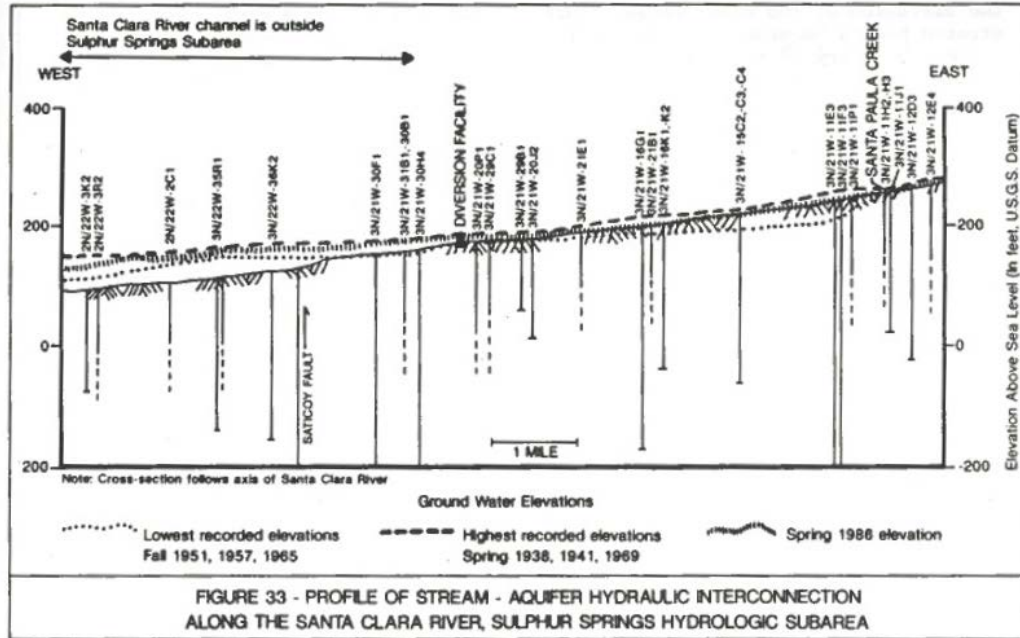


GROUNDWATER RESOURCE MANAGEMENT FUNDAMENTALS: GROUNDWATER BASIN CONNECTIVITY

Open-File Report 2014-03
May 2014



from CA Department of Water Resources, 1989

THIS REPORT IS PRELIMINARY AND IS SUBJECT TO MODIFICATION BASED
UPON FUTURE ANALYSIS AND EVALUATION

PREPARED BY
GROUNDWATER
RESOURCES
DEPARTMENT



UNITED WATER
CONSERVATION DISTRICT

GROUNDWATER RESOURCE MANAGEMENT FUNDAMENTALS: GROUNDWATER BASIN CONNECTIVITY

United Water Conservation District
Open-File Report 2014-03

**PREPARED BY
GROUNDWATER RESOURCES DEPARTMENT
MAY 2014**

THIS REPORT IS PRELIMINARY AND IS SUBJECT TO MODIFICATION BASED
UPON FUTURE ANALYSIS AND EVALUATION

Cover Photo: Figure 33 from Update of Basin Plan for Piru, Fillmore, and Santa Paula Hydrologic Areas: Final Project Report, 1989, California Department of Water Resources

Preferred Citation: United Water Conservation District, 2014, Groundwater Resource Management Fundamentals: Groundwater Basin Connectivity, United Water Conservation District Open-File Report 2014-03.

GROUNDWATER RESOURCE MANAGEMENT FUNDAMENTALS: GROUNDWATER BASIN CONNECTIVITY

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	GROUNDWATER BASIN HYDROLOGIC CONNECTION	2
2.1	HISTORICAL PERSPECTIVE	2
2.2	RECENT INVESTIGATIONS	5
2.2.1	STEVE BACHMAN	6
2.2.2	CH2M HILL - HGL.....	6
2.2.3	FOX CANYON GROUNDWATER MANAGEMENT AGENCY	6
2.2.4	HOPKINS GROUNDWATER CONSULTANTS	6
2.2.5	SANITATION DISTRICTS OF LOS ANGELES COUNTY.....	7
2.2.6	VENTURA COUNTY WATERSHED PROTECTION.....	7
3	REFERENCES.....	7

GROUNDWATER RESOURCE MANAGEMENT FUNDAMENTALS: GROUNDWATER BASIN CONNECTIVITY

UWCD OPEN-FILE REPORT 2014-03

EXECUTIVE SUMMARY / ABSTRACT

As water resource management strategies, in particular those for groundwater resources, are being developed at the State, county, and local levels in response to the current drought conditions, it is important to recognize the regional nature of this resource in Ventura County. The groundwater basins within United Water Conservation District are known to be interconnected so that actions in one basin (e.g., groundwater extraction, recharge, precipitation) have impacts on the immediate area but also on downgradient basins. This concept of groundwater basin connectivity in Ventura County is not new, and has been known to researchers, practitioners, and water management agencies for many decades.

1 INTRODUCTION

As Ventura County and the rest of the State of California continue to deal with drought conditions there is an increased interest and reliance on groundwater resources. Over the past decade or so the CA Department of Water Resources and others have promoted water supply planning by watershed groups or other local entities, and this approach has generally been accepted by planners and stakeholders. In Ventura County, there is significant groundwater flow between defined groundwater basins both within and between watersheds, and stream flow in the dry seasons is commonly dependent on groundwater discharges to stream channels. Groundwater flow between connected subbasins has long been recognized in southern Ventura County, most notably in the groundwater basins that underlie the watersheds of the Santa Clara River and Calleguas Creek.

The intent of this Open-File Report is to document the historical evolution of the concept of the hydrologic connectivity of groundwater basins in the Santa Clara River valley and the Oxnard Plain coastal area, and to summarize the underlying scientific data supporting the hydrologic connectivity principle. The idea of groundwater basin connectivity is not new, and in fact, predates the formation of United Water Conservation District (United), but is a concept that is embraced by United as a key tenet of their groundwater management activities. As a primary groundwater management entity for the Santa Clara River valley and Oxnard Plain area, United has extensive datasets supporting the concept of groundwater flow or movement (i.e., connectivity) between the subbasins in its jurisdiction.

The current drought conditions being experienced in Ventura County have reinvigorated a desire by several entities to develop basin-wide or regional water supply management plans. Clearly, the hydrologic relationships between the groundwater basins are important factors for recognition in water supply management plans. The effects of groundwater extraction or wastewater discharge, for example, impact downgradient subbasins and respective stakeholders. Recognition of this important hydrologic relationship is fundamental to creating long-term sustainable groundwater resource management strategies.

The current regulatory setting in California includes several attempts to “manage” groundwater resources or water resource, in general, but those attempts are often focused at a local level (e.g., Urban Water Management Plans, Agricultural Water Management Plans) that do not account for the regional nature of this resource. These “entity-specific” plans are not, by themselves, sufficient for water resource sustainability planning purposes as they frequently ignore or minimize the importance of the regional nature of the hydrologic system.

This Open-File Report has been prepared to provide Ventura County water resource management agencies (e.g., Fox Canyon Groundwater Management Agency, Ventura County Watershed Protection District, United Water Conservation District) and local municipalities and businesses that may be stakeholders in the development of water resource management and sustainability plans a guiding framework for thinking about how the hydrologic systems in the Santa Clara River valley and the greater Oxnard Plain coastal area function.

2 GROUNDWATER BASIN HYDROLOGIC CONNECTION

The hydrologic interconnection between the subbasins within the boundary of United has been accepted by major regulatory and research organizations (e.g., CA State Water Resources Control Board [and predecessors such as CA Division of Water Rights and Division of Water Resources], CA Department of Water Resources, Ventura County Watershed Protection District, U.S. Geological Survey) active in the area. The following sections highlight some of the more significant historical studies, as well as documenting the ongoing acceptance of the connectivity concept in more recent technical studies.

2.1 HISTORICAL PERSPECTIVE

As population, industry and agriculture expanded in Ventura County in the early 20th century, it soon became apparent that a reliable water supply was a limiting factor. Numerous applications were filed with the California Division of Water Resources to appropriate water from one watershed to another, including proposals to deliver water from Piru and Sespe Creeks to the Moorpark area and to divert water from the upper Sespe drainage for use in the Ventura River watershed. California officials found it necessary to study the water resources of the County before ruling on the various applications for water rights. The initial *Ventura County Investigation* was conducted by Richard Jamison and published by the CA Division of Water Rights in 1928. This publication was

largely a study of surface watersheds to identify potential dam sites and estimate yields, with sparse discussion of groundwater. A second publication with the same title was printed in 1933, as Bulletin No. 46 of the CA Division of Water Resources. The 1933 Bulletin 46 included considerations of groundwater resources, the percolation of streamflow, and relationships between surface water and groundwater resources. Another significant advancement was the concept of the regional resources of the Santa Clara watershed operating as part of a single large system: “the Coastal Plain derives its natural supply from overflow of water which has percolated into the Santa Clara River Valley and also from percolation of floods crossing Montalvo Basin [Oxnard Forebay]. As development increases in the valley, supply to the plain decreases.”

In the late 1940s the region experienced several years of below-normal precipitation. Seawater intrusion was recognized as a serious threat to the groundwater resources of the Oxnard Plain at this time, and the local population was growing in this period of post-war American prosperity. The California State Water Resources Control Board published a 1953 update to Bulletin No. 12, *Ventura County Investigation*, which included details from more recent investigations on the groundwater resources of the region. The bulletin introduces the seven basins of the Santa Clara River Hydrologic Unit as the most important in Ventura County. Consistent with earlier investigations, groundwater occurring in the Piru, Fillmore, Santa Paula, and Oxnard Forebay Basins is classified as unconfined, while the aquifers of the Mound, Oxnard Plain and Pleasant Valley Basins are confined by clay beds of low permeability. Recharge mechanisms for the unconfined basins are identified (“The unconfined ground water basins are replenished by percolation of flow in the Santa Clara River and its tributaries, percolation of direct precipitation, artificial spreading and percolation of surface waters, and by percolation of the unconsumed residuum of water applied for irrigation and other uses”) and recharge to the confined aquifers of the Mound, Oxnard Plain, and Pleasant Valley Basins is noted to be “largely supplied by subsurface flow from areas of free ground water.” The major mechanisms for groundwater losses from the basins are also identified (“Ground water in the seven major basins of the Santa Clara River Hydrologic Unit is disposed of by effluent discharge to lower basins, by pumped extractions to meet beneficial consumptive uses, by consumptive use of phreatophytes in areas of high ground water, and by subsurface flow to lower basins and to the ocean”).

The 1953 update of Bulletin 12 includes discussion of the Mound basin, which had previously been mapped as portions of the Oxnard Plain and Montalvo basins. The Mound basin discussion includes comments on groundwater recharge and flow (“Ground water flow in the Mound Basin moves under pressure, generally in a south-westerly direction, from Santa Paula Basin and from areas of outcrop of the San Pedro formation which receives percolation of direct precipitation and stream flow in minor watercourses”) and groundwater exchange with adjacent basins (“Examination of ground water contour maps indicates that there may also be subsurface inflow to and outflow from the Oxnard Plain Basin through the San Pedro formation, depending on the relative ground water levels in the Mound and Oxnard Plain Basins”). The report acknowledges uncertainties regarding interpretation of the geology and hydrology of the Mound basin, but concludes “that the primary recharge of the basin is by subsurface inflow through the San Pedro formation from the Santa Paula Basin, and that the contribution from the outcrop of the San Pedro formation to the

north of the basin is of secondary magnitude”. The concept that not just surface water flow but also groundwater flow from higher elevations within the watershed serves to recharge the downstream basins is prevalent within the publication.

In addition to these early public investigations, local water agencies were also studying the watershed and the groundwater basins for water resource management options. The Santa Clara Water Conservation District (SCWCD) was established in 1927, and by 1931 was operating groundwater recharge facilities in the Oxnard Forebay near Saticoy and along Santa Paula Creek. The SCWCD was active in efforts to prevent the appropriation of water to areas outside the watershed of the Santa Clara River. Engineering staff from SCWD worked under a formal Tri-Party Agreement with Ventura County and the California Division of Water Resources to complete the technical work presented in *Bulletin 12: Ventura County Investigation* (CA DWR, 1953). One of the findings of that joint investigation was that the water resources native to Ventura County were inadequate to support existing use, and that the importation of water from other areas was required to support the growing population and economy.

The recognition that a serious problem of overdraft and seawater intrusion already exists in coastal areas motivated the reorganization of the SCWCD into United Water Conservation District (United). United was established in 1950, and all assets of the SCWCD were transferred to the new agency by 1952. United had a much greater bonding capacity than the SCWCD, as urban parcels within the district now contributed funding to the district via property tax assessments. United promptly put its new bonding capacity to use when local voters approved the construction of the Santa Felicia dam on Piru Creek, with the understanding that “the entire Coastal Plain is dependent upon the Santa Clara River system for its water supply.” United also recognized that the groundwater basins within the district boundaries operated as components of a large hydrologic system, and that the water-bearing materials of the “alluvial formation not only underlies the entire Santa Clara Valley but also extends beneath the Coastal Plain from Saticoy to Ventura and Point Mugu” (Hinds, 1957).

With extensive study of the surface water yields of the tributaries of the Santa Clara River already completed by the various Ventura County investigations, United hired the esteemed groundwater geologist John F. Mann to further investigate the groundwater basins of the District. Dr. Mann’s 1959 report estimated potential groundwater yields from the various basins, delineated specific aquifer units, and reported on water quality problems specific to some aquifers and locations. Mann’s report detailed the occurrence of groundwater underflow between the various groundwater basins within the district. Earlier reports had commonly focused on rising water and gains in surface water flow around basin boundaries, and less on the subsurface flow at these constrictions in the groundwater flow system.

Following an extended period of population growth and several dry years in the mid-1970s, the California Department of Water Resources published Bulletin 118-80, *Ground water basins in California*. This publication introduced the “Ventura Central Basin” and reasoned “the four valleys identified in Bulletin 118 (1975) as the Santa Clara River Valley, Pleasant Valley, Arroyo Santa Rosa Valley and Las Posas Valley are contiguous and hydrologically continuous” and stated

“ground water moves into the Santa Clara River Valley from the other three valleys, particularly into the Oxnard Plain.” This change in naming convention sourced from a recognition that the local groundwater basins are more appropriately considered subbasins of a larger regional system. Bulletin 118-80 also identified the Ventura Central Basin as a basin “subject to critical conditions of overdraft” (defined as: “a basin is subject to critical conditions of overdraft when continuation of present water management practices would result in significant adverse overdraft-related environmental, social, or economic impacts”). This designation by the state was one of the factors that motivated the creation of the Fox Canyon Groundwater Management Agency (GMA) to address local groundwater overdraft issues.

In the late 1980s, with financial support from United, Calleguas MWD, and the Fox Canyon GMA, the U.S. Geological Survey (USGS) began a major investigation of the regional alluvial-aquifer systems of the Santa Clara River and Calleguas Creek watersheds. The study of the hydrogeology of the Santa Clara-Calleguas Basin was completed as part of the Southern California Regional Aquifer-System Analysis (RASA) Program. The regional groundwater system in southern Ventura County was selected as a representative southern California basin for study, with cultural practices and geohydrologic processes common to other basins or groups of basins. Publications from the RASA study noted that “the onshore part of the Santa Clara-Calleguas alluvial basin is about 32 mi long and includes about 310 mi²” and that “the Santa Clara-Calleguas Basin is a regional groundwater basin that can be divided into 12 onshore subbasins” (USGS, 2003). These themes were of course by now familiar concepts within the study area.

Some years later, United again contracted the USGS (1998) to study the subbasins of the Santa Clara River Valley, this time focusing on the interaction between surface water and groundwater. The USGS report summarized “...the groundwater system and stream aquifer interactions along the Santa Clara River” and contained additional technical discussions of the hydrologic conditions (e.g., rising groundwater at subbasin boundaries, correlations of water quality with surface water flow magnitudes, interaction between various aquifers) in the Santa Clara River valley.

2.2 RECENT INVESTIGATIONS

United’s understanding of the hydrologic interactions within the District has been guided by the early researchers summarized previously. Subsequent studies by researchers, regulatory agencies, as well as practitioners (e.g., groundwater consultants) have substantiated these interactions and helped refine the concepts on how the connectivity between surface water and groundwater resources, and the well documented connectivity between groundwater basins, are important considerations for strategic water resource management strategies. The following sections provide brief summaries of some of the more recent studies and Table 1 includes a list of several studies that have discussed the movement of groundwater between subbasins, but the list is not intended to be exhaustive of all technical reports.

2.2.1 STEVE BACHMAN

Bachman (2013) included discussions of groundwater movement across basin boundaries, the continuity of aquifers, and the influence of surface water quality on groundwater quality in support of modeling efforts for the Northern Pleasant Valley Desalter.

2.2.2 CH2M HILL - HGL

Groundwater modeling efforts to support the Upper Santa Clara River Chloride TMDL Collaborative Process (CH2M-Hill HGL 2006, 2008) were performed using a connected groundwater subbasin conceptual model where groundwater and surface water traveled from the Eastern basin (Upper Santa Clara River area) into the Piru and ultimately the Fillmore subbasins.

2.2.3 FOX CANYON GROUNDWATER MANAGEMENT AGENCY

The Groundwater Management Plan (2007) prepared by the Fox Canyon Groundwater Management Agency includes descriptions of aquifers (e.g., Fox Canyon aquifer) that extend through multiple groundwater subbasins, as well as groundwater movement between basins. The plan discussed groundwater flow from the Forebay to the Oxnard Plain subbasin and Pleasant Valley basin.

2.2.4 HOPKINS GROUNDWATER CONSULTANTS

Hopkins (2011) includes a map showing generalized groundwater flow from Santa Paula subbasin to the adjoining Forebay, Oxnard Plain, and Mound subbasins.

Hopkins (2012a) discusses groundwater quality in the Saticoy area and develops the following conclusions regarding poor quality [ground] water movement between subbasins:

“This same poor quality water [from the Santa Paula basin] cascades across the basin boundaries and has been observed to seasonally affect the quality of groundwater along the northern boundary of the Oxnard Forebay Basin, and may also be impacting the Mound Basin.”

A 2013 Hopkins report discussing the recycled water master plan for the City of Ventura includes groundwater elevation contouring indicating the movement of groundwater from the Santa Paula subbasin to adjacent subbasins.

Groundwater flow from the East Las Posas basin to the Pleasant Valley basin was deduced from groundwater elevation, water chemistry and isotopic analyses in Hopkins (2008).

Recharge of the Santa Paula basin by underflow from the Fillmore basin and movement of groundwater from the Santa Paula basin to the downgradient basins is recognized in Hopkins (2012b).

2.2.5 SANITATION DISTRICTS OF LOS ANGELES COUNTY

As part of the chloride TMDL mitigation project, the Sanitation District of Los Angeles County commissioned various studies (e.g., SDLAC, 2013) on the groundwater conditions in the Upper Santa Clara River Valley that extended into the Piru and Fillmore groundwater basins. These reports highlighted the movement of groundwater and surface water across subbasin boundaries in particular focusing on how groundwater movement impacted water quality.

2.2.6 VENTURA COUNTY WATERSHED PROTECTION

The Groundwater Section Annual Report produced by this agency has historically included groundwater elevation contour maps depicting the flow between basins. Their 2013 Annual Report, for example, includes the following statement:

“Following a review of information regarding the Mound Basin boundaries contained in United Water Conservation District’s open File Report 2012-01 and DWR Bulletin 118, it appears that the existing mapped boundaries may not in fact be complete barriers to groundwater flow. We have decided to continue potentiometric surface lines across the southern mapped Mound Basin boundary for the upper and lower system, and across the Santa Paula/Mound Basin Boundary for the upper system in this report. Doing so still demonstrates the boundary condition at the Santa Paula Basin and Mound Basin boundary, while providing information about water levels in the Oxnard Plain and Mound Basin on the same map.”

3 REFERENCES

- Bachman, Steve, 2013, Northern Pleasant Valley Desalter Groundwater Analysis and Modeling Final Report: prepared for Desalter Working Group, report dated December 2013.
- California Department of Water Resources, 1965, Bulletin No. 63-1, Sea Water Intrusion, Oxnard Plain of Ventura County.
- California Division of Water Rights, 1928, Ventura County Investigation, 228 p.
- CH2M-Hill HGL, 2006, Final Report: Task 2A – Conceptual Model Development, East and Piru Subbasins, Upper Santa Clara River Chloride TMDL Collaborative Process: prepared for Sanitation District of Los Angeles County and Los Angeles Regional Water Quality Control Board, report dated October 2006.
- CH2M-Hill HGL, 2008, Final Report: Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins, Upper Santa Clara River Chloride TMDL Collaborative Process: prepared for Sanitation District of Los Angeles County and Los Angeles Regional Water Quality Control Board, report dated March 2008.
- Fox Canyon Groundwater Management Agency, 2007, Update to the Fox Canyon Groundwater Management Agency Groundwater Management Plan: prepared by Fox Canyon

- Groundwater Management Agency, United Water Conservation District, and Calleguas Municipal Water District, report dated May 2007.
- Hanson, R.T., Martin, P., and Koczot, K.M., 2003, Simulation of Ground-Water/Surface-Water Flow in the Santa Clara –Calleguas Ground-Water Basin, Ventura County, California, U.S. Geological Survey, Water-Resources Investigations Report 02-4136, 157 p.
- Hopkins Groundwater Consultants, Inc., 2008, Preliminary Hydrogeological Study – Northeast Pleasant Valley Basin Surface Water and Groundwater Study, Somis, California: prepared for Calleguas Municipal Water District, report dated November 2008.
- Hopkins Groundwater Consultants, Inc., 2011, Review of Hydrogeological Conditions Pertinent to the United Water Conservation District 2011 Water Rate Study Dated February 2, 2011, report dated June 2011, report prepared for City of San Buenaventura
- Hopkins Groundwater Consultants, Inc., 2012a, Saticoy Groundwater Conditions Study, Ventura, California: prepared for Ventura Regional Sanitation District, report dated November 2012.
- Hopkins Groundwater Consultants, Inc., 2012b, Historical Changes in Santa Paula Basin Conditions Contributing to Long-Term Water Level Variations, Santa Paula, California: prepared for City of San Buenaventura, report dated September 2012.
- Hopkins Groundwater Consultants, Inc., 2013, Preliminary Hydrogeological Study – Recycled Water Master Plan, Groundwater Replenishment and Reuse Project, Ventura, California: prepared for the City of San Buenaventura, report dated January 2013.
- Mann, J.F., Jr., 1959, A plan for ground water management, United Water Conservation District: Report to United Water Conservation District, 120 p.
- Mukae, M., and Turner, J., 1975, Ventura County Water Resources Management Study, Geologic Formations, Structures and History in the Santa Clara-Calleguas Area, in Compilation of Technical Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 28 p.
- Price, Jr., Wm. P, 1957, Water Development Plans of the United Water Conservation District, A Report to the Board of Directors United Water Conservation District, report dated April 1957.
- Sanitation District of Los Angeles County, 2013, Santa Clarita Valley Sanitation District Chloride Compliance Facilities Plan and Environmental Impact Report: report dated October 2013.
- State of California Department of Public Works: Division of Water Resources, 1933, Edward Hyatt, State Engineer, Bulletin No. 46: Ventura County Investigation.
- State Water Resources Control Board, 1953, Bulletin No. 12, Ventura County Investigation.
- Turner, J.M., 1975, Aquifer delineation in the Oxnard-Calleguas area, Ventura County, in Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 45 p.
- U.S. Geological Survey, 1998, Evaluations of Surface-Water/Ground-Water Interactions in the Santa Clara River Valley, Ventura County, California: USGS Water Resources Investigation Report 98-4208.

Table 1 - Groundwater Basin Hydrologic Connection

Representative References		Surface Water - Groundwater Interaction	Watershed Interconnectivity	Groundwater Basin Connectivity				
				SCR Basins (a)	Coastal Basins (b)	Santa Paula, Forebay, Mound basins	Forebay, Oxnard Plain, Pleasant Valley	Las Posas, Pleasant Valley, Oxnard Plain
California Division of Water Rights, 1928, Ventura County Investigation, 228 p.	1928	X	X					
Ventura County Investigation, 1933, CA Division of Water Resources, Bulletin 46	1933	X	X	X	X			
State of California Department of Public Works: Division of Water Resources, 1933, Edward Hyatt, State Engineer, Bulletin No. 46: Ventura County Investigation.	1933	X	X	X	X	X	X	X
Mann, Jr., John F., 1952, Overdraft on the Deep Aquifer in Pleasant Valley and Possibilities of Recharge by Spreading, report dated July 1952, report prepared for United Water Conservation District	1952						X	X
Ventura County Investigation, 1953, CA State Water Resources Control Board, Bulletin 12	1953	X	X	X	X			
Hinds, Julian, 1953, Investigations, Plans, and Estimates for a Supplemental Water Supply in the Santa Clara Valley and Vicinity	1953	X	X	X	X			
Price, Jr., Wm. P., Water Development Plans for UWCD, 1957, report from General Manager and Chief Engineer to Board of Directors	1957	X	X	X	X	X		
A Plan for Groundwater Development, 1959, Dr. John Mann	1959	X	X	X	X			
Geotechnical Consultants, Inc., 1972, Hydrogeological Investigation of the Mound Ground Water Basin, prepared for the City of San Buenaventura	1972	X		X		X		
Ground-Water Basins of California, 1975, CA Department of Water Resources, Bulletin 118	1975	X	X	X	X			
Mukae, M., and Turner, J., 1975, Ventura County Water Resources Management Study, Geologic Formations, Structures and History in the Santa Clara-Calleguas Area, in Compilation of Technical Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 28 p.	1975	X	X	X	X	X	X	X
Turner, J.M., 1975, Aquifer delineation in the Oxnard-Calleguas area, Ventura County, in Compilation of Technical Information Records for the Ventura County Cooperative Investigation: California Department of Water Resources, 45 p.	1975	X	X		X	X	X	X
Ground-Water Basins of California, 1980, CA Department of Water Resources, Bulletin 118	1980	X	X	X	X			
Mukae, Mike, 1988, General Geology and Groundwater Occurrence within Calleguas Municipal Water District Service Area: progress report 6, 1988, prepared for Metropolitan Water District.	1988	X	X					X
Update of Basin Plan for Piru, Sespe, and Santa Paula Hydrologic Areas: Final Project Report, 1989, CA Department of Water Resources	1989	X	X	X				
Staal Gardner & Dunne, Inc., 1992, Assessment of Hydrogeologic Impacts, City of San Buenaventura Saticoy Well No. 3, Ventura, California, report dated December 1992, report prepared for City of San Buenaventura Engineering Department	1992					X		
Izbicki, John, 1996, Source, Movement, and Age of Ground Water in a Coastal California Aquifer: U.S. Geological Survey Fact Sheet 126-96.	1996	X			X		X	
Fugro, 1996, Calendar Year 1995 Annual Report, Mound Ground Water Basin, Ventura County, California, report dated May 1996, report prepared for City of San Buenaventura	1996					X		
U.S. Geological Survey, 1998, Evaluations of Surface-Water/Ground-Water Interactions in the Santa Clara River Valley, Ventura County, California: USGS Water Resources Investigation Report 98-4208.	1998	X	X	X	X	X	X	X
Ground-Water Basins of California, 2003, CA Department of Water Resources, Bulletin 118	2003	X	X	X	X			
Simulation of Ground-Water / Surface-Water Flow in the Santa Clara - Calleguas Ground-Water Basin, Ventura County, CA, 2003, U.S. Geological Survey Water Resource Investigations Report 02-4136	2003	X	X	X	X	X	X	
CH2M-Hill HGL, 2006, Final Report: Task 2A – Conceptual Model Development, East and Piru Subbasins, Upper Santa Clara River Chloride TMDL Collaborative Process: prepared for Sanitation District of Los Angeles County and Los Angeles Regional Water Quality Control Board, report dated October 2006.	2006	X		X				
Fox Canyon Groundwater Management Agency, 2007, Update to the Fox Canyon Groundwater Management Agency Groundwater Management Plan: prepared by Fox Canyon Groundwater Management Agency, United Water Conservation District, and Calleguas Municipal Water District, report dated May 2007.	2007	X	X		X		X	X
Hopkins Groundwater Consultants, 2008, Preliminary Hydrogeological Study – Northeast Pleasant Valley Basin Surface Water and Groundwater Study, Somis, California: prepared for Calleguas Municipal Water District, report dated November 2008.	2008						X	X
CH2M-Hill HGL, 2008, Final Report: Task 2B-1 – Numerical Model Development and Scenario Results, East and Piru Subbasins, Upper Santa Clara River Chloride TMDL Collaborative Process: prepared for Sanitation District of Los Angeles County and Los Angeles Regional Water Quality Control Board, report dated March 2008.	2008	X	X					
Hopkins Groundwater Consultants, 2011, Review of Hydrogeological Conditions Pertinent to the United Water Conservation District 2011 Water Rate Study Dated February 2, 2011, report dated June 2011, report prepared for City of San Buenaventura	2011					X		
Hopkins Groundwater Consultants, 2012, Saticoy Groundwater Conditions Study, Ventura, California, prepared for Ventura Regional Sanitation District	2012			X		X		
Hopkins Groundwater Consultants, 2012, Historical Changes in Santa Paula Basin Conditions Contributing to Long-Term Water Level Variations, Santa Paula, California: prepared for City of San Buenaventura, report dated September 2012.	2012					X		
Groundwater Section Annual Report-2013, 2013, Ventura County Watershed Protection District, Water and Environmental Resources	2013	X	X	X	X	X	X	X
Hopkins Groundwater Consultants, 2013, Preliminary Hydrogeological Study – Recycled Water Master Plan, Groundwater Replenishment and Reuse Project, Ventura, California: prepared for the City of San Buenaventura, report dated January 2013.	2013				X	X		
Bachman, Steve, 2013, Northern Pleasant Valley Desalter Groundwater Analysis and Modeling Final Report: prepared for Desalter Working Group, report dated December 2013.	2013	X						X
Sanitation District of Los Angeles County, 2013, Santa Clarita Valley Sanitation District Chloride Compliance Facilities Plan and Environmental Impact Report: report dated October 2013.	2013	X	X	X				

(a) - general discussion of the Santa Clara River subbasins (Piru, Fillmore, or Santa Paula basins)
 (b) - general discussion of the Coastal subbasins (Mound, Forebay, Oxnard Plain, Pleasant Valley, or West Las Posas) basins