a drought disaster, both for agriculture and the wildlife refuges. In addition, there were significant impacts for both coho salmon and sucker fisheries in the Klamath River watershed. As a result of the reduced surface water deliveries, significant groundwater development occurred, and groundwater extraction increased from an estimated 6,000 acre-feet in 1997 to roughly 60,000 acre-feet in 2001. Because of the complexity of the basin's water issues, a long-term Klamath Project Operation plan has not yet been finalized. Since 1995, USBR has issued an annual operation plan based on estimates of available supply. The Scott River Valley and Shasta Valley rely to a significant extent on surface water diversions. In most years, surface water supplies the majority of demand, and groundwater extraction supplements supply as needed depending on wet or dry conditions. Discussions are under way to develop strategies to conjunctively use surface water and groundwater to meet environmental, agricultural, and other demands.

Groundwater Quality

Groundwater quality characteristics and specific local impairments vary with regional setting within the North Coast HR. In general, seawater intrusion and nitrates in shallow aquifers are problems in the coastal groundwater basins; high total dissolved solids (TDS) content and general alkalinity are problems in the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese can be problems in the inland basins of Mendocino and Sonoma counties.

Water Quality in Public Supply Wells

From 1994 through 2000, 584 public supply water wells were sampled in 32 of the 63 basins and subbasins in the North Coast HR. Analyzed samples indicate that 553 wells, or 95%, met the state primary Maximum Contaminant Levels (MCL) for drinking water. Thirty-one wells, or 5%, sampled have constituents that exceed one or more MCL. Figure 26 shows the percentage of each contaminant group that exceeded MCLs in the 31 wells.

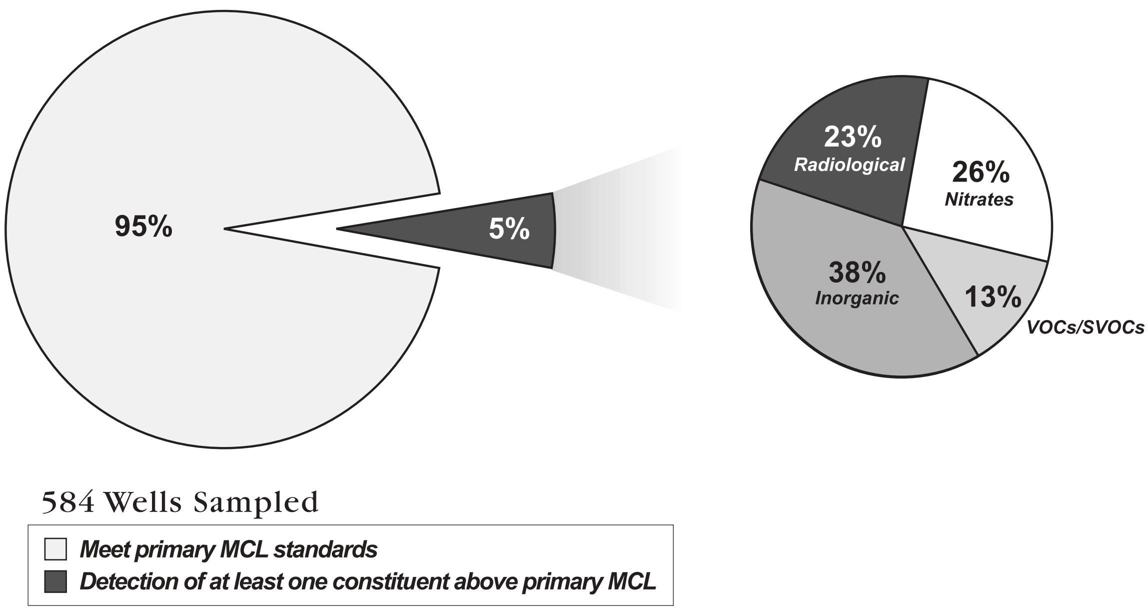

Figure 26 MCL exceedances in public supply wells in the North Coast Hydrologic Region

Table 13 lists the three most frequently occurring individual contaminants in each of the five contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 13 Most frequently occurring contaminants by contaminant group in the North Coast Hydrologic Region

Contaminant group wellsInorganics – Primary exceedance	Contaminant - # of wells Aluminum – 4	Contaminant - # of wells Arsenic – 4	Contaminant - # of 4 tied at 1
Inorganics – Secondary	Manganese – 150	Iron – 108	Copper – 2
Radiological	Radium 228 – 3	Combined RA226 + RA228 – 3	Radium 226 – 1
Nitrates	Nitrate(as NO_3) – 7	Nitrite(as N) – 1	
VOCs/SVOCs	TCE – 2	3 tied at 1 exceedance	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 14, along with other modifications to North Coast HR.

Table 14 Modifications since Bulletin 118-80 of groundwater basins in North Coast Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21
Modoc Plateau Recent Volcanic Area	deleted	1-23
Modoc Plateau Pleistocene Volcanic Area	deleted	1-24
Gualala River Valley	deleted	1-47
Wilson Grove Formation Highlands	1-59	2-25
Fort Ross Terrace Deposits	1-61	
Wilson Point Area	1-62	

Fort Ross Terrace Deposits (1-61) and Wilson Point Area (1-62) have been defined since B118-80 and are included in this update. Mad River Valley Groundwater Basin (1-8) has been subdivided into two subbasins. Sebastopol Merced Formation (2-25) merged into Basin 1-59 and was renamed Wilson Grove Formation Highlands.

There are a couple of deletions of groundwater basins from Bulletin 118-80. The Modoc Plateau Recent Volcanic Area (1-23) and the Modoc Plateau Pleistocene Volcanic Area (1-24) are volcanic aquifers and were not assigned basin numbers in this bulletin. These are considered to be groundwater source areas as discussed in Chapter 6. Gualala River Valley (1-47) was deleted because the State Water Resources Control Board determined the water being extracted in this area as surface water within a subterranean stream.

Table 15 North Coast Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-1	SMITH RIVER PLAIN	40,450	B	500	50	7	10	33	164	32 - 496
1-2	KLAMATH RIVER VALLEY									
1-2.01	UPPER KLAMATH LAKE BASIN - Tule Lake	85,930	B	3,380	1,208	40	8	5	721	140 - 2,200
1-2.02	UPPER KLAMATH LAKE BASIN - Lower Klamath	73,330	B	2,600	1,550	4	-	-	-	-
1-3	BUTTE VALLEY	79,700	B	5,000	2,358	28	13	9	310	55 - 1,110
1-4	SHASTA VALLEY	52,640	B	1,200	273	9	15	24	-	-
1-5	SCOTT RIVER VALLEY	63,900	B	3,000	794	6	10	5	258	47 - 1,510
1-6	HAYFORK VALLEY	3,300	B	200	-	-	5	-	-	-
1-7	HOOPA VALLEY	3,900	B	300	-	-	4	-	125	95 - 159
1-8	MAD RIVER VALLEY									
1-8.01	MAD RIVER VALLEY LOWLAND	25,600	B	120	72	4	9	2	184	55 - 280
1-8.02	DOWS PRAIRIE SCHOOL AREA	14,000	B	-	-	-	3	-	-	-
1-9	EUREKA PLAIN	37,400	B	1,200	-	4	4	6	177	97 - 460
1-10	EEL RIVER VALLEY	73,700	B	1,200	-	8	11	29	237	110 - 340
1-11	COVELO ROUND VALLEY	16,400	C	850	193	9	5	29	239	116 - 381
1-12	LAYTONVILLE VALLEY	5,020	A	700	7	4	3	-	149	53 - 251
1-13	LITTLE LAKE VALLEY	10,000	A	1,000	45	7	7	-	340	97 - 1,710
1-14	LOWER KLAMATH RIVER VALLEY	7,030	B	-	-	-	-	-	-	43 - 150
1-15	HAPPY CAMP TOWN AREA	2,770	B	-	-	-	-	17	-	-
1-16	SEIAD VALLEY	2,250	B	-	-	-	2	2	-	-
1-17	BRAY TOWN AREA	8,030	B	-	-	-	-	-	-	-
1-18	RED ROCK VALLEY	9,000	B	-	-	-	-	-	-	-
1-19	ANDERSON VALLEY	4,970	C	300	30	7	5	7	-	80 - 400
1-20	GARCIA RIVER VALLEY	2,240	C	-	-	-	-	-	-	-
1-21	FORT BRAGG TERRACE AREA	24,100	C	75	14	-	-	51	185	26 - 650
1-22	FAIRCHILD SWAMP VALLEY	3,300	B	-	-	-	-	-	-	-
1-25	PRAIRIE CREEK AREA	20,000	B	-	-	-	-	1	106	-
1-26	REDWOOD CREEK AREA	2,000	B	-	-	1	0	4	-	102 - 332
1-27	BIG LAGOON AREA	13,400	B	-	-	1	0	31	174	-
1-28	MATTOLE RIVER VALLEY	3,150	B	-	-	-	-	2	-	-
1-29	HONEYDEW TOWN AREA	2,370	B	-	-	-	-	1	-	-
1-30	PEPPERWOOD TOWN AREA	6,290	B	-	-	-	-	1	-	-
1-31	WEOTT TOWN AREA	3,650	B	-	-	-	-	2	-	-
1-32	GARBERVILLE TOWN AREA	2,100	B	-	-	-	-	5	-	-
1-33	LARABEE VALLEY	970	B	-	-	-	-	-	-	-
1-34	DINSMORES TOWN AREA	2,300	B	-	-	-	-	3	-	-
1-35	HYAMPOM VALLEY	1,350	B	-	-	-	-	1	-	-
1-36	HETTENSHAW VALLEY	850	B	-	-	-	-	-	-	-
1-37	COTTONEVA CREEK VALLEY	760	C	-	-	-	-	-	118	118
1-38	LOWER LAYTONVILLE VALLEY	2,150	C	-	-	-	-	-	-	-
1-39	BRANSCOMB TOWN AREA	1,320	C	-	-	-	-	-	130	80 - 179
1-40	TEN MILE RIVER VALLEY	1,490	C	-	-	-	-	-	-	-
1-41	LITTLE VALLEY	810	C	-	-	-	-	-	-	-

Table 15 North Coast Hydrologic Region groundwater data (continued)

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Types of Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
1-42	SHERWOOD VALLEY	1,150	C	-	-	-	-	-	-	-
1-43	WILLIAMS VALLEY	1,640	C	-	-	-	-	-	-	-
1-44	EDEN VALLEY	1,380	C	-	-	-	-	-	140	140
1-45	BIG RIVER VALLEY	1,690	C	-	-	-	-	2	-	-
1-46	NAVARRO RIVER VALLEY	770	C	-	-	-	-	-	-	-
1-48	GRAVELLEY VALLEY	3,000	C	-	-	-	-	3	-	-
1-49	ANAPOLIS OHLSON RANCH FOR. HIGHLANDS	8,650	C	36	-	-	0	1	260	260
1-50	KNIGHTS VALLEY	4,090	C	-	-	-	-	-	-	-
1-51	POTTER VALLEY	8,240	C	100	-	2	0	1	-	140 - 395
1-52	UKIAH VALLEY									
1-53	SANEL VALLEY	5,570	C	1,250	-	5	8	6	-	174 - 306
1-54	ALEXANDER VALLEY									
1-54.01	ALEXANDER AREA									
1-54.02	CLOVERDALE AREA	6,500	C	-	500	3	-	13	-	130 - 304
1-55	SANTA ROSA VALLEY									
1-55.01	SANTA ROSA PLAIN	80,000	A	1,500	-	43	-	155	-	-
1-55.02	HEALDSBURG AREA	15,400	C	500	-	8	-	28	-	90 - 500
1-55.03	RINCON VALLEY	5,600	C	-	-	2	-	12	-	-
1-56	McDOWELL VALLEY	1,500	C	1,200	-	-	-	-	145	143 - 146
1-57	BODEGA BAY AREA	2,680	A	150	-	-	-	6	-	-
1-59	WILSON GROVE FORMATION HIGHLANDS	81,500	C	-	-	14	-	68	-	-
1-60	LOWER RUSSIAN RIVER VALLEY	6,600	C	500 +	-	1	-	32	-	120 - 210
1-61	FORT ROSS TERRACE DEPOSITS	8,490	C	75	27	-	-	13	320	230 - 380
1-62	WILSON POINT AREA	700	B	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS = total dissolved solids

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San Francisco Bay Hydrologic Region

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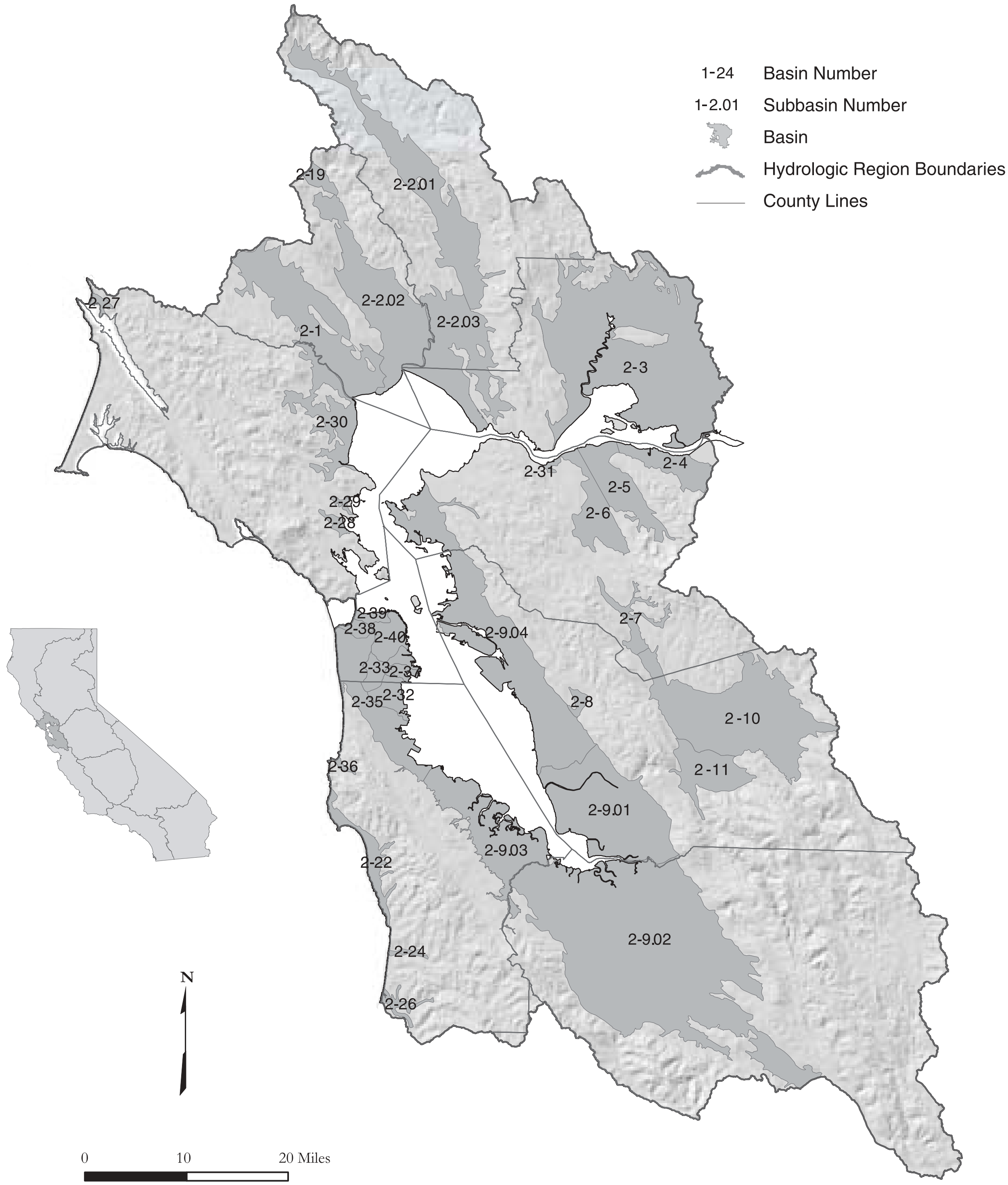

Figure 27 San Francisco Bay Hydrologic Region

Basins and Subbasins of the San Francisco Bay Hydrologic Region

Basin/subbasin	Basin name
2-1	Petaluma Valley
2-2	Napa-Sonoma Valley
2-2.01	Napa Valley
2-2.02	Sonoma Valley
2-2.03	Napa-Sonoma Lowlands
2-3	Suisun-Fairfield Valley
2-4	Pittsburg Plain
2-5	Clayton Valley
2-6	Ygnacio Valley
2-7	San Ramon Valley
2-8	Castro Valley
2-9	Santa Clara Valley
2-9.01	Niles Cone
2-9.02	Santa Clara
2-9.03	San Mateo Plain
2-9.04	East Bay Plain
2-10	Livermore Valley
2-11	Sunol Valley
2-19	Kenwood Valley
2-22	Half Moon Bay Terrace
2-24	San Gregorio Valley
2-26	Pescadero Valley
2-27	Sand Point Area
2-28	Ross Valley
2-29	San Rafael Valley
2-30	Novato Valley
2-31	Arroyo Del Hambre Valley
2-32	Visitacion Valley
2-33	Islais Valley
2-35	Merced Valley
2-36	San Pedro Valley
2-37	South San Francisco
2-38	Lobos
2-39	Marina
2-40	Downtown San Francisco

Description of the Region

The San Francisco Bay HR covers approximately 2.88 million acres (4,500 square miles) and includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda counties (Figure 27). The region corresponds to the boundary of RWQCB 2. Significant geographic features include the Santa Clara, Napa, Sonoma, Petaluma, Suisun-Fairfield, and Livermore valleys; the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Range. While being the smallest in size of the 10 HRs, the region has the second largest population in the State at about 5.8 million in 1995 (DWR 1998). Major population centers include the cities of San Francisco, San Jose and Oakland.

Groundwater Development

The region has 28 identified groundwater basins. Two of those, the Napa-Sonoma Valley and Santa Clara Valley groundwater basins, are further divided into three and four subbasins, respectively. The groundwater basins underlie approximately 896,000 acres (1,400 square miles) or about 30 percent of the entire HR.

Despite the tremendous urban development in the region, groundwater use accounts for only about 5 percent (68,000 acre-feet) of the region's estimated average water supply for agricultural and urban uses, and accounts for less than one percent of statewide groundwater uses.

In general, the freshwater-bearing aquifers are relatively thin in the smaller basins and moderately thick in the more heavily utilized basins. The more heavily utilized basins in this region include the Santa Clara Valley, Napa-Sonoma Valley, and Petaluma Valley groundwater basins. In these basins, the municipal and irrigation wells have average depths ranging from about 200 to 500 feet. Well yields in these basins range from less than 50 gallons per minute (gpm) to approximately 3,000 gpm. In the smaller basins, most municipal and irrigation wells have average well depths in the 100- to 200-foot range. Well yields in the smaller and less utilized basins are typically less than 500 gpm.

Land subsidence has been a significant problem in the Santa Clara Valley Groundwater Basin in the past. An extensive annual monitoring program has been set up within the basin to evaluate changes in an effort to maintain land subsidence at less than 0.01 feet per year (SCVWD 2001). Additionally, groundwater recharge projects have been implemented in the Santa Clara Valley to ensure that groundwater will continue to be a viable water supply in the future.

Groundwater Quality

In general, groundwater quality throughout most of the region is suitable for most urban and agricultural uses with only local impairments. The primary constituents of concern are high TDS, nitrate, boron, and organic compounds.

The areas of high TDS (and chloride) concentrations are typically found in the region's groundwater basins that are situated close to the San Francisco Bay, such as the northern Santa Clara, southern Sonoma, Petaluma, and Napa valleys. Elevated levels of nitrate have been detected in a large percentage of private wells tested within the Coyote Subbasin and Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (in the Central Coast HR) located to the south of the Santa Clara Valley (SCVWD 2001). The shallow aquifer zone within the Petaluma Valley also shows persistent nitrate contamination. Groundwater with high TDS, iron, and boron levels is present in the Calistoga area of Napa Valley, and elevated boron levels in other parts of Napa Valley make the water unfit for agricultural uses. Releases of fuel hydrocarbons from leaking underground storage tanks and spills/leaks of organic solvents at industrial sites have caused minor to significant groundwater impacts in many basins throughout the region. Methyl tertiary-butyl ether (MTBE) and chlorinated solvent releases to soil and groundwater continue to be problematic. Environmental oversight for many of these sites is performed either by local city and county enforcement agencies, the RWQCB, the Department of Toxic Substances Control, and/or the U.S. Environmental Protection Agency.

Water Quality in Public Supply Wells

From 1994 through 2000, 485 public supply water wells were sampled in 18 of the 33 basins and subbasins in the San Francisco Bay HR. Analyzed samples indicate that 410 wells, or 85 percent, met the state primary MCLs for drinking water standards. Seventy-five wells, or 15 percent, have constituents that exceed one or more MCL. Figure 28 shows the percentages of each contaminant group that exceeded MCLs in the 75 wells.

Table 16 lists the three most frequently occurring contaminants in each contaminant group and the number of wells in the HR that exceeded the MCL for those contaminants.

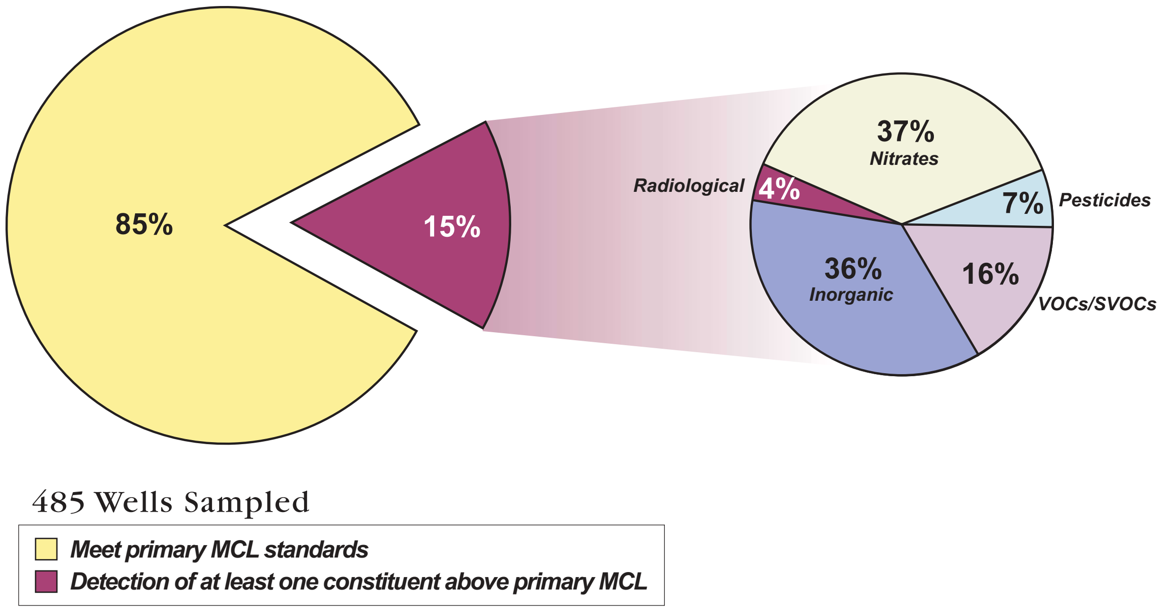

Figure 28 MCL exceedances in public supply wells in the San Francisco Bay Hydrologic Region

Table 16 Most frequently occurring contaminants by contaminant group in the San Francisco Bay Hydrologic Region

Contaminant group	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of wells
Inorganics	Iron – 57	Manganese – 57	Fluoride – 7
Radiological	Gross Alpha – 2	Radium 226 – 1	
Nitrates	Nitrate (as NO_3) – 27	Nitrate + Nitrite – 3	Nitrite (as N) – 1
Pesticides	Di(2-Ethylhexyl)phthalate – 4	Heptachlor – 1	
VOCs/SVOCs	PCE – 4	Dichloromethane – 3	TCE– 2 Vinyl Chloride – 2

TCE = Trichloroethylene
PCE = Tetrachloroethylene
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Coumpound

Changes from Bulletin 118-80

Since Bulletin 118-80 was published, RWQCB 2 boundary has been modified. This resulted in several basins being reassigned to RWQCB 1. These are listed in Table 17.

Table 17 Modifications since Bulletin 118-80 of groundwater basins in San Francisco Bay Hydrologic Region

Basin name	New number	Old number
McDowell Valley	1-56	2-12
Knights Valley	1-50	2-13
Potter Valley	1-51	2-14
Ukiah Valley	1-52	2-15
Sanel Valley	1-53	2-16
Alexander Valley	1-54	2-17
Santa Rosa Valley	1-55	2-18
Lower Russian River Valley	1-60	2-20
Bodega Bay Area	1-57	2-21

No additional basins were assigned to the San Francisco Bay HR in this revision. However, the Santa Clara Valley Groundwater Basin (2-9) has been subdivided into four subbasins instead of two, and the Napa-Sonoma Valley Groundwater Basin is now three subbasins instead of two.

There are several deletions of groundwater basins from Bulletin 118-80. The San Francisco Sand Dune Area (2-34) was deleted when the San Francisco groundwater basins were redefined in a USGS report in the early 1990s. The Napa-Sonoma Volcanic Highlands (2-23) is a volcanic aquifer and was not assigned a basin number in this bulletin. This is considered to be a groundwater source area as discussed in Chapter 6. Bulletin 118-80 identified seven groundwater basins that were stated to differ from 118-75: Sonoma County Basin, Napa County Basin, Santa Clara County Basin, San Mateo Basin, Alameda Bay Plain Basin, Niles Cone Basin, and Livermore Basin. They were created primarily by combining several smaller basins and subbasins within individual counties. This report does not consider these seven as basins. There is no change in numbering because the basins were never assigned a basin number.

Table 18 San Francisco Bay Hydrologic Region groundwater data

Basin/Subbasin	Basin Name	Area (acres)	Groundwater Budget Type	Well Yields (gpm)		Active Monitoring			TDS (mg/L)	
				Maximum	Average	Levels	Quality	Title 22	Average	Range
2-1	PETALUMA VALLEY	46,100	C	100	-	16	7	24	347	58-650
2-2	NAPA-SONOMA VALLEY									
2-2.01	NAPA VALLEY	45,900	A	3,000	223	19	10	23	272	150-370
2-2.02	SONOMA VALLEY	44,700	C	1,140	516	18	9	35	321	100-550
2-2.03	NAPA-SONOMA LOWLANDS	40,500	C	300	98	0	6	9	185	50-300
2-3	SUISUN-FAIRFIELD VALLEY	133,600	C	500	200	21	17	35	410	160-740
2-4	PITTSBURG PLAIN	11,600	C	-	-	-	-	9	-	-
2-5	CLAYTON VALLEY	17,800	C	-	-	-	-	48	-	-
2-6	YGNACIO VALLEY	15,500	C	-	-	-	-	-	-	-
2-7	SAN RAMON VALLEY	7,060	C	-	-	-	-	-	-	-
2-8	CASTRO VALLEY	1,820	C	-	-	-	-	-	-	-
2-9	SANTA CLARA VALLEY									
2-9.01	NILES CONE	57,900	A	3,000	2,000	350	120	20	-	-
2-9.02	SANTA CLARA	190,000	C	-	-	-	10	234	408	200-931
2-9.03	SAN MATEO PLAIN	48,100	C	-	-	-	2	14	407	300-480
2-9.04	EAST BAY PLAIN	77,400	A	1,000	UNK	29	16	7	638	364-1,420
2-10	LIVERMORE VALLEY	69,500	A	-	-	-	-	36	-	-
2-11	SUNOL VALLEY	16,600	C	-	-	-	-	2	-	-
2-19	KENWOOD VALLEY	3,170	C	-	-	-	-	13	-	-
2-22	HALF MOON BAY TERRACE	9,150	C	-	-	5	-	9	-	-
2-24	SAN GREGORIO VALLEY	1,070	C	-	-	-	-	-	-	-
2-26	PESCADERO VALLEY	2,900	C	-	-	3	-	4	-	-
2-27	SAND POINT AREA	1,400	C	-	-	-	-	6	-	-
2-28	ROSS VALLEY	1,770	C	-	-	-	-	-	-	-
2-29	SAN RAFAEL VALLEY	880	C	-	-	-	-	-	-	-
2-30	NOVATO VALLEY	20,500	C	-	-	-	-	1	-	-
2-31	ARROYO DEL HAMBRE VALLEY	790	C	-	-	-	-	-	-	-
2-32	VISITACION VALLEY	880	C	-	-	-	-	-	-	-
2-33	ISLAIS VALLEY	1,550	C	-	-	-	-	-	-	-
2-35	MERCED VALLEY	10,400	C	-	-	-	-	10	-	-
2-36	SAN PEDRO VALLEY	880	C	-	-	-	-	-	-	-
2-37	SOUTH SAN FRANCISCO	2,170	C	-	-	-	-	-	-	-
2-38	LOBOS	2,400	A	-	-	-	-	-	-	-
2-39	MARINA	220	A	-	-	-	-	-	-	-
2-40	DOWNTOWN SAN FRANCISCO	7,600	C	-	-	-	-	-	-	-

gpm - gallons per minute
mg/L - milligram per liter
TDS - total dissolved solids

Central Coast Hydrologic Region

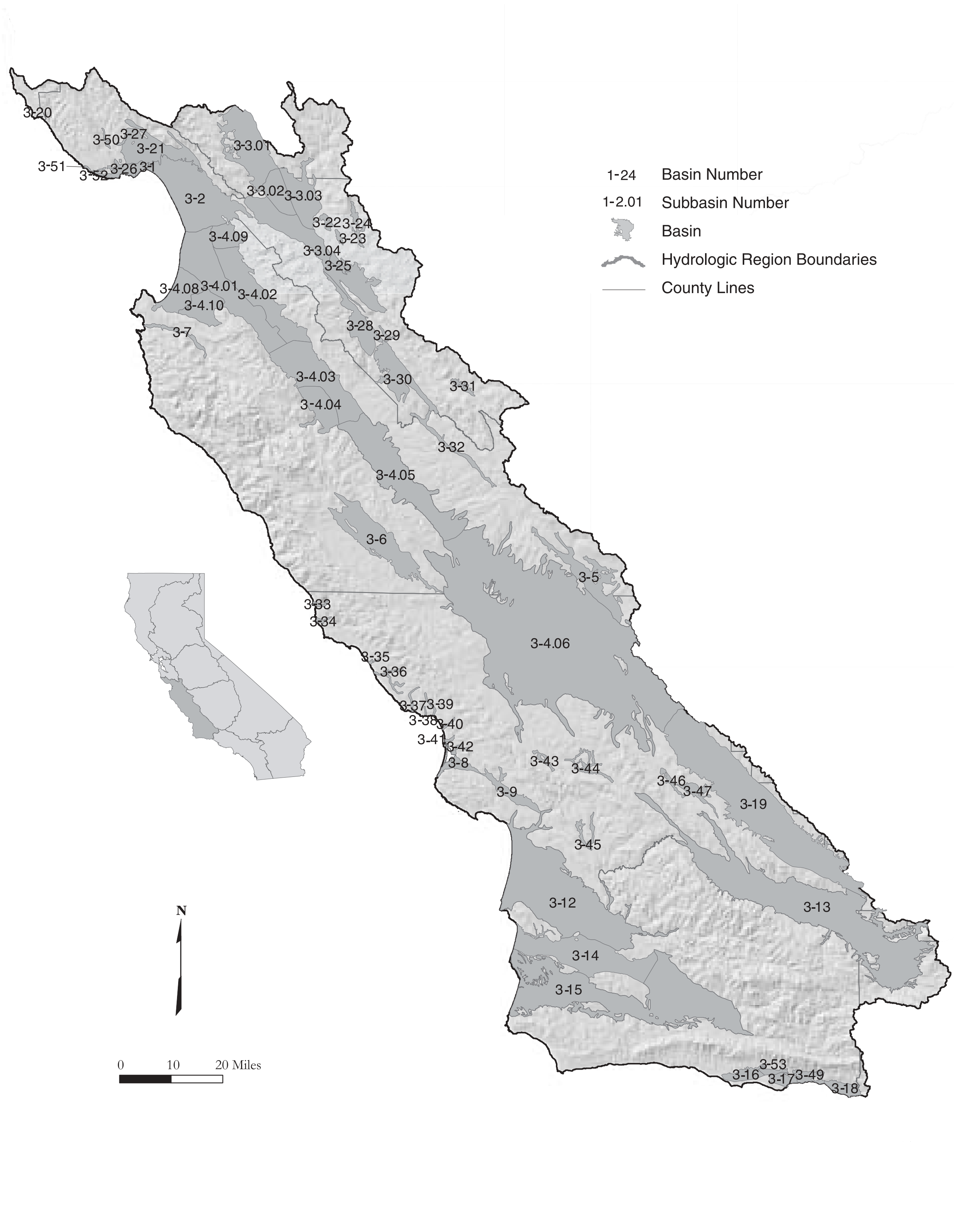

Figure 29 Central Coast Hydrologic Region

Basins and Subbasins of Central Coast Hydrologic Region

RegionBasin/ subbasin	Basin name
3-1	Soquel Valley
3-2	Pajaro Valley
3-3	Gilroy-Hollister Valley
3-3.01	Llagas Area
3-3.02	Bolsa Area
3-3.03	Hollister Area
3-3.04	San Juan Bautista Area
3-4	Salinas Valley
3-4.01	180/400 Foot Aquifer
3-4.02	East Side Aquifer
3-4.04	Forebay Aquifer
3-4.05	Upper Valley Aquifer
3-4.06	Paso Robles Area
3-4.08	Seaside Area
3-4.09	Langley Area
3-4.10	Corral de Tierra Area
3-5	Cholame Valley
3-6	Lockwood Valley
3-7	Carmel Valley
3-8	Los Osos Valley
3-9	San Luis Obispo Valley
3-12	Santa Maria River Valley
3-13	Cuyama Valley
3-14	San Antonio Creek Valley
3-15	Santa Ynez River Valley
3-16	Goleta
3-17	Santa Barbara
3-18	Carpinteria
3-19	Carrizo Plain
3-20	Ano Nuevo Area
3-21	Santa Cruz Purisima Formation
3-22	Santa Ana Valley
3-23	Upper Santa Ana Valley
3-24	Quien Sabe Valley
3-25	Tres Pinos Valley
3-26	West Santa Cruz Terrace
3-27	Scotts Valley
3-28	San Benito River Valley
3-29	Dry Lake Valley
3-30	Bitter Water Valley
3-31	Hernandez Valley
3-32	Peach Tree Valley
3-33	San Carpoforo Valley
3-34	Arroyo de la Cruz Valley

RegionBasin/ subbasin	Basin name
3-35	San Simeon Valley
3-36	Santa Rosa Valley
3-37	Villa Valley
3-38	Cayucos Valley
3-39	Old Valley
3-40	Toro Valley
3-41	Morro Valley
3-42	Chorro Valley
3-43	Rinconada Valley
3-44	Pozo Valley
3-45	Huasna Valley
3-46	Rafael Valley
3-47	Big Spring Area
3-49	Montecito
3-50	Felton Area
3-51	Majors Creek
3-52	Needle Rock Point
3-53	Foothill

Description of the Region

The Central Coast HR covers approximately 7.22 million acres (11,300 square miles) in central California (Figure 29). This HR includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura counties. Significant geographic features include the Pajaro, Salinas, Carmel, Santa Maria, Santa Ynez, and Cuyama valleys; the coastal plain of Santa Barbara; and the Coast Range. Major drainages in the region include the Salinas, Cuyama, Santa Ynez, Santa Maria, San Antonio, San Lorenzo, San Benito, Pajaro, Nacimiento, Carmel, and Big Sur Rivers.

Population data from the 2000 Census suggest that about 1.4 million people or about 4 percent of the population of the State live in this HR. Major population centers include Santa Barbara, Santa Maria, San Luis Obispo, Gilroy, Hollister, Morgan Hill, Salinas, and Monterey.

The Central Coast HR has 50 delineated groundwater basins. Within this region, the Gilroy-Hollister Valley and Salinas Valley groundwater basins are divided into four and eight subbasins, respectively. Groundwater basins in this HR underlie about 2.390 million acres (3,740 square miles) or about one-third of the HR.

Groundwater Development

Locally, groundwater is an extremely important source of water supply. Within the region, groundwater accounted for 83 percent of the annual supply used for agricultural and urban purposes in 1995. For an average year, groundwater in the region accounts for about 8.4 percent of the statewide groundwater supply and about 1.3 percent of the total state water supply for agricultural and urban needs. In drought years, groundwater in this region is expected to account for about 7.2 percent of the statewide groundwater supply and about 1.9 percent of the total State water supply for agricultural and urban needs (DWR 1998).

Aquifers are varied and range from large extensive alluvial valleys with thick multilayered aquifers and aquitards to small inland valleys and coastal terraces. Several of the larger basins provide a dependable and drought-resistant water supply to coastal cities and farms.

Conjunctive use of surface water and groundwater is a long-standing practice in the region. Several reservoirs including Hernandez, Twitchell, Lake San Antonio, and Lake Nacimiento are operated primarily for the purpose of groundwater recharge. The concept is to maintain streamflow over a longer period than would occur without surface water storage and thus provide for increased recharge of groundwater. Seawater intrusion is a major problem throughout much of the region. In the Salinas Valley Groundwater Basin, seawater intrusion was first documented in the 1930s and has been observed more than 5 miles inland.

Groundwater Quality

Much of the groundwater in the region is characterized by calcium sulfate to calcium sodium bicarbonate sulfate water types because of marine sedimentary rock in the watersheds. Aquifers intruded by seawater are typically characterized by sodium chloride to calcium chloride, and have chloride concentrations greater than 500 mg/L. In several areas, groundwater exceeds the MCL for nitrate.

Water Quality in Public Supply Wells

From 1994 through 2000, 711 public supply water wells were sampled in 38 of the 60 basins and subbasins in the Central Coast HR. Analyzed samples indicate that 587 wells, or 83 percent, met the state primary MCLs for drinking water. One-hundred-twenty-four wells, or 17 percent, have constituents that exceed one or more MCL. Figure 30 shows the percentages of each contaminant group that exceeded MCLs in the 124 wells.

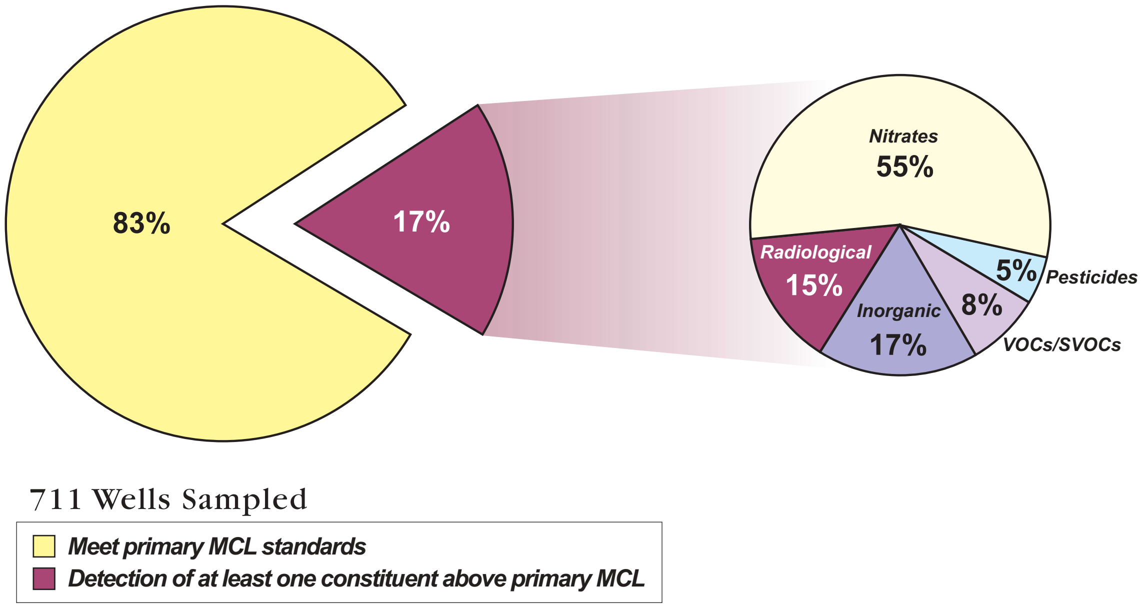

Figure 30 MCL exceedances in public supply wells in the Central Coast Hydrologic Region

Table 19 lists the three most frequently occurring contaminants in each of the six contaminant groups and shows the number of wells in the HR that exceeded the MCL for those contaminants.

Table 19 Most frequently occurring contaminants by contaminant group in the Central Coast Hydrologic Region

Contaminant group wells	Contaminant - # of wells	Contaminant - # of wells	Contaminant - # of
Inorganics – Primary	Antimony – 6	Aluminum – 4	Chromium (Total) – 4
Inorganics – Secondary	Iron – 145	Manganese – 135	TDS – 11
Radiological	Gross Alpha – 15	Radium 226 – 3	Uranium – 3
Nitrates	Nitrate (as NO_3) – 69	Nitrate + Nitrite – 24	
Pesticides	Heptachlor – 4	Di (2-Ethylhexyl) phthalate – 2	
VOCs/SVOCs	TCE – 3	3 are tied at 2 exceedances	

TCE = Trichloroethylene
VOC = Volatile Organic Compound
SVOC= Semivolatile Organic Compound

Changes from Bulletin 118-80

Four new basins have been defined since Bulletin 118-80. They are Felton Area, Majors Creek, Needle Rock Point, and Foothill groundwater basins. Additionally, new subbasins have been broken out in both the Gilroy-Hollister Valley Groundwater Basin (3-3) and the Salinas Valley Groundwater Basin (3-4) (Table 20).

Table 20 Modifications since Bulletin 118-80 of groundwater basins and subbasins in Central Coast Hydrologic Region

Subbasin name	New number	Old number
Llagas Area	3-3.01	3-3
Bolsa Area	3-3.02	3-3
Hollister Area	3-3.03	3-3
San Juan Bautista Area	3-3.04	3-3
180/400 Foot Aquifer	3-4.01	3-4
East Side Aquifer	3-4.02	3-4
Upper Forebay Aquifer	3-4.04	3-4
Upper Valley Aquifer	3-4.05	3-4
Pismo Creek Valley Basin	3-12	3-10
Arroyo Grande Creek Basin	3-12	3-11
Careaga Sand Highlands Basin	3-12 and 3-14	3-48
Felton Area	3-50	
Majors Creek	3-51	
Needle Rock Point	3-52	
Foothill	3-53	

Pismo Creek Valley Basin (3-10) and Arroyo Grande Creek Basin (3-11) have been merged into the Santa Maria River Valley Basin (3-12).
Careaga Sand Highlands Basin (3-48) has been merged into the Santa Maria River Valley Basin (3-12) and San Antonio Creek Valley Basin (3-14).