REQUEST FOR COUNCIL ACTION CITY OF SAN DIEGO		CERTIFICATE NUMBER (FOR COMPTROLLER'S USE ONLY) NA
TO: CITY COUNCIL	FROM (ORIGINATING DEPARTMENT): Public Utilities	DATE: 2/17/2015
SUBJECT: Cooperative Hydrogeologic Investigations Agreement with United States Geological Survey (USGS)		
PRIMARY CONTACT (NAME, PHONE): George Adrian,(619) 533-4680, MS 906	SECONDARY CONTACT (NAME, PHONE): Marsi A. Steirer, (619) 533-4112, MS 906	

COMPLETE FOR ACCOUNTING PURPOSES

FUND					
FUNCTIONAL AREA					
COST CENTER					
GENERAL LEDGER ACCT					
WBS OR INTERNAL ORDER					
CAPITAL PROJECT No.					
AMOUNT	0.00	0.00	0.00	0.00	0.00
FUND					
FUNCTIONAL AREA					
COST CENTER					
GENERAL LEDGER ACCT					
WBS OR INTERNAL ORDER					
CAPITAL PROJECT No.					
AMOUNT	0.00	0.00	0.00	0.00	0.00

COST SUMMARY (IF APPLICABLE): City of San Diego's Anticipated Payments for the Joint Funding Agreement:

$690,725 FY 2016
$349,579 FY 2017
$171,701 FY 2018
$1,212,005 Total City of San Diego

$1,212,005 Total Sweetwater Authority (SWA) Funding
$601,336 Total USGS, Federal Matching Fund (FMF)
$3,025,346 Total Joint Funding Agreement

ROUTING AND APPROVALS

CONTRIBUTORS/REVIEWERS:		APPROVING AUTHORITY	APPROVAL SIGNATURE	DATE SIGNED
Environmental Analysis		ORIG DEPT.	Wright-Travis, Marie	02/23/2015
Liaison Office		CFO		
Financial Management		DEPUTY CHIEF		
Equal Opportunity Contracting		COO		
Comptroller		CITY ATTORNEY	Palmucci, Ray	03/09/2015

		COUNCIL PRESIDENTS OFFICE		
PREPARATION OF:	☒ RESOLUTIONS	☐ ORDINANCE(S)	☒ AGREEMENT(S)	☐ DEED(S)

1. Authorizing the Mayor, or his designee, to execute a Joint Funding Agreement with United States Geological Survey (USGS) for the San Diego Cooperative Hydrogeologic Investigations project in an amount not to exceed $1,212,005 for a duration of three years; and

2. Authorizing the Chief Financial Officer to expend an amount not to exceed $1,212,005 from Water Utility Operating Fund 700011 for the purpose of funding the Joint Funding Agreement with USGS, anticipated to be spent as follows, contingent upon adoption of the Annual Appropriation Ordinance for the applicable fiscal year, and contingent upon City Comptroller furnishing one or more certificates certifying that funds necessary for expenditure are, or will be, on deposit with the City Treasurer:

$690,725 FY 2016
$349,579 FY 2017
$171,701 FY 2018
$1,212,005 Total

3. Determine that this activity is categorically exempt from CEQA pursuant to State CEQA Guidelines Section 15306.

STAFF RECOMMENDATIONS:
Approve Requested Action

SPECIAL CONDITIONS (REFER TO A.R. 3.20 FOR INFORMATION ON COMPLETING THIS SECTION)

COUNCIL DISTRICT(S):	All
COMMUNITY AREA(S):	All
ENVIRONMENTAL IMPACT:	This activity is categorically exempt from CEQA pursuant to State CEQA Guidelines Section 15306.
CITY CLERK INSTRUCTIONS:	Please return two (2) copies of the 1472, Comptrollers Certificate, and Resolution to Jennifer Wolverton, 858-654-4479 MS901

COUNCIL ACTION
EXECUTIVE SUMMARY SHEET
CITY OF SAN DIEGO

DATE: 2/17/2015
ORIGINATING DEPARTMENT: Public Utilities
SUBJECT: Cooperative Hydrogeologic Investigations Agreement with United States Geological Survey (USGS)
COUNCIL DISTRICT(S): All
CONTACT/PHONE NUMBER: George Adrian/(619) 533-4680, MS 906

DESCRIPTIVE SUMMARY OF ITEM:
Authorize the execution of a three-year Cooperative Hydrogeologic Investigations Agreement with USGS for an amount not to exceed $1,212,005, to complete the final synthesis and reporting of the San Diego Hydrogeology project.
STAFF RECOMMENDATION:
Approve Requested Action
EXECUTIVE SUMMARY OF ITEM BACKGROUND: In 2002, the City of San Diego (City) adopted its first Long-Range Water Resources Plan (Long-Range Plan), which provided direction for the Public Utilities Department (department) to pursue additional conservation, recycled water and groundwater development. In 2012, the Long-Range Plan was updated identifying strategies to increase local water supply reliability and reduced dependency on imported water. Since the adoption of its first Long-Range Plan, the department has partnered with USGS to define the geology and hydrology of local groundwater basins to achieve its goals for local water supply development and water reliability.

The department has partnered with USGS, for more than a decade, to define the geology and hydrology of specific groundwater basins in San Diego. The first step was the installation of a multiple-depth monitoring well near Qualcomm Stadium in 2003. In 2008, USGS installed a multiple-depth monitoring well in Balboa Park to map the subsurface geology of the area. In 2010, a groundwater flow model was developed for the San Diego River drainage basin to determine the amount of water flowing to the coast. The department expanded USGS' earlier investigations with water agencies in the San Diego Formation (a large groundwater basin running from the Downtown San Diego to the Mexican border) with its own installation of two monitoring wells in the Chollas Creek vicinity. These wells were important in defining the subsurface extent of the San Diego Formation for its use as a water supply and storage source. In 2010, USGS installed a monitoring well east of the San Diego Zoo Safari Park in San Pasqual Valley, to monitor any changes in groundwater quality as a result of proposed development outside San Pasqual Valley. In 2013, two additional monitoring wells were installed in San Pasqual Valley to help characterize groundwater flow and track salinity.

The primary objective of these hydrogeology projects was to develop an integrated, comprehensive understanding of the geology and hydrology of the San Diego area for the use of specific groundwater basins as water supply and storage source(s). These past joint funded projects totaled $3.6 million, with the City contributing $3.26 million, and $416,400 from USGS.

Before this joint effort, no comprehensive geologic and hydrologic study had been made of the San Diego area. As a result it is difficult for the City to understand the effects of urbanization on the local groundwater, surface-water, and biologic resources for groundwater development.

This proposal is to complete the analysis and reporting of the San Diego Hydrogeology project. The focus will be on completing a comprehensive interpretive report that integrates all data and findings of the San Diego Hydrogeology project, finalization of a regional groundwater flow model, and the publication of nine technical foundational reports supporting the comprehensive report. The total cost of this remaining work is $3,025,346 and will be expended over the span of three years (FY 2016-2018). USGS will fund $601,336, and the remaining $2,424,010 will be equally shared by the City and Sweetwater Authority (SWA) for $1,212,005 each.

The USGS comprehensive interpretive report, foundational reports, and related data will finalize more than ten years of study and research work. In addition to the general hydrogeologic knowledge, the City and SWA critically need to further our mutual understanding and management of the San Diego Formation. The USGS' balanced and unbiased knowledge will provide the basis for the technical and scientific management of the basin as a local water resource for decades to come. Without this data, decisions and management of the basin will be made using decades old, simplistic information, possibly leading to mis-management of the basin and contamination via seawater intrusion which would then irrevocably damage the basin.

Among federal agencies, only USGS has the established mission and expertise to conduct a national effort to assess the status and trends of a whole resource. Many federal, state, and local agencies use the results of USGS studies. Users of groundwater information provided by the USGS rely on its unbiased scientific accuracy for purposes ranging from development of water management plans to economic forecasts.

FISCAL CONSIDERATIONS: Total cost of this Joint Funding Agreement is not to exceed $3,025,346. USGS will provide $601,336, SWA will fund $1,212,005, and the City's total cost is not to exceed $1,212,005 and will be expended over the three year duration of this agreement. It is anticipated that $690,725 will be spent in FY 2016, $349,579 in FY 2017 and $171,701 in FY 2018. Funding will be available in Water Utility Operating Fund 700011, contingent upon adoption of the Annual Appropriation Ordinance for the applicable fiscal year, and contingent upon City Comptroller furnishing one or more certificates certifying that funds necessary for expenditure are, or will be, on deposit with the City Treasurer.

EQUAL OPPORTUNITY CONTRACTING INFORMATION: USGS is an agency of the U.S. Government, and as such, is exempt from submitting Work Force Reports. Refer to San Diego Municipal Code Section 22.2703 (b). This agreement is not subject to the City's Equal Opportunity Contracting (San Diego Ordinance No. 18173, Section 22.2701 through 22.2708). This agreement is subject to the City's Non-Discrimination in Contracting Ordinance (San Diego Municipal Code Sections 22.3501 through 22.3517).

PREVIOUS COUNCIL and/or COMMITTEE ACTION: In June 2014, a presentation was made by the department and USGS to the Environment Committee to provide an update regarding USGS water resource investigations and City Council authorized the amendment to the existing

monitoring agreement with the USGS for water resource investigation (R-309040). On December 2013, the City Council approved the 2012 Long-Range Plan (R-308636) and on March 2004, the first Joint Funding Agreement with the USGS was approved by Mayoral Action (C-12590).

COMMUNITY PARTICIPATION AND PUBLIC OUTREACH EFFORTS: The Public Utilities Department has been actively involved in public outreach efforts through presentations to community groups and by providing project fact sheets and project information on the City's web page at www.sandiego.gov.

KEY STAKEHOLDERS AND PROJECTED IMPACTS: This action is an initiative to meet the goals of the Long-Range Plan and ensure a reliable water supply for the City's water rate payers. In addition, the City, regional, state and federal agencies will gain scientific knowledge from these activities.

Wright-Travis, Marie
Originating Department

_____
Deputy Chief/Chief Operating Officer

RESOLUTION NUMBER R-_____

DATE OF FINAL PASSAGE _____

A RESOLUTION OF THE COUNCIL OF THE CITY OF SAN DIEGO AUTHORIZING THE EXECUTION OF A THREE-YEAR COOPERATIVE HYDROGEOLOGIC INVESTIGATIONS AGREEMENT WITH UNITED STATES GEOLOGICAL SURVEY

WHEREAS, in 2002, the City of San Diego (City) adopted its first Long-Range Water Resources Plan (Long-Range Plan), which provided direction for the Public Utilities Department (Department) to pursue additional conservation, recycled water and groundwater development; and

WHEREAS, in 2012, the Long-Range Plan was updated, identifying strategies to increase local water supply reliability and reduced dependency on imported water by partnering with United States Geological Survey (USGS) to define the geology and hydrology of local groundwater basins to achieve its goals for local water supply development and water reliability; and

WHEREAS, this proposal is to complete the analysis and reporting of the San Diego Hydrogeology project by completing a comprehensive report that integrates all data and findings of the San Diego Hydrogeology project, finalization of a regional groundwater flow model, and the publication of nine technical foundational reports supporting the comprehensive report; and

WHEREAS, the City and the Sweetwater Authority need to further our mutual understanding and management of the San Diego Formation, thus the USGS' balanced and unbiased knowledge will provide the basis for the technical and scientific management of the basin as a local water resource for decades to come; NOW, THEREFORE,

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

1. That the Mayor, or his designee, is authorized and empowered to execute, for and on behalf of the City, a Joint Funding Agreement with USGS for the Cooperative Hydrogeologic Investigations of the San Diego Formation and the San Pasqual Basin (Agreement), in an amount not to exceed $1,212,005 over three years for the project described in this resolution, under the terms and conditions set forth in the Agreement on file with the Office of the City Clerk as Document No. RR-_____.

2. That the Chief Financial Officer is authorized to expend an amount not to exceed $1,212,005 from Water Utility Operating Fund 700011 for the purpose of funding the Agreement with USGS, contingent upon adoption of the Annual Appropriation Ordinance for the applicable fiscal year, and contingent upon the City Comptroller furnishing one or more certificates certifying that funds necessary for expenditure are, or will be, on deposit with the City Treasurer:

(a) $690,725 in Fiscal Year 2016;

(b) $349,579 in Fiscal Year 2017; and

(c) $171,701 in Fiscal Year 2018, for a total expenditure of $1,212,005.

APPROVED: JAN I. GOLDSMITH, City Attorney

By _____
Raymond C. Palmucci
Deputy City Attorney

RCP:mt
03/09/2015
Or.Dept:PUD
Doc. No. 966061

I hereby certify that the foregoing Resolution was passed by the Council of the City of San Diego, at this meeting of _____.

ELIZABETH S. MALAND
City Clerk

By_____
Deputy City Clerk

Approved: _____
(date)

_____
KEVIN L. FAULCONER, Mayor

Vetoed: _____
(date)

_____
KEVIN L. FAULCONER, Mayor

DOCKET SUPPORTING INFORMATION CITY OF SAN DIEGO **EQUAL OPPORTUNITY CONTRACTING PROGRAM EVALUATION**	DATE: March 4, 2015
SUBJECT: Cooperative Hydrogeologic Investigations Agreement with United States Geological Survey (USGS)	

GENERAL CONTRACT INFORMATION

Recommended Agency:	United States Geological Survey
Amount of this Action:	$ 690,725.00 FY 2016 $ 349,579.00 FY 2017 $ 171,701.00 FY 2018
Total Contract Amount:	$1,212,005.00 (Not to Exceed)
Funding Agency:	City of San Diego
Goal:	N/A

SUBCONTRACTOR PARTICIPATION

There is no subcontractor activity associated with this action.

EQUAL EMPLOYMENT OPPORTUNITY COMPLIANCE

Equal Opportunity: Required

The United States Geological Survey is a Government Agency, and as such, is exempt from submitting Work Force Reports. Refer to San Diego Municipal Code Section 22.2703(b).

This agreement is not subject to the City's Equal Opportunity Contracting (San Diego Ordinance No. 18173, Section 22.2701 through 22.2708).

This agreement is subject to the City's Non-Discrimination in Contracting Ordinance (San Diego Municipal Code Sections 22.3501 through 22.3517).

ADDITIONAL COMMENTS

Authorize the execution of a three-year Cooperative Hydrogeologic Investigations Agreement with USGS for an amount no to exceed $1,212,005.00 to complete the final synthesis and reporting of the San Diego Hydrogeology project.

KM

THE CITY OF SAN DIEGO

SUBMIT

Request for Human Resources Approval for Purchase Requisition

(Contracting Out Review Request Form)

FEB 1 1 2015

Requesting Department: Public Utilities / Long-Range Planning and Water Resources Division,

Vendor Name: United States Geological Survey (USGS)

WBS No. or Project Title Cooperative Hydrogeologic Investigations Agreement with USGS

Purchase Requisition # (If available):

Department Contact: George Adrian

Date of Request: 02/11/2015

Contract Amount/Estimate: $ 1,212,000.00

Contract/Service Duration: three years

NOTE: *Please provide a description of the activity/services requested and what the request to contract out work will cover. (Please use plain language for the terms/definitions)*

Please submit request to HumanResources@sandiego.gov or MS 56L

Question	Department Response
What is the contract/service for? (Please be specific as to the scope of work)	This is a joint funded project between the USGS and the City of San Diego to complete the analysis and prepare a comprehensive interpretive report that integrates all data and findings of the San Diego Hydrogeology Project including finalization of a regional groundwater flow model, and the publication of nine technical foundational reports.
What is the location of the project/service?	San Diego region. Work covers the groundwater basins in and around the City of San Diego.
Are City employees currently performing any of the work?	No.
Do City employees currently have the expertise to do this work in-house? If not, why not?	No, This is highly specialized work that requires the preparation of complex computer modeling and analysis. In addition to a sophisticated review and interpretation of the geologic and chemical data making up the groundwater basins.

Will any City employees be displaced as a result of this contract/service?	No.
If this is a renewal of an existing contract, how long have these services been contracted out?	No.
Is this a Public Works project? * (i.e. construction, reconstruction or repair of City buildings, street or other facilities)	No.
Is this a Tenant Improvement project? * (i.e. changes to the interior of a City facility, such as floors, wall coverings, shelves, ceilings, windows, partitions, etc.)	No.
Was another Department contacted to determine if they can or do perform this service (i.e. Streets, Facilities, etc.)? If so, please attach communication. If not, why was another Department not contacted?	No, no other department is capable of performing work of this specialization and sophistication. 2/11/15 per conversation w/ Project Manager George Adrian highly technical specialized modeling

***NOTE:** If Public Works project ($100,000 in labor costs or less) or Tenant Improvement project ($250,000 in labor costs or less) requires HR review/approval. All other contracts require HR review/approval regardless of dollar amount. Remember – Departments cannot intentionally bundle services to avoid the threshold labor costs.*

HUMAN RESOURCES DEPARTMENT USE ONLY

☑ APPROVED

Based on the Department's representation, this contract is _____ from a labor relations perspective.

Human Resources Department Liaison _____ Date 2-11-15

Form 9-1366
(Oct. 2005)

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

JOINT FUNDING AGREEMENT

Customer #:	6000000810
Agreement #:	15WSCA600081010
Project #:	
TIN #:	95--6000776
Fixed Cost Agreement	NO

FOR

WATER RESOURCES INVESTIGATIONS

THIS AGREEMENT is entered into as of the, 30th day of January, 2015 by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the CITY OF SAN DIEGO WATER DEPARTMENT, party of the second part.

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation is continuation of hydrologic investigations designed to provide the scientific understanding necessary to implement the City's Groundwater Program. The services to be provided by the USGS are defined in Exhibit A which is attached and herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of $0.00

   (a) by the party of the first part during the period

Amount	Date	to	Date
$300,668.00	July 1, 2015		June 30, 2018

   (b) by the party of the second part during the period

Amount	Date	to	Date
$1,212,005.00	July 1, 2015		June 30, 2018

   USGS DUNS NUMBER IS 1761-38857. Total funding for this agreement is $1,512,673.00. Total funding in 2 (a) provided by USGS is $300,668.00. Total funding in 2(b) provided by SDWD is $1,212,005.00.

   (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

   (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

9-1366 (Continuation) Customer #: 6000000810 Agreement #: 15WSCA600081010

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.
8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.
9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040). Billing documents are to be rendered QUARTERLY. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

	U.S. Geological Survey United States Department of the Interior		City of San Diego, Water Department
	USGS Point of Contact		**Customer Point of Contact**
Name:	Irene A. Rios, Budget Analyst	Name:	Halla Razak, Director
Address:	USGS CA WSC 4165 Spruance Rd., Suite 200 San Diego, CA 92101	Address:	City of San Diego Water Department C/O George Adrian 525 B. Street, Suite 300 San Diego, CA 92101
Telephone:	619-225-6156	Telephone:	619-553-4680
Email:	iarios@usgs.gov	Email:	

Signatures and Date

Signature:	Date: 2-6-15	Signature:	Date:
Name:	Eric G. Reichard	Name:	
Title:	Director, USGS CA WSC	Title:	

Hydrogeology of the San Diego Area, California

— Final Synthesis and Reporting —

a proposal by the

United States Geological Survey

1.0 EXECUTIVE SUMMARY

Since 2001, the United States Geological Survey (USGS) has investigated the hydrogeology of the San Diego area, in particular along the coast. A suite of studies has been supported by the City of San Diego and other local water agencies in cooperation with the federal government. These joint efforts have resulted in a vast amount of new data and a much improved understanding of groundwater resources in the San Diego area.

This proposal is to ***complete the final synthesis and reporting of the San Diego Hydrogeology project***, in particular by developing a regional groundwater flow model, and publication of nine technical foundational reports and a comprehensive interpretive report that integrates all data and findings of the San Diego Hydrogeology project. The study area for this work is shown in figure 1 attached. This effort will ***span three years (July 2015 through June 2018)***.

Total cost of this work is $3,025,346. The USGS will provide 25% of most costs which equals $601,336 subject to the availability of federal matching funds. After the USGS contribution, the net cost of the work is $2,424,010. ***City of San Diego cost is $1,212,005***.

2.0 BACKGROUND

Since 2001, the United States Geological Survey (USGS) has investigated the hydrogeology of the San Diego area, in particular along the coast. The investigation has included installation of 77 wells at 15 multiple-depth monitoring-well sites; collection of nearly 3 million water-level measurements; collection and analysis of more than 3,000 samples to define the quality of surface water and groundwater; mapping surficial and subsurface geology; measurement of hydraulic properties of the aquifer; and development of four numerical models: a geologic framework model, a rainfall-runoff model, a cross-sectional groundwater flow model of the coastal sediment and seawater interface, and a regional groundwater flow model.

2.1 FOCUSED STUDIES

Since 2003, the USGS has partnered with the City of San Diego to define the geology and hydrology of selected areas of particular interest to the City. Data and interpretations from these focused studies are being integrated together and are vitally important in understanding the larger San Diego area.

2.1.1 San Diego River Drainage Basin

In 2003, the City of San Diego initiated studies with the USGS to define the extent and aquifer characteristics of the San Diego Formation. A first step was installation of a multiple-depth monitoring-well site (SDAQ) located on the prior Aquaculture site near Qualcomm Stadium.

Additionally, water-quality samples were obtained from four wells in Mission Valley.

In 2010, a groundwater flow model was developed for the San Diego River drainage basin. The focus of this model was to determine the amount of water flowing to the coast. This investigation resulted in the publication by Flint and others (2012).

2.1.2 Balboa Park

In 2008, the USGS installed a multiple-depth monitoring-well site (SDBP) in Balboa Park to map the subsurface geology of the area and to determine if local groundwater could be used to irrigate Balboa Park.

2.1.3 San Diego Formation

In 2010, the City expanded investigation of the San Diego Formation with the USGS installing two multiple-depth monitoring-well sites, one east of the La Nacion fault in Chollas Park (SDCP) and one west near the intersection of Home Avenue and Federal Boulevard (SDHF). These wells were critically important in defining subsurface stratigraphy, in particular the subsurface extent of the San Diego Formation.

2.1.4 San Pasqual Valley

Investigations in the San Pasqual Valley included installation of three multiple-depth monitoring-well sites, each about 300 feet deep with 3 wells. The wells were installed in valley alluvium, in weathered granite, and in fractured granite. Water-level and water-quality data from the wells show the relation between pumpage from the alluvium and groundwater in the granite.

In 2010, the USGS installed a multiple-depth monitoring well site (SDSY) just east of the Wild Animal Park, in order to monitor any changes in groundwater quality as a result of proposed development of a nearby canyon.

In 2013, the USGS to installed two additional multiple-depth monitoring-well sites, one near Cloverdale Road (SDCD), and one just east of Interstate 15 near Lake Hodges (SDLH). Subsequent testing at these sites helped determine the capability of groundwater to flow through weathered and fractured granite. Also, the SDLH site, being near the ouflow of the San Pasqual Valley, is able to track increasing salinity of the groundwater system.

2.2 PRODUCTS TO DATE

To date many abstracts and two interpretative reports have been published. Two comprehensive data reports will be published and distributed in 2015.

2.2.1 Abstracts

- Many abstracts, as listed on http://ca.water.usgs.gov/projects/sandiego/resources/project_pubs.html. Also, the following extended abstracts:
- Danskin, W.R., 2012, Gaining the necessary geologic, hydrologic and geochemical understanding for additional brackish groundwater development, coastal San Diego, California, United States: 22nd Salt Water Intrusion Meeting (SWIM), Buzios, Brazil, June 17-22, 2012. Extended abstract. http://ca.water.usgs.gov/sandiego/abstracts/SWIM.Danskin.LoRes.pdf
- Danskin, W.R., 2014, Freshwater intrusion: Return of meteoric groundwater back to the continent, San Diego, California, USA: 23nd Salt Water Intrusion Meeting (SWIM), Husum, Germany, June 15-20, 2014. Extended abstract.

2.2.2 Reports

- Anders, R., Mendez, G. O., Futa, K. and Danskin, W. R., 2013, A geochemical approach to determine sources and movement of saline groundwater in a coastal aquifer. Ground Water. doi: 10.1111/gwat.12108, 13 p. http://ca.water.usgs.gov/projects/sandiego/abstracts/AndersEtAl2013.pdf

- Flint, L.E., Flint, A.L., Stolp, B.J., and Danskin, W.R., 2012, A basin-scale approach for assessing water resources in a semiarid environment: San Diego region, California and Mexico, Hydrol. Earth Syst. Sci., 16, 3817-3833, doi:10.5194/hess-16-3817-2012. http://www.hydrol-earth-syst-sci.net/16/3817/2012/hess-16-3817-2012.html

2.3 BENEFITS

The USGS Professional Paper, foundational reports, and related data provide a range of benefits to the City of San Diego, including:

- Balanced and unbiased technical and scientific knowledge;
- Unbiased technical support for the operation and sustainable use of groundwater;
- Scientific and technical foundational information to prepare a Groundwater Management Plan (AB3030 style) for coastal San Diego County;
- Locations, science, and technical evaluation to extract additional fresh groundwater;
- Locations, science, and technical evaluation to extract additional saline groundwater;
- Regional water-level and water-quality data analysis and evaluation to aid in operation of the Reynolds Desalination Facility;
- Subsurface geologic information in the Tijuana River Valley that may provide additional aquifer injection and extraction opportunities; and
- Technical and scientific support to manage land subsidence and seawater intrusion in the coastal groundwater basins.

2.3.1 Approval of USGS publications

The USGS has a renowned publication review and approval process designed to ensure that the highest quality science is released to the public.

For an interpretative report, a multi-level review takes place both inside and outside the organization by senior technical colleagues and specialists. Commonly at least 10, and often 15 to 20 individuals will review a report before it can be approved by the Director and can be released to the public.

The City of San Diego will be provided an opportunity to review USGS Professional Paper and each foundational report concurrent with the standard USGS colleague-review process.

3.0 SCOPE OF WORK

An integrative report tying all prior work together and describing the hydrogeology of the San Diego area is what remains. The synthesis of all prior work and developed knowledge will result in a regional groundwater flow model. A comprehensive integrative report will describe the model and the geology and water resources of this coastal region.

3.1 PHASES

The proposed work is divided into two phases. Phase I is primarily synthesis of existing data and interpretations, and preparation of foundational reports on specific topics. Phase II is preparation of a comprehensive integrative report.

3.1.1 Phase I – Synthesis and Foundational Reports

Phase I focuses on synthesis of previously collected data and production of nine foundational reports, which are listed below as deliverables. These foundational reports are required in order to present the data, methods, and interpretations that will be integrated, summarized, and referenced in the USGS Professional Paper (Phase II). All foundational reports will have at least one USGS author, will be reviewed formally by the USGS, and must receive USGS Director's approval prior to publication.

3.1.2 Phase II – USGS Professional Paper

The USGS will prepare a comprehensive interpretive report that integrates all data and findings of the San Diego Hydrogeology project. This report will be authored by W.R. Danskin and other senior scientists of the USGS and will be submitted for approval as a USGS Professional Paper, which is designed for reports that present scientific information of broad scope and lasting interest and is the highest quality report series produced by the USGS. The USGS Professional Paper for the San Diego area will have about 150 single-spaced pages, and will include many maps, sections, graphs, and tables. The current table of contents is included as Attachment A.

Examples of similar, previously produced USGS reports by project staff include:

- Hollett, K.J., Danskin, W.R., McCaffrey, W.F., and Walti, C.L., 1991, Geology and water resources of Owens Valley, California: U.S. Geological Survey Water-Supply Paper 2370-B, 77 p.; http://pubs.er.usgs.gov/publication/wsp2370B;
- Danskin, W.R., 1998, Evaluation of the hydrologic system and selected water-management alternatives in the Owens Valley, California: U. S. Geological Survey Water-Supply Paper 2370H, 175 p.; http://pubs.er.usgs.gov/publication/wsp2370H; and
- Danskin, W.R., McPherson, K.R., and Woolfenden, L.R., 2006, Hydrology, description of computer models, and evaluation of selected water-management alternatives in the San Bernardino area, California: USGS Open-File Report: 2005-1278, 194 p., pending release as Professional Paper 1734; http://pubs.er.usgs.gov/publication/ofr20051278.

Historically, USGS Professional Papers and Water-Supply Papers were equivalent, but tended to be used to report primarily either geology or water topics, respectively. More recently, the Water-Supply Paper series was discontinued, and only USGS Professional Papers are produced.

3.2 WORK ELEMENTS, UNDER BOTH PHASES

3.2.1 Data Collection

- ***Data report #1***. Document data from 8 multiple-depth monitoring-well sites in a USGS report (Anders and others, c2015). These sites are SDBW, SDOT, SDOR, SDMC, SDNB, SDEP, SDBP, and SDAQ.
- ***Data report #2***. Document data from 7 multiple-depth monitoring-well sites in a USGS report (Kjos and others, c2015). These sites are SDCC, SDSW, SDCP, SDHF, SDSY, SDLH, and SDCD.
- ***Inventory wells.*** Inventory additional wells to obtain necessary site-specific or regional information. Likely wells include the new production wells installed for the expansion of the Reynolds Desalination Facility. Add these new wells to the USGS physical and electronic databases, a required step prior to sampling the wells for water levels or water quality or using the wells to estimate aquifer characteristics.
- ***Water quality.*** Collect selected groundwater-quality samples from existing or newly inventoried wells. Analyze the samples for a range of constituents including major and minor ions, trace elements, stable isotopes of hydrogen and oxygen, and radioactive isotopes tritium and carbon-14.
- ***Springs.*** Identify, visit, and inventory springs. If possible, collect discharge and water-quality data, which are important parts of a geochemical analysis and the regional groundwater flow model.
- ***Groundwater discharge.*** Collect samples of groundwater discharge under the San Diego Bay. Analyze for a range of chemical constituents to determine the source, age, and movement of the groundwater.

3.2.2 Geology

- ***Surficial geology.*** Integrate surficial geology throughout the study area, in particular vet the surficial mapping with Mexican geologists. Presently, surficial geologic materials are mapped somewhat differently on either side of the international border.
- ***Offshore geology.*** Coordinate with the Scripps Institute of Oceanography to collect and process acoustic geophysical data to produce offshore geologic maps and sections, in particular for the upper 400 feet of sediment. This information is necessary to identify locations to sample groundwater discharge and to develop the regional groundwater flow model.
- ***Geologic framework model.*** Prepare version 3.0 of the three-dimensional geologic framework model. Ensure that the model represents the major structural and depositional concepts, and honors the approximately 100 well and seismic data points. Critique the model with both local experts and Mexican geologists because the model spans the international border.

  This geologic framework model is a computerized numerical model that uses ArcView© and EarthVision© software to map the three-dimension sequence of geologic layers in the coastal San Diego Basin; from land surface down, these layers are Quaternary sediment, San Diego Formation, Otay Formation, Eocene sediment, Cretaceous rock, and crystalline bedrock. The geologic framework model extends in the north from approximately La Jolla, to south of the international border, and from approximately Interstate 15/805 in the east, to the offshore area west of Point Loma.
- ***Paleontology report.*** Document the paleontology used to define the subsurface geology in a USGS report (Rugh and others, c2016). Mr. Rugh is the subject-matter expert, in particular for the San Diego Formation, but he is not an USGS employee. Preparation of the report, therefore, requires a USGS co-author (Danskin) and a federal purchase order to pay for Mr. Rugh's services.
- ***Geology report.*** Document the geologic framework model in a USGS report (Cromwell and others, c2016). This model provides the required geologic information for the regional groundwater flow model.
- ***Gravity report.*** Document the gravity and basement mapping in a USGS report (Marshall and others, c2018). This information forms the bottom of the geologic framework model and helps define the overlying stratigraphy and aquifer thickness.

3.2.3 Land Deformation

- ***Land-deformation report.*** Document the land-deformation characteristics in a USGS report (Cha and others, c2017). Land subsidence resulting from pumpage is a concern expressed in environmental documents related to expansion of the Reynolds Desalination Facility. Initial work in 2003 showed that about 2 centimeters of land subsidence resulted from pumping in the vicinity of the facility.

3.2.4 Geochemistry

- ***Hyper-saline groundwater.*** Determine occurrence, sources, and movement of hyper-saline groundwater in coastal areas. Identified at the Navy Base multiple-depth monitoring-well site (SDNB), this type of shallow groundwater with salinity concentrations greater than seawater may affect operational decisions for the brackish desalination plant.

3.2.5 Aquifer Characteristics

- ***Specific-capacity tests.*** Obtain and analyze specific-capacity tests from the eastern part of San Diego County.
- ***Regional aquifer tests.*** Analyze the 2010 regional aquifer test in order to determine aquifer characteristics and response of the coastal aquifer to pumping.

- ***Aquifer characteristics report.*** Document the aquifer characteristics of the San Diego area in a USGS report (Schaefer and others, c2017). These characteristics—in particular, horizontal and vertical hydraulic conductivity, transmissivity, and storage coefficient—are critically important parameters used in the regional groundwater flow model.

3.2.6 Hydrology

- ***Water-level map.*** Identify and inventory wells for a water-level map. Collect water-level data. Interpret and compile data into a water-level map for water table and confined systems. These data and analysis are a required part of the regional groundwater flow model.
- ***Pumpage.*** Collect and collate measured pumpage wherever possible. Estimate pumpage, as needed for the entire study area, from land-use maps. These data and analyses are a required part of the regional groundwater flow model.
- ***Water budget.*** Create a water budget for the regional hydrologic system. Create a groundwater budget for the coastal aquifer. This analysis is a required part of the regional groundwater flow model.

3.2.7 Hydrologic Modeling

- ***Synthesis report.*** Document the synthesis of geology, geochemistry, and hydrology to better understand and simulate groundwater flow along a key coastal groundwater flowpath in a USGS report (Anders and others, c2016). This section includes the SDEP and SDNB multiple-depth monitoring-well sites.

  A cross-sectional groundwater flow model is used to test concepts of groundwater flow near the coast, occurrence hyper-saline conditions, and seawater intrusion. This computerized numerical model uses SUTRA software to simulate complex geology and density-dependent groundwater flow.
- ***Regional groundwater flow model.*** Develop and calibrate a regional groundwater flow model, spanning the entire study area (figure 1), which includes five major drainage basins: San Dieguito, San Diego, Otay, Sweetwater, and Tijuana. The model will include a range of hydrologic features including streams, springs, and pumpage for the Reynolds Desalination Facility.

  Initially, the regional model will use basic MODFLOW software to develop a rational simulation and water budget; subsequently, the model will evolve to using SEAWAT software. A critically important part of the model is simulating the greater density of seawater that is part of the coastal aquifer and influences groundwater flow and groundwater levels along the coast.
- ***Regional model report.*** Document the regional groundwater flow model in a USGS report (Stolp and others, c2018). This report will include documentation of Hydrology work elements (section 3.2.6).

3.2.8 USGS Professional Paper

- ***Data and concepts.*** Integrate all data and findings from the San Diego Hydrogeology project, from the year 2001 through 2015. Prepare figures to illustrate these findings. Present selected data in tables.
- ***USGS Professional Paper.*** Prepare a USGS report that summarizes and integrates the key data and findings from the San Diego Hydrogeology project. This report, which over the years has been referred to as a coffee-table book, will be written for a broad audience, including both the lay public and professionals alike. Approval will be requested from the USGS that the report be published as a USGS Professional Paper, the highest quality publication series of the USGS.

3.2.9 Website

The following will be added to the existing USGS project website:

- ***New data***. Add new data, for example water-level and water-quality data. Add data from the new production wells installed as part of the expanded the Reynolds Desalination Facility.
- ***New content.*** Add new reports, selected figures and tables, and other content so that the website represents the overall San Diego Hydrogeology project.
- ***Federal guidelines***. Modify the website to ensure it conforms to federal guidelines, for example access by seeing-impaired individuals.

3.2.10 Technical Outreach

- ***Cooperator***. Brief the City of San Diego staff at least quarterly. Brief the San Diego City Council, as requested, but at least once per year.
- ***Local water agencies***. Brief local water agencies including the Sweetwater Authority and the Otay Water District, as requested. Brief other agencies, such as the San Diego County Water Authority and Regional Water Quality Control Board, as often as once per year.
- ***San Diego Formation Groundwater Management Plan.*** Assist the City of San Diego, Sweetwater Authority, and other members of the Technical Advisory Committee charged with developing an AB3030-style Groundwater Management Plan for the coastal San Diego area.
- ***Academic colleagues.*** Meet with colleagues at Scripps Institute of Oceanography, at least twice per month. Meet with colleagues at San Diego State University, University of San Diego, and the Center for Scientific Research and Higher Education of Ensenada (CICESE) in Mexico as needed.
- ***Professional organizations.*** Attend professional meetings, such as those hosted by the San Diego Association of Geologists, the American Geophysical Union, and the Geological Society of America, to ensure that the technical work being done on the San Diego Hydrogeology project is of the highest quality. Consider hosting a technical conference to present results of the San Diego Hydrogeology project and other similar studies. This technical outreach and exchange is an important part of USGS participation in local water studies and helps ensure that the federal contribution has a significant benefit both locally and nationally.

3.2.11 Special Investigations

During the course of this 3-year study, opportunities will arise to investigate special topics that are not known now, but are of pressing interest to the City and to the San Diego Hydrogeology project. These opportunities may include:

- ***Improved operation of the Reynolds Desalination Facility.*** Mapping fresh groundwater near the facility and under the San Diego Bay may prompt operational questions that can be answered efficiently while key personnel and equipment are available and doing field work. Similarly, installation of the new multiple-depth monitoring-well site (SDMV) may prompt questions that can be answered while the drilling equipment is on site.
- ***General water questions by the City.*** As part of researching additional opportunities for local water resources, the City of San Diego occasionally encounters questions or opportunities relating to surface water or groundwater resources in the San Diego area. Often, the USGS has the equipment and expertise to efficiently answer these questions, for example by using unusual geophysical equipment, by sampling water quality, and by analyzing for hard-to-detect compounds. These answers then can be integrated into the San Diego Hydrogeology project and can be incorporated in one or more of the reports listed in this proposal.

- ***Hydrogeologic complexity.*** Planned investigations, especially under the previously unexplored San Diego Bay, may identify hydrogeologic complexities that warrant further data collection or analysis. Probable topics include additional fresh groundwater and active faulting.

Doing any special investigation requires additional scoping and budget by the USGS, and approval by the City.

3.2.12 Multiple-depth Monitoring-well Site

A multiple-depth monitoring-well site (SDMV) will be installed to manage the Reynolds Desalination Facility. The well site will have the following characteristics:

- ***Siting and permitting.*** The well site will be located at Marina View Park near San Diego Bay in Chula Vista. Permitting will involve the property owner, the Port of San Diego, and will include approval of a stormwater management plan.
- ***Installation.*** As with the other multiple-well sites, the SDMV site will include drilling a single borehole and collecting cuttings every 10 feet; collecting a broad range of geophysical logs; installing 5-6 piezometers; installing a 3-inch-diameter deep piezometer so that salinity can be monitored via future electromagnetic (EM) logging; collecting and analyzing a broad range of chemical constituents from each piezometer; conducting slug-tests on each piezometer to determine the hydraulic characteristics; equipping the site with pressure-recording transducers and transmission capability to the internet; establishing sites in the USGS physical and electronic databases; and adding all information to the project website.
- ***Special features.*** This well site will involve coring the upper 100 feet of sediment to detect any hyper-saline conditions, such as those found at the SDNB and SDSE well sites; drilling deep enough to encounter the Otay Formation in order to vet and improve the geologic framework model; and analyzing cuttings via a paleontologist to confirm formations encountered.

3.3 DELIVERABLES

3.3.1 Data

Water-level and water-quality data collected as part of the project are archived in perpetuity in national USGS databases. These data can be accessed via the project website http://ca.water.usgs.gov/sandiego.

3.3.2 Reports

The following reports will be provided in both paper and pdf format, as soon as they are published. All reports, including journal articles, must be approved by the Director of the USGS before publication. The following list includes a short name and planned authors, publication date, title, type of report, and estimated pages.

1. ***Data report 1***. Anders and others, c2015, Geologic, hydrologic, and water-quality data from surface-water and groundwater sites in San Diego County, California, 2001–2009: USGS Data Series report, 400 p.
2. ***Data report 2.*** Kjos and others, c2015, Geologic, hydrologic, and water-quality data from surface-water and groundwater sites in San Diego County, California, 2010 – 2013: USGS Data Series report, 350 p.
3. ***Paleontology.*** Rugh and others, c2016, Paleontological mapping of the San Diego Formation, San Diego County, California: USGS Scientific Investigations Report, 40 p.
4. ***Geology.*** Cromwell and others, c2016, Geologic framework model for coastal San Diego County, California: Journal article, 16 p.
5. ***Gravity.*** Marshall and others, c2018, Contours of basement rock based on gravity measurements for coastal San Diego County, California: USGS Map Series report, 1 pl.
6. ***Land Deformation.*** Cha and others, c2017, Land deformation in the coastal San Diego area, California: Journal article, 12 p.
7. ***Hydraulics.*** Schaefer and others, c2017, Hydraulic characteristics of rocks and sediment in San Diego County, California: USGS Scientific Investigations Report, 80 p.
8. ***Synthesis.*** Anders and others, c2016, Synthesis of geology, hydrology, and water quality in the San Diego area, California: Journal article, 12 p.
9. ***Modeling.*** Stolp and others, c2018, Simulation of regional groundwater flow in the San Diego area, California: USGS Scientific Investigations Report, 100 p.
10. ***Professional Paper (coffee-table book).*** Danskin and others, c2018, Geology and water resources of southeastern San Diego County, California, USA, and northern Baja California, Mexico: USGS Professional Paper, 150 p.

The City of San Diego and Sweetwater Authority will be provided an opportunity to review the above reports concurrent with the standard USGS colleague-review process. The project schedule provides for a one-month turnaround for such reviews by the City of San Diego and Sweetwater Authority.

3.3.3 Models

The following numerical models will be provided, including all datasets, as soon as the respective documentation report is published. Report numbers refer to the list in section 3.3.2 Reports. A brief description of the models is given in the respective section.

1. Geologic framework model (report #4) is described in section 3.2.2 under *Geologic framework model*;
2. Cross-sectional density-dependent model (report #8) is described in section 3.2.7 under *Synthesis report*; and
3. Regional groundwater flow model (report #9) is described in section 3.2.7 under *Regional groundwater flow model*.

3.3.4 Webpage

The project webpage [http://ca.water.usgs.gov/sandiego] will be updated with additional data and reports, and with selected figures and tables.

3.4 SCHEDULE

Work will commence as soon as the joint funding agreement is approved by the City of San Diego and the USGS. The estimated schedule for the work elements is given below. The USGS Professional Paper will be submitted for colleague review by October 2016, and is estimated to be approved for publication by September 30, 2017. At that point, contents of the report can be cited. Formal publication will follow and is estimated to be complete by July 2018.

The schedule of work elements is provided in table 1 below. Work elements for FY15, which is funded by the Sweetwater Authority, are included table 1 in order to understand the overall project activities.

Table 1. Schedule of work elements

Work Element	FY15				FY16				FY17				FY18			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Data Collection																
Data report #1	x	x	x	x	x	x										
Data report #2	x	x	x	x	x	x										
Inventory wells	x	x	x	x	x	x	x	x								
Water quality					x	x	x									
Springs					x	x	x									
Groundwater discharge	x	x	x	x	x	x	x	x								
2. Geology																
Surficial geology	x	x	x	x	x	x	x	x								
Offshore geology		x	x	x	x	x	x	x								
Geologic framework model	x	x	x	x	x	x	x	x								
Paleontology report	x	x	x	x	x	x	x	x								
Geology report	x	x	x	x	x	x	x	x								
Gravity report								x	x	x	x	x	x	x	x	x
3. Land deformation																
Land deformation report							x	x	x	x	x	x	x			

Table 1. Schedule of work elements																
Work Element	**FY15**				**FY16**				**FY17**				**FY18**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
4. Geochemistry																
Hyper-saline groundwater					x	x	x	x	x	x	x	x				
5. Aquifer characteristics																
Specific-capacity tests	x	x	x													
Regional aquifer tests		x	x													
Aquifer characteristics report	x	x	x	x	x	x	x	x	x							
6. Hydrology																
Water-level map	x	x	x	x	x	x	x	x								
Pumpage	x	x	x	x	x	x	x	x								
Water budget	x	x	x	x	x	x	x	x	x							
7. Hydrologic modeling																
Synthesis report	x	x	x	x	x	x	x	x								
Regional groundwater model	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Regional model report									x	x	x	x	x	x	x	x
8. USGS Professional Paper																
Data and concepts	x	x	x	x	x	x	x	x								
Prepare report	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9. Website																
New data	x	x	x	x	x	x	x	x	x	x	x	x		x		x
New content	x	x	x	x	x	x	x	x	x	x	x	x		x		x
Federal guidelines				x				x				x				x
10. Technical outreach																
Cooperator	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Local water agencies	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Groundwater management plan		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Academic colleagues	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Professional organizations		x		x		x		x		x		x		x		x
11. Special investigations																
Improved operations	x	x	x	x	x	x	x	x	x	x	x	x				
General water questions	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hydrogeologic complexity	x	x	x	x	x	x	x	x	x	x	x	x				
12. Monitoring-well site																
Siting and permitting			x	x	x											
Installation						x	x	x								

3.5 COST

3.5.1 Phase I and II

Total cost for completing phase I and II is $3,025,346. The USGS will provide 25% of the non-drilling costs which equals $601,336 subject to the availability of federal matching funds.

Net cost of the study after the USGS contribution is $2,424,010. ***City of San Diego cost is $1,212,005.***

Payment would be made via a cooperative agreement between the City of San Diego and the USGS.

Work Element	FY16	FY17	FY18
1. Data collection	114,344	0	0
2. Geology	157,610	111,300	86,110
3. Land deformation	25,757	62,540	22,890
4. Geochemistry	15,450	26,500	0
5. Aquifer characteristics	85,497	15,900	0
6. Hydrology	107,120	10,600	0
7. Hydrologic modeling	202,917	265,677	82,840
8. USGS Professional Paper	138,020	265,294	153,000
9. Website	24,720	29,680	21,800
10. Technical outreach	62,830	65,720	51,230
11. Special investigations	81,000	79,000	40,000
12. Monitoring-well site	620,000	0	0
TOTAL	**$ 1,635,265**	**$ 932,211**	**$ 457,870**

Figure 1. Study area for the project, “Hydrogeology of the San Diego area, California.”

Attachment 1: Preliminary outline of the USGS Professional Paper

Geology and Water Resources of Southeastern San Diego County, USA,

and Northern Baja California, Mexico

by

Wesley R. Danskin, Bert J. Stolp, and Robert Anders

Introduction
Purpose and Scope, Background, Previous Investigations, Acknowledgements
Description of Study Area
Climate, Population, Land use, Water use
Methods of Investigation
Monitoring Wells, Geochemical Sampling, Geologic Framework Model
Geology
Geologic units
Granite, Metavolcanics, Cretaceous rocks, Eocene sediment, Oligocene, San Diego Formation, Quaternary deposits
Geologic Framework Model
Water Resources
Precipitation
Surface Water
Groundwater
Hydraulic Characteristics, Water Levels, Water Budget
Water Quality
Water Management
Water-Management Issues, Alternatives
Additional Sources of Water Supply
Discussion
Suggestions for Future Work
Summary and Conclusions
References Cited

Figures

1. Map of study area.
2. Graph of sea level changes over the past 23,000 years.
3. Graph of population changes in the San Diego area, 1900 to 2010.
4. Map of coastline and coastal streams during last glacial maximum, 23,000 years ago.
5. Map of surficial geology.
6. Map of gravity and depth to bedrock.
7. Geologic sections.
8. Isopack of the San Diego Formation.
9. Schematic of multiple-depth monitoring well.
10. Map of precipitation stations and contours.
11. Map of surface water and gages.
12. Map of springs and seeps.
13. Map of hydraulic characteristics.

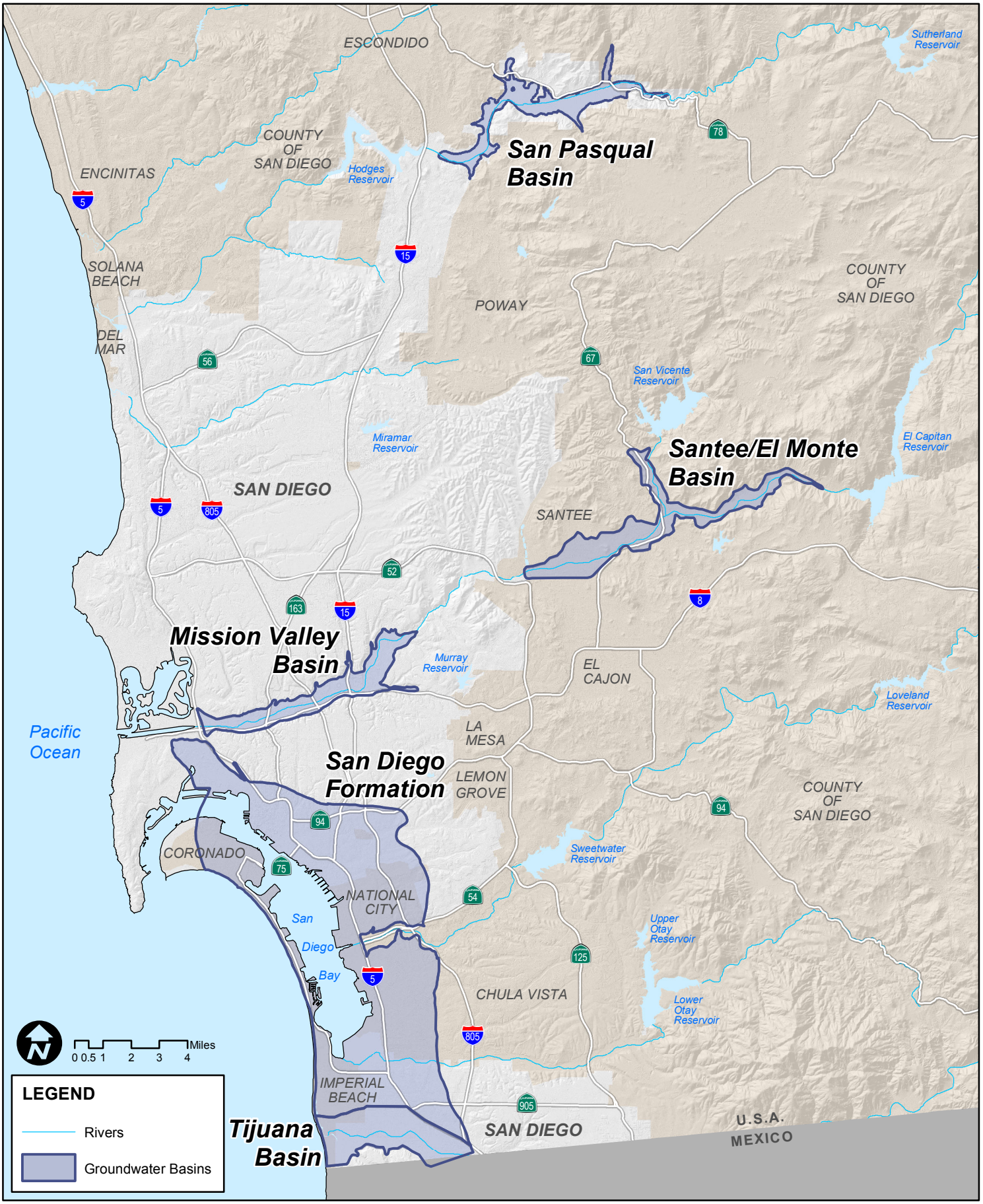
14. Graph showing relation of geologic units and hydraulic characteristics.
15. Map of unconfined and confined groundwater levels.
16. Hydrographs from selected multiple-depth monitoring-well sites.
17. Graph of major components of regional water budget.
18. Trilinear diagrams of water-quality characteristics.
19. Map of hydrogen and oxygen isotopic values.
20. Geochemical sections.
21. Graphs of groundwater age and salinity with depth.
22. Map of water sources.

Tables

1. Major geologic, hydrologic, and human events.
2. Monitoring wells.
3. Geologic formations and their hydraulic characteristics.
4. Water budget.

Plates

1. Study area, including physiography, geology, streams, and monitoring wells.



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01/29/15

City of San Diego PUBLIC UTILITIES Water & Wastewater

Long-Range Planning & Water Resources Division

City of San Diego Public Utilities Department

Groundwater Basins

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