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NAPA VALLEY SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

Section 3 – Water Resource and Land Use Monitoring and Management Programs

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SECTION 3 OBJECTIVES

- *Section 3 describes local, state, and federal agencies with existing water and land use monitoring and management programs in the Napa Valley Subbasin. These descriptions provide context and a general understanding of efforts underway by other agencies, which may influence groundwater conditions in the Subbasin.*
- *Section 3 describes the extent of recent and historical monitoring networks in the Napa Valley Subbasin. This information precedes a discussion, in a subsequent Section of this GSP, of the monitoring network that the GSA will use to track groundwater-related conditions for the purposes of SGMA.*
- *Section 3 describes the beneficial uses and users of groundwater in the Subbasin. These descriptions precede additional details to be addressed in subsequent Sections of this GSP, including identification of significant and unreasonable impacts on beneficial users.*

SECTION 3 SUMMARY

Many local, state, and federal agencies implement monitoring and management programs in the Napa Valley Subbasin. The objectives of those monitoring programs are often dictated by statutory or regulatory requirements intended to protect groundwater and surface water quality. This Section of the Napa Valley GSP describes those programs and their monitoring networks. Monitoring programs or projects implemented by other entities may also provide data useful for the evaluation of basin conditions and are described in Section 6.

Monitoring conducted in the Napa Valley Subbasin since 2015 has included:

- *77 groundwater level monitoring wells and sites*
- *85 groundwater quality monitoring well and sites*
- *22 surface water flow and 7 surface water quality sites*
- *3 ground station capable of tracking land subsidence*

Groundwater use is reported from 101 wells, primarily public supply wells. Surface water diversions are reported for 93 points of diversion or onstream storage.

Subsequent GSP Sections will synthesize historical and current data to describe groundwater and surface water conditions and describe how the monitoring network that the NCGSA will use going forward to inform its management of the Subbasin.

Beneficial uses and users of groundwater in the Subbasin include:

- Overlying groundwater rights holders supplying domestic and agricultural users
- Municipal well operators and public water systems
- Local land use and planning agencies

- Environmental users of groundwater
- Uses and users of interconnected surface water, including freshwater species and agricultural users, and
- Disadvantaged communities

Beneficial users are distributed throughout the Subbasin and rely on groundwater to varying degrees. Many users, such as domestic and agricultural well owners and groundwater dependent ecosystems intrinsically have a high degree of groundwater reliance, whereas municipal well operators and some public water systems and surface water users may have somewhat less reliance on groundwater. However, the interconnected nature of groundwater and surface water, previously recognized by the NCGSA, creates the potential for groundwater conditions to effect surface water users that rely on surface water occurring within the Subbasin. The NCGSA is responsible for considering the interests and needs of all beneficial uses and users of groundwater in the Subbasin. Additional information presented later in this Plan addresses groundwater reliance by beneficial users in quantitative terms and present management criteria that NCGSA will use to avoid significant and unreasonable effects due to groundwater conditions.

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NOTE: Highlighted text present in this draft will be updated as subsequent Sections and related material are developed, prior to release of the of the complete draft GSP.

3. WATER RESOURCE AND LAND USE MONITORING AND MANAGEMENT PROGRAMS

Existing monitoring and management programs within the Plan area include programs implemented by federal, state, regional, and local public agencies in support of regulatory or statutory requirements. Monitoring programs or projects implemented by others may also provide data useful for the evaluation of basin conditions presented in **Section 6**. Monitoring sites from the various networks described in this section were considered for incorporation as part of the groundwater sustainability plan (GSP) monitoring network, described in **Section 5**.

The Napa County Groundwater Sustainability Agency (NCGSA) intends to continue using current groundwater and surface water monitoring programs to inform the evaluation of GSP monitoring network sufficiency and fill data gaps where necessary. The current monitoring and management programs are not expected to limit operational flexibility in the Subbasin. This Plan incorporates all available data collected through the numerous programs and monitoring networks in the Subbasin and implements standards consistent with the state and federal drinking water quality programs. State and federal water quality programs inform the sustainability criteria developed in this Plan, which are presented in **Section 9**. Additionally, projected water budgets presented in this Plan are consistent with the land use and zoning measures presented in local General Plans. Updated assessments of land use and water demand projections, and the assumptions associated with each, are described in greater detail in **Section 8.6** to **Section 8.8.**

3.1. Water Resources Monitoring and Management Programs (10727.2 G) (§354.8 c, d, and e)

3.1.1. Local Monitoring and Management Agencies

3.1.1.1. County of Napa

Napa County has managed environmental resources through land use controls and other regulations for over five decades. Although the terminology was different, the County Board of Supervisors (BOS) understood even in the 1960s that the "sustainable yield" should not be exceeded.

Napa Valley Agricultural Preserve

In response to encroaching urban growth, the Napa Valley Agricultural Preserve (or Ag Preserve) was first established by the Napa County BOS in 1968 through the adoption of Napa County Ordinance No. 274. The intent of the Ag Preserve was to protect agricultural lands from encroaching urban development. This landmark set of zoning laws, which encompassed Ag Preserve and Ag Watershed lands, established agriculture as the highest and best use of the land in Napa County. The Ag Preserve established a 20-acre minimum parcel size on the valley floor, which was later increased to 40-acres in

1979. In 1973, the minimum parcel size in the Ag Watershed, essentially all the hillside areas that make up the greater Napa River Watershed, was established at 40 acres. The Ag Preserve and Ag Watershed protections limit the ability to create small, privately owned parcels, and therefore limit the amount of development and groundwater demand that can occur in Napa Valley, preserving the runoff and recharge potential of the valley and its surroundings.

Five decades later, Ag Preserve and Ag Watershed protections are supported by more than 37,000 acres of farmland and open space now covered by Conservation Agreements between landowners and the Land Trust of Napa County by the Ag Preserve and Ag Watershed have. Additional protections to agricultural land were passed in 1980, in which voters approved an initiative known as Measure A, which limits housing growth in the unincorporated county areas to less than 1% per year. In 1990 and again in 2008, voters approved initiatives prohibiting the conversion of agricultural lands to non-agricultural uses without a vote of the people. This remains in effect through 2058. Through these land use management actions, groundwater demand in Napa Valley and the surrounding Napa River Watershed continue to be managed through controls on growth and development.

Napa County Stormwater Management Program

The Napa County Stormwater Management Program (NCSWMP) is a joint effort involving Napa County, the Cities of American Canyon, Napa, St. Helena, and Calistoga, and the Town of Yountville. The collective goal of the program is to prevent stormwater pollution, protect and enhance water quality in creeks and wetlands, preserve beneficial uses of local waterways, and comply with state[1] and federal regulations regarding stormwater. Countywide implementation of the program includes stormwater management planning and annual reporting, tracking and reporting of illicit discharges, developing best management practices (BMPs), and conducting public outreach, participation, and education. Napa County adopted Chapter 16.28 in the Code of Ordinances in 2004 to implement stormwater management and discharge control throughout the County.

The cities of Napa, St. Helena, and Calistoga, and the Town of Yountville implement a Local Program, with a reference to each local agency below.[2]

- City of Napa: The Bridges and Urban Drainage Division of the Public Works Department coordinates and oversees implementation of the City of Napa's local program, enforced through Title 8.36 of the City of Napa Municipal Code.
- Town of Yountville: The Engineering Division of the Planning Department coordinates and oversees implementation of the Town of Yountville's Stormwater Management Program (SWMP), enforced through Title 13 Division 5 of the Yountville Municipal Code.

[1] https://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.html
[2] The City of American Canyon, which is located outside of the Napa Valley Subbasin, also implements a local stormwater management program in coordination with the County of Napa.

- City of St. Helena: The Department of Public Works coordinates and oversees implementation of the City of St. Helena's SWMP, enforced through Title 13.32 of the City of St. Helena Municipal Code.
- City of Calistoga: The Department of Public Works coordinates and oversees implementation of the City of Calistoga's SWMP, enforced through Ch. 19.05 of the Calistoga Municipal Code.

For more information regarding the Napa County Stormwater Management Program, visit https://www.countyofnapa.org/1351/Stormwater-Program.

Napa County Water Availability Analysis

Napa County Groundwater Conservation Ordinance, County Code Section 13.15, describes activities requiring discretionary approval of use permits to develop groundwater of source of water supply. The County requires that discretionary projects proposing to use groundwater provide a Water Availability Analysis (WAA) as part of the required California Environmental Quality Act (CEQA) analysis of proposed discretionary projects. The WAA includes components for evaluating potential adverse impacts on the groundwater basin as a whole, on groundwater levels in neighboring non-project wells, and on surface waters. The WAA was first adopted by the Napa County Planning Commission in 1991 and later revised in 2003, 2007, and 2015, the Water Availability Analysis (WAA) outlines the procedures and water demand criteria for the Napa Valley Subbasin based on analyses of safe yield, published by the USGS in 1973 and by Montgomery Engineers in 1991 (Faye, 1973 and James M. Montgomery Consulting Engineers, 1991).

The WAA established groundwater use thresholds across residential, agricultural, commercial, and industrial sectors, based on the premise that each landowner has equal right to the groundwater below their property. The current WAA provides objective water use criteria, well spacing and construction criteria, and surface water setback and streamflow depletion criteria (**Appendix 3A**, **Appendix 3B**, **Appendix 3C**). Proposed projects are subject to site-specific study under certain conditions, including projects that do not initially meet the applicable screening criteria and any project located in areas outside of the Napa Valley Floor, an area defined by the County with a boundary similar to that of the Subbasin.

Public Water Systems Regulation

Napa County has a contract with the California State Water Resources Control Board to oversee water systems with less than 200 service connections. The County Environmental Health Division ensures that safe and potable drinking water is available by identifying risk factors that contribute to acute and chronic illness and working with water system operators to minimize these risks. Public water systems are required to monitor and report water quality data from their systems. The County regulates those systems to ensure that federal and state drinking water quality standards are met.

Well and On-site Wastewater Regulation

The Napa County regulates wastewater treatment and disposal systems in the unincorporated area of Napa County and parcels not served by public sewer located within city limits. The Well and Onsite Wastewater Treatment subdivision of the Environmental Health Division reviews and issues permits for water well construction, soil borings, monitoring wells and geothermal wells.

The Well and Onsite Wastewater Treatment subdivision is also responsible for permitting and inspecting alternative sewage treatment systems, liquid wastewater haulers, winery wastewater ponds and holding tanks. Well and Onsite Wastewater Treatment staff review use permit applications, building permit plans and applications, and lot line adjustments for compliance with requirements found in Napa County Code.

Bay Area Integrated Regional Water Management Plan

The County of Napa and City of Napa participate in a regional effort to “coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay” (Bay Area IRWMP, 2020). Public agencies throughout the nine-county San Francisco Bay Area participate in the IRWMP.

In 2005, the County formed the Napa County regional water management group (RWMG), a working group of local water agencies, where the Napa County Flood Control and Water Conservation District served as the lead agency. The RWMG worked together to draft the Napa-Berryessa Integrated Regional Water Management Plan (IRWMP) Functional Equivalent (Napa-Berryessa Regional Water Management Group, 2005).

In 2009, the California Department of Water Resources (DWR) established Integrated Regional Water Management (IRWM) regions that have been accepted through the Regional Acceptance Process (DWR, 2009). An IRWM is defined by DWR as “a collaborative effort to identify and implement water management solutions on a regional scale that increase self-reliance, reduce conflict, and manage water to concurrently achieve social, environmental, and economic objectives” (DWR, 2015a). Currently, there are two formally accepted IRWM regions that occur in Napa County: 1) the San Francisco Bay Area Region and 2) the Westside Sacramento Region.[3] The San Francisco Bay Area Region includes the entire Napa River Watershed and the Napa Valley Subbasin.

The County has contributed to the Bay Area IRWMP through the San Francisco Bay RWMG, including the most recent update completed in 2019. The County’s participation in the Bay Area IRWMP enables further coordination and sharing of information on water resources management planning programs

[3] The Westside Sacramento IRWM Region includes northern and eastern areas of Napa County within the Putah Creek/Lake Berryessa watershed. The Westside Region also covers parts of Yolo, Solano, Lake, and Colusa Counties but is not within the Plan Area for the Napa Valley Subbasin GSP.

and projects, particularly those that are a high priority for the County and other local agencies in the region.

3.1.1.2. City of Napa

Drought Contingency Plan

In 2020, Napa Valley municipalities and the County of Napa began development of the Napa Valley Drought Contingency Plan (NVDCP). The City of Napa serves as the lead agency for the NVDCP. The NVDCP enables coordinated drought response actions by Napa Valley municipalities and the Napa County Flood Control and Water Conservation District. Analyses prepared for the NVDCP consider the projected municipal water demands and water supply variability due to climate change, both for sources of supply located within the Napa River Watershed and for State Water Project supplies. The NVDCP also describes proposed projects and mitigation actions that the municipalities and the Napa County Flood Control and Water Conservation District will implement to balance future water supplies and demands.

Urban Water Management Plan

Updated in 2017, the City of Napa Urban Water Management Plan (UWMP) provides a framework for long-term water resource planning to meet the specific requirements of California Assembly Bill 797 in 1983, titled the Urban Water Management Planning Act. The Act was signed into law in 1984 and is contained in Water Code Division 6, Part 2.6, Sections 10610 through 1056. The plan includes an assessment of the City's water supply system reliability applying a 20-year projection under differing hydrologic conditions, including normal, single-dry, and multiple-dry years. Under these projections, the City summarizes its five-stage plan for addressing potential water shortages and the actions that would be taken in response to a devastating interruption of water supplies. To promote water conservation the City has adopted several demand management measures, including metered water use, conservation pricing of water utilities, and programs such as the Water Offset Program and the Napa Sanitation District Recycled Water Agreement.

The City of Napa Urban Water Management Plan can be accessed at https://www.cityofnapa.org/609/Urban-Water-Management-Plan.

Water Efficient Landscape Guidelines

The City of Napa Water Efficient Landscape Guidelines, updated in 2015, provide support for the City of Napa's Efficient Landscape Ordinance (WELO), required under the California State Model WELO (California Code of Regulations Title 23, Division 2, Ch. 2.7). These guidelines establish a structure for planning, designing, installing, and maintaining water efficient landscapes in new construction and rehabilitation projects. To establish efficient use of water without waste, a Maximum Applied Water Allowance is set as an upper limit prior to the issuance of a building permit to reduce water use in the landscape to the lowest practical amount. The City of Napa plans to release an update to the Water Efficient Landscape Guidelines by July 2021.

The City of Napa Water Efficient Landscape Guidelines and WELO can be accessed at https://www.cityofnapa.org/602/Water-Efficient-Landscape-Ordinance-WELO.

3.1.1.3. Napa Sanitation District

Wastewater Treatment Plant Master Plan

Updated in 2011, Napa Sanitation District (NapaSan) Wastewater Treatment Plant Master Plan includes an evaluation of the Wastewater Treatment Plant (WWTP) performance, optimization, identification and rectification of existing deficiencies, and defines a cost-effective path for the next 20 years. NapaSan manages the WWTP to remove many trace constituents from the local water environment, however, the system is not designed for consistent trace constituent removal to low concentrations. Hence, the District has implemented a Pollution Prevention and Source Control Program to control sources of pollutants to the WWTP to address this issue. In addition, NapaSan employs a pretreatment program for industrial and commercial facilities. Pollutants targeted in the pretreatment program include heavy metals such as copper, lead, mercury and nickel, and organic material that might elevate BOD loading to the WWTP. NapaSan encourages the industrial and commercial facilities with high quantities of such pollutants in their wastewater streams to reduce their concentration and mass before discharging to NapaSan collection system. NapaSan enforces this pretreatment program in accordance with federal pretreatment regulations (40 Code of Federal Regulations (CFR), Part 40), pretreatment standards put forth by the Clean Water Act, and its NPDES permit.

The Napa Sanitation District's Wastewater Treatment Plant Master Plan can be accessed at https://www.napasan.com/177/Wastewater-Treatment-Plant.

Strategic Plan for Recycled Water Use in the Year 2020

Released in 2005, NapaSan completed a Strategic Plan for recycled water use through the year 2020 and provides population and business growth projections. The plan proposed strategies to increase recycled water capacity, production, and funding, with strategies ranging from minimal to full recycling and maximizing use of existing storage to optimize larger recycled water users. The plan outlines the benefits of water recycling to include; 1) augmenting existing water supplies; 2) preventing overdraft of groundwater resources; 3) ensuring the highest quality water is reserved for potable uses; and 4) increasing NapaSan's ability to comply with summer river discharge prohibitions. In addition to outlining several other strategies to expand the recycled water program, the plan assesses options to expand operations at the Suscol Water Recycling Facility (WRF).

The Napa Sanitation District's Strategic Plan for Recycled Water Use in the Year 2020 can be accessed at https://www.napasan.com/DocumentCenter/View/439/Strategic-Plan-for-Recycled-Water-Use-PDF

3.1.1.4. Town of Yountville

Recycled Water Program

Updated in 2006, the Town of Yountville has implemented a General Water Reuse Permit (Order No. 96-011) program to ensure recycled water produced in the town is safely and legally applied to irrigation sites. The Recycled Water Program is predominantly used for irrigation at a local golf course and irrigation at local vineyards. Depending on the type of permit, the program holds the user or the Town of Yountville responsible for reporting water use, water quality, or any violations of the permit that may take place. The Town of Yountville is responsible for submitting an annual report to the SWRCB each year, in which the report includes user site inspection reports, user self-monitoring reports, and more.

The Town of Yountville Recycled Water Program can be accessed at https://www.townofyountville.com/departments-services/public-works/wastewater/recycled-water-program.

Sewer System Management Plan

Updated in 2016, the Town of Yountville's Sewer System Management Plan (SSMP) was developed in compliance with Section D.13 of the SWRCB WQO-2006-0003 Statewide General WDR for Sanitary Sewer Systems and the associated Monitoring Reporting Program (MRP). The plan pursues proper management of the system to provide appropriate procedures for reporting and responding to sewer overflows, reduce the potential and frequency of sewer overflows, proper monitoring of the sewer system, and mitigating the impact of sewer overflows.

The Town of Yountville Sewer System Management Plan can be accessed at https://www.townofyountville.com/departments-services/public-works/wastewater.

3.1.1.5. City of St. Helena

Water Supply Plan

Last updated in 2010, the City of St. Helena Water Supply Plan provides an evaluation of the City's potable water demand and potable water supply to inform strategies that the City could adopt to facilitate the St. Helena General Plan and Housing Element, and to reduce the probability and impact of future water supply deficiencies. The City has worked towards minimizing the use of groundwater as a potable water supply source for municipal use. The water supply plan evaluates the City's water demand and water supply reliability through several hydrologic conditions, and also provides several water supply strategies to eliminate projected water supply deficits. These strategies include measures to maintain groundwater use to the historical average annual amount, maintain the City's total water supply to 2008 levels, and maximize water conservation, which includes the complete termination of groundwater use for potable water supply.

Sewer System Management Plan (SSMP)

Updated in 2016, the City of St. Helena's SSMP was developed to comply with Provision D.13 of State Water Board Water Quality Order (WQO) 2006-0003 Sanitary Sewer System Waste Discharge Requirements (WDR) and the associated MRP. The goals of this plan include the proper management, operation, and maintenance of all parts of the wastewater collection system, adequate capacity to convey peak flows, minimizing frequency of Sanitary Sewer Overflows (SSOs), and mitigating the impact of SSOs. The SSMP includes an Overflow Emergency Response Plan and a Sanitary Sewer Overflow Water Quality Monitoring Program.

For more information regarding the development of the City of St. Helena Integrated Utility Master Plan and related documents, access the city's Public Works website at https://www.cityofsthelena.org/publicworks/page/rfp-city-st-helena-integrated-utility-master-plan.

3.1.1.6. City of Calistoga

Sewer System Management Plan (SSMP)

Updated in 2014, the City of Calistoga's SSMP was developed in compliance with Provision D.13 of State Water Board WQO 2006-0003 Sanitary Sewer System WDR and the associated MRP. The SSMP includes an Overflow Emergency Response Plan, pursuant to NPDES permit requirements and the Sanitary Sewer WDR to facilitate proper incident reporting procedures and to ensure that the protection of the environment and the public's health and safety remain a priority. These plans are made with the intent to minimize the effects of overflow with respect to impacts on public health, beneficial uses and water quality of surface waters and on customer service. The Capital Improvement Plan outlines measures for monitoring and managing the sewer system and ensuring the system is operating within capacity.

The City of Calistoga Sewer System Management Plan can be accessed at http://www.ci.calistoga.ca.us/home/showdocument?id=20277.

3.1.2. State and Federal Monitoring and Management Agencies

3.1.2.1. California Water Resources Control Board (SWRCB)

The California State Water Resources Control Board (SWRCB) maintains jurisdiction over Waste Discharge Requirements (WDRs), underground storage tanks, groundwater cleanup programs, and overall groundwater quality through policies and enforcement. Through California's Porter-Cologne Water Quality Control Act (Porter-Cologne Act), the SWRCB is the designated agency in charge of water quality, safe and reliable drinking water, and water rights. The SWRCB has a Regional Boards that adopt Water Quality Control Plans, knows as a "Basin Plan." The Basin Plans define water quality requirements for their specific region. The San Francisco Regional Water Quality Control Board (Water Board) Basin Plan, who's jurisdictional area includes the Napa Valley Subbasin, is discussed in **Section 3.1.6.1**.

The SWRCB is responsible for storing environmental data for regulated facilities in California in their Geotracker database, which includes groundwater levels and groundwater quality data. GeoTracker was initially developed in 2000 pursuant to a mandate by the California State Legislature (AB 592, SB 1189 (Stats. 1997, Chapter 814 and 185). Data from these regulated facilities usually include manual groundwater level measurements and samples from groundwater monitoring wells at each regulated site.

In addition to the GeoTracker program, the State and Regional Boards enforce groundwater quality protection through WDRs. Waste Discharge Requirements are considered the most important state regulatory controls for ensuring groundwater quality and compliance with Basin Plans, and include controls over the following: agricultural runoff, domestic septic systems, injection wells, wastewater recycled for reuse or discharged to land, dairy operations and timber harvesting. In the case that a contamination occurs in violation of any WDR, the State and Regional Boards are responsible for cleanup and abatement of groundwater sites impacted by the contamination. More information regarding the WDR Program can be accessed at https://www.waterboards.ca.gov/water_issues/programs/waste_discharge_requirements/.

The SWRCB maintains an online database containing records of investigations, actions related to cleanup activities, identified known contaminant cleanup sites, and permitted underground storage tanks. The online database can be accessed at http://geotracker.waterboards.ca.gov/.

SWRCB Division of Drinking Water

The Division of Drinking Water (DDW), within the SWRCB, is responsible for enforcing the Safe Drinking Water Act (SDWA). The DDW ensures access to safe drinking water through regulations that include water quality monitoring requirements for regulated public water systems. California has enacted its own SDWA that implements the requirements of the federal SDWA and, for some contaminants, sets more stringent Maximum Contaminant Levels (MCLs). More information regarding the DDW can be accessed at https://www.waterboards.ca.gov/drinking_water/programs/.

3.1.2.2. California Department of Toxic Substances Control

The California Department of Toxic Substance Control (DTSC) regulates hazardous wastes. The DTSC is responsible for enforcement of the federal Resource Conservation and Recovery Act (RCRA) and related state law requirements, such as California's Hazardous Waste Control Law. The DTSC regulations place controls on all phases of management of hazardous wastes, including generation, treatment, storage, transportation and disposal. Through the DTSC's Hazardous Waste Management Program and Site Mitigation and Restoration Program, groundwater is protected through the oversight of hazardous waste management and remediation. The DTSC maintains an online database of permitted hazardous waste sites, corrective action facilities, and information regarding site cleanup. Additionally, the DTSC enforces the Toxic Injection Well Control Act and the Toxic Pit Cleanup Act, both of which require monitoring and hazardous waste containment. The DTSC shares toxic site cleanup responsibilities with the California's Regional Water Quality Control Boards (Water Boards). Records can be accessed through the online database at https://www.envirostor.dtsc.ca.gov/public/.

3.1.2.3. California Geologic Energy Management Division

The California Geologic Energy Management Division (CalGEM), previously the Division of Oil, Gas, and Geothermal Resources (DOGGR), is mandated by Division 3 of the Public Resources Code to supervise the drilling, operation, maintenance, and abandonment of oil, gas, and geothermal wells in California. Regional Boards regulate well development drilling fluid and mud disposal and produced water disposal and reuse, which includes disposal discharge to ponds, roads, and the use of produced water as irrigation water. These discharges are regulated under individual and general WDRs. When these WDRs involve discharges from oil and gas operations to land, the CalGEM consults with the applicable Water Board. Another step being taken to understand and address water quality in areas of oil and gas development is the Water Quality in Areas of Oil and Gas Production – Regional Groundwater Monitoring Program undertaken by the State Board. The purpose of the program is to improve the understanding of threats posed to groundwater resources by oil and gas operations, including the extent of any contamination due to oil and gas development and the processes responsible for the contamination. More information on the California Geologic Energy Management Division can be accessed at https://www.conservation.ca.gov/CalGEM. More information on the Water Quality in Areas of Oil and Gas Production – Regional Groundwater Monitoring Program can be accessed at https://www.waterboards.ca.gov/water_issues/programs/groundwater/sb4/regional_monitoring/.

3.1.2.4. California Department of Pesticide Regulation

The California Department of Pesticide Regulation (DPR) is responsible for enforcing state laws and regulations consistent with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which mandates regulation of pesticide distribution, sale, and use. County agricultural commissioners are responsible for enforcement and permitting the use of restricted pesticides. DPR conducts regular surface water and groundwater sampling to monitor for pesticide contamination. Additionally, the Pesticide Contamination Prevention Act requires the DPR to protect groundwater from pesticide pollution through its groundwater protection program, whereby: 1) thresholds are placed on pesticides posing risk to groundwater; 2) a database of wells sampled for pesticides is maintained; 3) areas sensitive to pesticide contamination are identified (known as groundwater protection areas); and 4) mitigation measures are developed to prevent the movement in those areas. In addition to its databases of pesticide sampling in groundwater, DPR provides summaries of annual sampling and detections to the state legislature. More information on the California Department of Pesticide Regulation can be accessed at https://www.cdpr.ca.gov/.

3.1.2.5. United States Environmental Protection Agency

The federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) established a program to clean up uncontrolled or abandoned hazardous waste sites as well as accidents, spills and other emergency releases of pollutants and contaminants. Sites designated as a federal "Superfund" sites are eligible to receive funding for remediation and the U.S. Environmental Protection Agency (USEPA) is authorized to seek cooperation and funding from the parties potentially responsible for the contaminated sites. The California Carpenter-Presley-Tanner Hazardous Substances Account Act provides additional oversight, primarily for petroleum contamination sites that are exempt from CERCLA. Both state and federal Superfund programs maintain a list of sites found to pose sufficient risk to public health and/or the environment, with the federal list referred to as the USEPA's National Priority List (NPL) and the state list referred to as the "Hazardous Waste and Substances Site List." The California list of Hazardous Waste and Substances Sites is updated annually by CalEPA and maintained on DTSC's EnviroStor website, accessed at https://www.envirostor.dtsc.ca.gov/public/. More information regarding the state and federal Superfund programs can be accessed at https://dtsc.ca.gov/dtscs-cortese-list/ and https://www.epa.gov/superfund.

3.1.3. Groundwater Level Monitoring

Groundwater level monitoring can provide information on the volume and accessibility of groundwater in an aquifer system and can also indicate the direction of groundwater flow within an aquifer system. Groundwater level monitoring has been underway in the Napa Valley Subbasin for many decades. The earliest groundwater level records date to the 1918. The scope of monitoring expanded in the 1960s, when the USGS and County of Napa cooperated on a study of groundwater availability in Napa Valley (Faye, 1973). Since 2015, groundwater levels have been monitored at 77 wells or sites in the Napa Valley Subbasin (**Figure 3-1**).[4] The frequency of data collection in recently monitored wells ranges from continuous monitoring by automated pressure transducers to 5-year measurement intervals. Only four wells, monitored by the USGS, are revisited at five-year intervals. Ten County-owned dedicated monitoring wells currently have continuous pressure transducers installed to record groundwater levels. All others are monitored semi-annually or monthly. In addition to recently monitored wells, 260 wells were monitored prior to 2015 (**Figure 3-2**). **Table 3-1** summarizes the recent and historic groundwater level monitoring sites in the Plan Area by the reporting agency.

Table 3-1: Groundwater Level Monitoring Sites in Plan Area by Monitoring Entity

Monitoring Agency/Program	Well Count	
	Historical (pre-2015)	Recent (2015 to Present)
California Department of Water Resources	95	4
County of Napa	12	60
State Water Resources Control Board, GeoTracker	60	9
U.S. Geological Survey	93	4
Note: Some wells monitored historically may have data reported by more than one agency or program.		

3.1.3.1. County of Napa

In 2009, the County of Napa implemented a Comprehensive Groundwater Monitoring Program to meet action items identified in Napa County's 2008 General Plan update (Napa County, 2008). The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information.

[4] The SWRCB GeoTracker program often includes locations with dozens of monitored wells. For the purposes of this Section, all wells at a given SWRCB GeoTracker site are counted as a single site.

The program covers the continuation and refinement of countywide groundwater level and quality monitoring efforts for the purpose of understanding groundwater conditions, trends, and availability.

Funding from DWR through the 2012 Local Groundwater Assistance Grant Program enabled Napa County to construct 10 monitoring wells at five sites in the Napa Valley Subbasin in September 2014. The intent of the project was to enhance the understanding of groundwater-surface water interactions in the Napa Valley Subbasin. In general, each monitoring site consists of two wells; one is constructed to represent groundwater conditions at the water table surface and at elevations similar to the adjacent surface water channel, and the second is constructed to a deeper depth with screen intervals coinciding with aquifer materials and depths likely to be accessed by production wells in the vicinity. These wells are monitored continuously using transducers and data are collected from each instrument every two months. In early 2020, DWR awarded Napa County a Sustainable Groundwater Management planning grant that includes funding for the construction of eight additional groundwater-surface water monitoring wells at four additional sites in the Subbasin. The NCGSA is committed to the long-term operation of these facilities to improve the understanding of surface water and groundwater interactions.

As of fall 2019, the County regularly monitored groundwater levels at 64 wells in the Plan Area. Eight wells were monitored by Napa County at a monthly interval, to address temporal data gaps identified in the 2014 Annual Monitoring Report (LSCE, 2015). The portion of the County's current groundwater level monitoring network that focuses on groundwater-surface water interactions includes a total of 16 sites, 10 of which are monitored using continuously recording instrumentation at dedicated monitoring facilities.

In addition to its own monitoring efforts, the County provides tools and training to enable residents to monitor groundwater levels in their own wells. Residents are encouraged to contact Napa County staff to reserve a time to access their groundwater level measuring tool to measure levels during the spring and fall. The County notes that measurements collected over multiple years allows for seasonal trends to be identified. The monitoring tool provided by the County is a handheld device that detects the depth to groundwater using sound waves. County staff provide in-person training and assist with the initial calibration of the tool at a given well. Information regarding the County's Do It Yourself (DIY) Groundwater Level Monitoring program can be accessed at https://www.napawatersheds.org/DIY-monitoring-program.

3.1.3.2. U.S Geological Survey Groundwater Level Monitoring

The USGS maintains a publicly accessible database of water quality and groundwater level information (National Water Information System, or NWIS database). The NWIS database has water quality and/or water level data for 396 groundwater sites in the Napa region. Of the sites within the NWIS database, well construction information is provided for some of the sites, including construction date, well depth, and/or hole depth information. All USGS NWIS data have undergone QA/QC by the USGS. Groundwater level data collected by the USGS in the Napa Valley Subbasin span from 1920 to 2019. Groundwater level data collected by the USGS can be accessed at https://waterdata.usgs.gov/nwis/gw.

3.1.3.3. California Department of Water Resources and the California Statewide Groundwater Elevation Monitoring Program

The County of Napa participates in the CASGEM program as a designated Monitoring Entity, in accordance with Senate Bill SBX7 – 6 and has performed groundwater level (i.e., elevation) monitoring since 2011. Additionally, the CASGEM groundwater level monitoring network constitutes a portion of the overall countywide monitoring network. As of fall 2019, the County's CASGEM network included 20 privately-owned wells in the Subbasin. DWR also currently monitors four wells in the Napa Valley Subbasin as part of its voluntary groundwater monitoring efforts also reported through the CASGEM Program. More information regarding the CASGEM Program can be accessed at https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM.

3.1.3.4. California State Water Resources Board GeoTracker Program

Three sites were monitored in the Subbasin for groundwater levels as part of the SWRCB Regulated Facilities GeoTracker Program in 2019, although more sites have been monitored in the past. The groundwater level monitoring frequency is typically semi-annual or quarterly, although more frequent measurements are sometimes recorded. GeoTracker sites with data reported in 2019 are located in the Plan Area, although other sites monitored in past years have been located at various sites outside the Subbasin. The GeoTracker Program acts as a clearinghouse for data collected by various entities subject to approved monitoring plans and procedures. In Napa County many regulated facilities in the GeoTracker program are overseen by the County Environmental Health Division, in coordination with the SWRCB.

3.1.4. Groundwater Extraction and Use Monitoring

Groundwater extraction monitoring occurs at 101 wells in the Plan Area (**Figure 3-3**). These facilities include those designated as public water systems and other facilities required under a discretionary permit to report groundwater extraction.

3.1.4.1. Public Water System Groundwater Extraction

Community Water Systems

Four municipalities overlie parts of the Napa Valley Subbasin that regularly serve its residents through a water supply system: the City of Calistoga, the City of St. Helena, the Town of Yountville, and the City of Napa. Municipal groundwater extraction by these four municipalities is reported to the NCGSA annually, in which groundwater pumped in the Subbasin has accounted for less than 2% of total municipal water use over the last 20 years, approximately. The City of St. Helena maintains two active groundwater production wells located near the Napa River, south of Pope Street. These wells are referred to as the Stonebridge Wells and have a production capacity ranging from 395 to 565 AF annually. The City of Napa does not pump groundwater for municipal supply, the Town of Yountville owns an emergency municipal well to provide back-up supply during drought conditions with an annual capacity of 300 AF, and the City of Calistoga has not used groundwater as a source of supply since approximately 2000.

Other community water systems in the Plan Area report monthly production and deliveries of groundwater to the SWRCB through the Electronic Annual Reporting system.

Non-Community Water Systems

A non-community water system includes both Non-Transient Non-Community Water Systems (NTNCWS) and Transient Non-Community Water Systems (TNCWS). These non-community water systems serve either 25 or more of the same persons over 6 months of the year, or at least 25 different persons over 6 months of the year. Within the Plan area, these systems often include schools, hospitals, wineries, and other businesses. Such systems within the Plan area are subject to discretionary permitting, discussed in **Section 3.1.4.4**, in which permit holders are required to monitor groundwater extraction.

3.1.4.2. Agricultural Groundwater Extraction

Similar to many areas of the state, there is no comprehensive data collection of groundwater use by agriculture in the Subbasin. In the past, this has been addressed through the use of a root zone model to quantify the rate of water application on agricultural land to meet evapotranspiration demands by crops or other irrigated vegetation types. This root zone model accounted for other water uses as well, including recycled water and diverted surface water. Building on this past work, the Napa Valley Integrated Hydrologic Model (NVIHM) quantifies groundwater extraction within the Plan area using a supply and demand framework that integrates groundwater flow, surface water flow, landscape, subsidence, and reservoir processes. A detailed discussion of agricultural water use in the Plan area is provided in **Section 7.2**.

3.1.4.3. Groundwater Dependent Ecosystem Groundwater Use

Estimates of groundwater use by Groundwater Dependent Ecosystems (GDEs) have been made using spatial evapotranspiration datasets developed by LandSat imagery and processed according to the METRIC Evapotranspiration (ET) method.[5] This method is among several approaches for quantifying water use by vegetation described in draft guidance released by DWR in early 2020 (DWR, 2020). GDE groundwater use has been reported on a yearly basis starting in 2018. The NVIHM expands on this work by calculating groundwater use by GDEs as part of its simulation of evaporation and transpiration by vegetation across the Plan Area as part of historical, current, and future water budgets. A detailed discussion of GDE water use in the Plan area is presented in **Section 7.2**.

3.1.4.4. County of Napa Discretionary Permit Extraction Monitoring

The California Environmental Quality Act (CEQA) requires that agencies with land use permitting authority, including the County, conduct an environmental analysis of all discretionary permit applications considered for approval. Napa County regulates groundwater usage and well development through the implementation of discretionary permits and by following guidance outlined in the WAA

[5] Mapping EvapoTranspiration at high Resolution with Internalized Calibration (METRIC) is an analytical method that applies an energy balance method to calculate field-scale evapotranspiration using energy flux data collected by satellites, paired with data from ground reference points.

(**Section 3.1.1.1**). Discretionary permits implement conditions of approval determined through the WAA that require permittees to monitor groundwater levels in project wells and record amounts of groundwater pumped at regular intervals. Additionally, permittees are required to report those data to Napa County and make project wells available as part of the County's groundwater monitoring program, subject to certain conditions. Through the issuance of discretionary permits, monitoring data may be used to determine baseline water quality conditions, track groundwater levels, and assist the NCGSA in monitoring groundwater extraction within the Plan area.

3.1.5. Groundwater Quality Monitoring

Groundwater quality data are collected by Napa County, DWR, USGS, the DDW, and the SWRCB. Since 2015, groundwater levels have been monitored at 85 wells or sites in the Napa Valley Subbasin (**Figure 3-4**). The frequency of data collection in recently monitored wells ranges from continuous monitoring by automated transducers to 5-year sampling intervals. Four wells, monitored by the USGS, are revisited at five-year intervals, as part of the GAMA Program. Ten County-owned dedicated monitoring wells currently have continuous pressure transducers installed to record temperature and conductivity. These wells have also been sampled for laboratory analysis of general minerals and metals regulated in drinking water supplies. Wells with data reported to DDW are sampled for regulated drinking water constituents at various intervals according to the water system classification. Wells in the GeoTracker Program are typically sampled quarterly or semi-annually for constituents that often include volatile organic compounds but vary according to the specific requirements of the regulated facility. DWR has monitored two wells in recent years for general minerals and metals regulated in drinking water supplies. In addition to recently monitored wells, 191 wells were monitored prior to 2015 (**Figure 3-5**). **Table 3-2** summarizes the recent and historic groundwater quality monitoring sites in the Plan area.

Table 3-2: Groundwater Quality Monitoring Sites in Plan Area by Monitoring Entity

Monitoring Agency/Program	Well Count	
	Historical (pre-2015)	Recent (2015 to Present)
California Department of Water Resources	29	2
California Division of Drinking Water	77	56
County of Napa	-	10
State Water Resources Control Board, GeoTracker	63	13
U.S. Geological Survey	22	4

Note: Some wells monitored historically may have data reported by more than one agency or program.

3.1.5.1. California State Water Resources Board GeoTracker Program

Outlined in Title 22 of the California Code of Regulations (CCR), groundwater quality monitoring is mandated according to the size of a community water system that is supplied by groundwater resources, in which groundwater quality is then reported to the SWRCB. Groundwater quality data in Napa County are collected principally at sites regulated by the SWRCB through the Division of Drinking Water and Geotracker program, although data are also available from other public agencies. Also discussed in **Section 3.1.2.1**, data collected by regulatory agencies monitoring groundwater quality for compliance purposes submit reports to the SWRCB that are made accessible through the GeoTracker database. The approximate frequency of GeoTracker wells monitored in the Subbasin range from less than annually to annually or more frequent, in which key water quality constituents are generally evaluated, including electrical conductivity (EC), total dissolved solids (TDS), chloride, and nitrate, are tested. More details regarding the current groundwater quality monitoring network in the Plan area are provided in **Section 9.4.4**. In addition to the GeoTracker program, the State and Regional Board enforce groundwater quality protection through the enforcement of WDRs, discussed in **Section 3.1.6.1**.

3.1.5.2. U.S Geological Survey (USGS) Groundwater Quality Monitoring

The USGS maintains a publicly accessible database of water quality and groundwater level information through the NWIS database. The NWIS database has water quality and/or water level data for 396 groundwater sites in the Napa region. Groundwater quality data collected by the USGS span from 1949 to 2019. Groundwater quality data collected by the USGS can be accessed at https://waterdata.usgs.gov/nwis/gw.

In addition to past groundwater quality data collected by the USGS, the USGS implemented the Groundwater Ambient Monitoring and Assessment (GAMA) program, discussed below, in which the Napa Valley takes part in the North San Francisco Bay study unit.

<u>Groundwater Ambient Monitoring and Assessment (GAMA) Program</u>

As part of the GAMA program, for wells in the Napa Valley Subbasin are monitored on a five-year cycle. The GAMA program, created by the SWRCB in 2000 and later expanded by Assembly Bill 599- the Groundwater Quality Monitoring Act of 2001, is an interagency collaboration to monitor and assess groundwater quality in basins all around the State of California. The State and Regional Water Boards, DWR, Department of Pesticide Regulations, USGS, and Lawrence Livermore National Laboratory all participate in the GAMA Program in collaboration with local agencies and well owners. The USGS, however, serves as the technical lead for the Priority Basin Project (GAMA-PBP), which conducts water-quality assessments of shallow aquifers, the groundwater resources typically used for private domestic and small system drinking-water supplies. More information on the USGS GAMA program can be accessed at https://ca.water.usgs.gov/gama/.

Goals of the GAMA Program:

- Improve statewide comprehensive groundwater monitoring.
- Increase the availability to the public of groundwater quality and contamination information.

- Establish ambient groundwater quality on a basin wide scale.
- Continue periodic groundwater sampling and groundwater quality studies in order to characterize chemicals of concern and identify trends in groundwater quality.
- Centralize the availability of groundwater information to the public and decision makers to better protect our groundwater resources.

All four GAMA wells in the Subbasin are sampled by the USGS and belong to the USGS' public supply trends network.

3.1.5.3. California Department of Water Resources Groundwater Quality Monitoring

DWR maintains a variety of databases that contain hydrologic data for the State of California, including the Water Data Library (WDL), the Water Data Information System (WDIS) and the WellMA database. For Napa County, the WDL consists of water level measurements (1918 to present) and the WDIS consists of water quality results (1944 to present). DWR administers the CASGEM program, discussed in **Section 3.1.3.3**, to regularly and systematically collect and report groundwater data to determine seasonal and long-term trends in California's groundwater basins and subbasins. Although groundwater level monitoring is the main focus of the CASGEM program, groundwater quality data is periodically collected from CASGEM wells and reported to the WDL. The WDL can be accessed at https://wdl.water.ca.gov/.

3.1.5.4. Napa County Groundwater Quality Monitoring

Funding from DWR through the 2012 Local Groundwater Assistance Grant Program enabled the County of County to construct 10 monitoring wells at five sites in the Napa Valley Subbasin in September 2014. Napa County has monitored groundwater quality at these 5 sites within the Plan area since 2018. Each of the five sites includes a dual-completion monitoring well to enable monitoring of groundwater conditions at specific depth intervals. These dual-completion wells consist of two separate casings in a single borehole. Each casing is independent of the other with distinct total depths and screen intervals. The construction details for each casing were developed based on site-specific hydrogeologic and surface water channel considerations. These sites serve as the Plan area's monitoring network to protect against depletion of interconnected surface water, discussed in greater detail in **Section 5.4**.

3.1.5.5. Public Water Systems Groundwater Quality Monitoring

Beginning in 2001, Title 22 of the California Code of Regulations Sections 64469 and 64819 established requirements and the format for reporting laboratory results of public water systems' water quality analyses. All certified drinking water analytical laboratories—including those that are subcontractors of other laboratories—are required to submit water quality data directly to the Division of Drinking Water (DDW) in digital, electronic form. These submittals are referred to as Electronic Data Transfer (EDT). The EDT Library supplies links to water quality monitoring schedules, files for the DDW water quality database, and county small water system water quality data files. All drinking water quality data of public water supply systems submitted to the DDW through the EDT portal can be accessed at https://sdwis.waterboards.ca.gov/PDWW/.

3.1.5.6. Surface Water Monitoring

Since 2015, surface water levels and streamflow have been monitored at 22 sites in the Napa Valley Subbasin (**Figure 3-6**). These sites include seven sites where surface water quality data are monitored. Monitoring is conducted by the USGS at two stream gauges that have been in operation since the mid twentieth century, although one of the two gauges was relocated in more recent years. The NCFCWCD collects stream level or streamflow data at 15 sites. The County also collects surface water level and quality data at five sites near to five dual-completion monitoring wells along the Napa River and Dry Creek as part of its groundwater-surface water monitoring network. In addition to recently monitored sites, 6 sites were monitored in the Subbasin prior to 2015, although all of those six sites ceased operation by 1984 (**Figure 3-7**). **Table 3-3** summarizes the recent and historic surface water monitoring sites in the Plan Area.

Table 3-3: Surface Water Monitoring Sites in Plan Area by Monitoring Entity

	Well Count	
Monitoring Agency/Program	Historical	Recent
County of Napa / Napa County Flood Control and Water Conservation District	-	20
U.S. Geological Survey	6	2

3.1.5.7. San Francisco Bay Regional Water Quality Control Board

<u>Water Quality Control Plan, TMDLs, and Surface Water Ambient Monitoring Program (SWAMP)</u>

The San Francisco Bay Regional Water Quality Control Board (Water Board) regulates surface water and groundwater quality in the San Francisco Bay region, which includes the Napa Valley Watershed. The SF Bay Regional Water Board is responsible for administering water rights, water pollution control, and water quality functions for the state as part of the California Environmental Protection Agency (Cal/EPA) (Basin Plan, 2019). The SF Bay Regional Water Board, acting under the SWRCB, provides policy guidance and budgetary authority to the Regional Water Boards, which conduct planning, permitting, and enforcement activities. The Regional Water Boards shares authority with the SWRCB to implement the federal Clean Water Act (CWA) and the state Porter-Cologne Act. The SF Bay Regional Water Board's overall mission is to protect surface waters and groundwater in the region through the following tasks:

- Addressing region-wide water quality concerns through the creation and triennial update of a Water Quality Control Plan (Basin Plan);
- Preparing new or revised policies addressing region-wide water quality concerns;
- Adopting, monitoring compliance with, and enforcing waste discharge requirements and
- National Pollutant Discharge Elimination System (NPDES) permits;
- Providing recommendations to the State Water Board on financial assistance programs, proposals for water diversion, budget development, and other statewide programs and policies;
- Coordinating with other public agencies that are concerned with water quality control;

- Informing and involving the public on water quality issues.

By law, the SF Bay Regional Water Board is required to develop, adopt (after public hearing), and implement a Basin Plan for the Region. Serving as the region's Water Quality Control Plan, the Basin Plan is the master policy document that contains descriptions of the legal, technical, and programmatic bases of water quality regulation in the Region. At the regional level, the Basin Plan outlines water quality objectives both to define the appropriate levels of environmental quality and to control activities that can adversely affect the aquatic systems.

The Basin Plan provides both narrative and numerical water quality objectives that apply to all surface waters within the region (except the Pacific Ocean). Consistent with the U.S. Environmental Protection Agency (EPA's) water quality criteria, the Basin Plan outlines criteria for the following constituents:

- Bacteria (Fecal Coliform, Total Coliform, E. Coli)
- Bioaccumulation
- Biostimulatory substances
- Color
- Dissolved oxygen
- Floating material
- Oil and grease
- Population and community ecology
- pH
- Radioactivity
- Salinity
- Sediment
- Settleable material
- Suspended material
- Sulfide
- Taste and odor
- Temperature
- Toxicity
- Turbidity
- Un-ionized ammonia

At the county level, the SF Bay Regional Water Board has implemented a Pathogens Total Maximum Daily Load (TMDL) and Sediment TMDL program (as part of the Napa River Sediment Reduction and Habitat Enhancement Plan). The Basin Plan builds upon previous and ongoing successful efforts to reduce pathogen and sediment loads in the Napa River and its tributaries, and requires actions consistent with the California Water Code (CWC) Section 13000; the state's Nonpoint Source Pollution Control Program Plan (CWC Section 13369) and its Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program; compliance with applicable NPDES permits; and the human waste discharge prohibition. The SF Bay Regional Water Board monitors the success of these programs through their Surface Water Ambient Monitoring Program (SWAMP)[6]. In addition to the TMDL programs in place, the Basin Plan has also implemented a comprehensive urban runoff control program, in which the City of Napa is currently in the preliminary phase of conducting a baseline control program.

In the past, the Napa River was on EPA's 303(d) list of impaired water bodies due to nutrients, which resulted in the SF Bay Regional Water Board implementing Nutrient TMDL measures. Landowners, local watershed organizations, and many federal, state and local government agencies collaborated to implement nonpoint and point source control measures to reduce nutrient loading to the river. Due to

[6] https://www.waterboards.ca.gov/water_issues/programs/swamp/

these efforts, nutrient levels have since decreased, and in 2014 the Napa River was delisted as an impaired water body.

Information regarding the SF Bay Regional Water Board's Water Quality Control Plan can be accessed at https://www.waterboards.ca.gov/sanfranciscobay/basin_planning.html.

National Pollutant Discharge Elimination System (NPDES) Permit Program

Authorized by the CWA, the National Pollutant Discharge Elimination System (NPDES) Permit Program controls water pollution by regulating point sources that discharge pollutants, such as rock, sand, dirt, and agricultural, industrial, and municipal waste. The NPDES Program is a federal program that is implemented by the SWRCB and its nine Regional Water Quality Control Boards. Since its introduction in 1972, the NPDES Program has been responsible for significant improvements in water quality throughout the state and country. More information regarding the NPDES Permit Program in California can be accessed at https://www.waterboards.ca.gov/water_issues/programs/npdes/

Napa River and Sonoma Creek Vineyard Program

Although not included in the Basin Plan, the SF Bay Regional Water Board adopted a water quality control permit (General Permit) in 2017 for vineyard properties in the Napa River and Sonoma Creek Watersheds, implemented under the Napa River and Sonoma Creek Vineyard Program. The General Permit regulates parcels developed to include five-acre-or-larger vineyards that are located in the two watersheds. All vineyard parcels subject to the General Permit, regardless of slope of the planted area, must achieve performance standards for soil erosion in the farm area, and for discharge of nutrients and pesticides. Hillslope vineyard parcels, defined as vineyards where the average slope of the planted area is greater than five percent, also must achieve performance standards for vineyard storm runoff and for sediment discharge from unpaved roads. More information regarding General Permits under the Napa River and Sonoma Creek Vineyard Program can be accessed at https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/agriculture/vineyard/index.html.

3.1.5.8. U.S. Geological Survey (USGS) Stream Monitoring Network

Historically, the USGS has maintained 6 stream monitoring stations within the Plan area, with data spanning from 1929 to present. Monitoring includes stream flow monitoring at all 6 sites, accompanied by surface water quality monitoring at only one of the sites. Currently, the USGS maintains a stream monitoring site on the Napa River near St. Helena and a site on the Napa River near the City of Napa. Data are available on the National Streamflow Information Program (NSIP) web page of the USGS at https://waterdata.usgs.gov/nwis/sw.

3.1.5.9. Napa County

Discussed in **Section 3.1.5.4**, Napa County received funding from DWR in 2012 through the Local Groundwater Assistance Grant Program which enabled the County to construct 5 groundwater-surface water monitoring sites throughout the Plan area. These sites are equipped with a dual-completion monitoring well to allow monitoring of groundwater conditions at specific depth intervals and also include a stream transducer at each site. Surface water monitoring data at these sites span from 2015 to present. The County maintains the stream transducers as they collect stream levels, conductivity, TDS, salinity, and temperature at 15-minute intervals. Stream data is then compared with groundwater conditions at the nearby monitoring wells. These sites serve as the Plan area's monitoring network to protect against depletion of interconnected surface water, discussed in greater detail in **Section 5.4**.

Flood Alert Monitoring Network

Surface water in the Subbasin is monitored by the NCFCWCD as part of a flood monitoring system, with assistance from the Napa County Resource Conservation District (NCRCD). The NCRCD also conducts numerous watershed assessments regarding fish, habitat, water quality, and sediment TMDL monitoring. In partnership with the NCFCWCD, the NCRCD maintains the network of stream and precipitation gauges located throughout the Subbasin. This network of stream and precipitation gauges is referred to as Napa County's Flood Alert network, which provides real-time rain and stream data at monitoring intervals ranging from every hour to daily. There are approximately 20 Flood Alert precipitation and/or streamflow monitoring sites in the Subbasin. Flood Alert precipitation and streamflow monitoring sites are shown in **Figure 3-6**. Precipitation and streamflow observations collected by the Napa County Flood Alert monitoring network can be accessed at https://napa.onerain.com/.

Napa County Stream Watch – Citizen Science

As part of local efforts to engage residents of the Napa Valley Subbasin in watershed stewardship activities, in 2017 the NCRCD and the Watershed Information and Conservation Council (WICC) implemented Stream Watch, a citizen science program to collect qualitative observations of streamflow and litter accumulation. The Stream Watch program has 26 designated monitoring sites within the Subbasin and general vicinity that observers may visit and report observations to the WICC Stream Watch website. Observation guidelines are provided for both streamflow and litter observations to assure consistent qualitative reporting. Additionally, a photo of each site is required with each observation entry, which is later quality checked by NCRCD staff. For more information regarding the Stream Watch program, visit https://www.napawatersheds.org/observation-help.

3.1.6. Surface Water Diversion Monitoring

Surface water rights and diversions in the Subbasin are reported to the SWRCB Electronic Water Rights Information Management System (eWRIMS) annually. eWRIMS contains information on Statements of Water Diversion and Use that have been filed by water diverters, as well as registrations, certificates, and water right permits and licenses that have been issued by the SWRCB and its predecessors. The eWRIMS Report management System (RMS) is used by water right holders to submit reports required as a result of their diversion and use of water. eWRIMS provides information regarding California's water rights and has made the data accessible through tabular database and through Geographic Information System (GIS) mapping. **Figure 3-8** shows the location of surface water diversions within the Plan area that are reported to the eWRIMS database. All public users or stakeholders have access to eWRIMS data and can download information at https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/.

3.1.7. Land Subsidence Monitoring

High-resolution land surface elevation data are available in the Subbasin at benchmarks established through the National Geodetic Survey (NGS) and adjacent to the Subbasin at two continuous global positioning system (cGPS) stations (**Figure 3-9**). These include three benchmarks in the Subbasin that have been re-surveyed over many years. In addition to those sites, there are two continuous global positioning system (cGPS) stations located in the upper Napa River Watershed as part of a network that observes plate tectonic activities. While the cGPS stations do not directly monitor land surface elevations in the alluvial Subbasin, they provide valuable context regarding the elevation trends in the consolidated rock formations, which can influence elevation changes in the Subbasin.

3.1.7.1. Ground Station Monitoring

National Geodetic Survey Network

The NGS benchmarks in the Subbasin are located in the Calistoga, Oakville, and Napa vicinities. The last three measurements at these benchmarks were taken in 1994, 2007, and 2012. Access to mapping and data collected from the NGS sites can be accessed at https://geodesy.noaa.gov/NGSDataExplorer/.

UNAVCO GNSS/GPS Network

Several UNAVCO cGPS stations, although located outside of the Plan area, record continuous measurements in vertical displacement. These stations have been recording vertical displacement beginning in 2005 and 2007. Information from this monitoring can support monitoring of land subsidence resulting from extraction of groundwater, however, there are no known UNAVCO cGPS stations within the Plan area. Access to a map and data collected from the UNAVCO cGPS sites can be accessed at https://www.unavco.org/instrumentation/networks/status/all/realtime

3.1.7.2. Remote/Satellite Monitoring

Interferometric Synthetic Aperture Radar

In addition to periodic monitoring of the NGS benchmarks, the USGS monitors changes in land surface elevation using Interferometric Synthetic Aperture Radar (InSAR) data collected by the European Space Agency (ESA) Sentinel-1A satellite and processes by TRE ALTAMIRA Inc. (TRE), under contract with DWR as part of DWR’s SGMA technical assistance for GSP implementation. Data provided from TRE ALTAMIRA are delivered as point data and geographic information systems (GIS) rasters interpolated from point data to display the total vertical displacement relative to June 2015 and annual vertical displacement rates at monthly timesteps. Subsidence data have been tested for positional and vertical accuracy, revealing a vertical accuracy of 16 mm at 95% confidence level. Land surface elevation data from both the NGS and TRE provide two reliable sources of monitoring that are within the Plan area boundaries.

More information regarding TRE InSAR subsidence data can be accessed at https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence.

3.1.8. Conjunctive Use Programs

Conjunctive use is defined in the Napa County General Plan as a "program where surface water supplies are used during times when sufficient surface water is available to meet all water demands (generally the wetter years) and groundwater supplies are used instead of surface water supplies to meet some or all water demands during times when surface water supplies are not sufficient to meet all demands (generally drier years)." The conjunctive use of groundwater and surface water supplies improves water supply reliability and can mitigate the reduction of groundwater in storage. Agricultural and rural uses are prevalent in the Subbasin, in which conjunctive use of groundwater and surface water to satisfy demands is permitted through Policy CON-51 of the Napa County General Plan, stated below.

Policy CON-51*: Recognizing that groundwater best supports agricultural and rural uses, the County discourages urbanization requiring net increases in groundwater use and discourages incorporated jurisdictions from using groundwater except in emergencies or as part of conjunctive-use programs that do not cause or exacerbate conditions of overdraft or otherwise adversely affect the County's groundwater resources*.

3.2. Land Use Elements or Topic Categories of Applicable General Plans (§354.8 a and f)

The Subbasin is primarily vineyard and urban land. Municipal, followed closely by agriculture, are the largest water users in the Subbasin. Municipal demands are met primarily through local surface water resources and imported water, and agricultural demands are met primarily through groundwater sources.

3.2.1. Historical Land Use and Water Resource Management and Advisory Committees

Napa County GSA and its citizens have a legacy of watershed stewardship and proactive management of environmental resources. Efforts to conserve and preserve land, water, and ecological communities have been underway since the 1960s. A summary of these efforts are provided below.

In collaboration with Napa Valley municipalities, the County formed the Water Advisory Committee (WAC) in 1992 to guide future groundwater management actions. In 1993, the WAC synthesized recent studies of Napa Valley water demands and supplies and recommended management strategies to avoid future shortfalls. The management strategies developed by the WAC included short-term, mid-term, and long-term strategies for coordinated actions. Those recommended strategies furthered the County's understanding of water supply conditions and informed future actions, including the adoption of ordinances to regulate groundwater extraction and use, and adoption of County policy through the 2008 General Plan Update. Building on the work of the WAC, the County, through the NCFCWCD, in coordination with Napa Valley municipalities have avoided water supply shortfalls through a range of actions, including conservation, expansion of recycled water supplies, and increases in surface water supplies available through the State Water Project.

In 1999, the Napa County Board of Supervisors (BOS) adopted Ordinance No. 1162 with the intent to regulate the extraction and use and promote the preservation of the County's groundwater resources. This is accomplished through requiring groundwater permits for discretionary uses, defining and delineating groundwater deficient areas where exceptions to groundwater permitting requirements are not applicable, requiring groundwater permits for zoning or parcel subdivision applications where groundwater is required or anticipated to provide a source of supply. In addition to these regulations, the 1999 groundwater ordinance revised the County Code to include an objective "to avoid overdrafts in extraction from the groundwater basins of Napa County, to maximize the long-term beneficial use of Napa County's groundwater resources, and to ensure that sufficient groundwater is available for the long-term viability of agriculture in Napa County" (Napa County Code, §18.04). Later updates to the Groundwater Conservation Ordinance were introduced over time, with Ordinance No. 1230 (adopted November 5, 2003) providing an explicit definition of overdraft and implementing groundwater use restrictions dependent of land type and proportional to land acreage, and Ordinance No. 1254 (adopted March 8, 2005) excluding ministerial approval for applications for single-family dwelling units if a public water supply is available on the property.

In 2002, the County BOS created the Watershed Information and Conservation Council (WICC). The WICC serves as an advisory committee to the County BOS – assisting with the Board's decision making and serving as a conduit for citizen input by gathering, analyzing, and recommending options related to the management of watershed resources. The WICC is comprised of a Board of Directors (BOD) chosen to represent the diversity of the Napa County community. The WICC BOD includes representation from every municipality in Napa County (City of Calistoga, City of St. Helena, Town of Yountville, City of Napa, and City of American Canyon) and a broad at large membership representing environmental, agricultural, development and community interests. The WICC is charged with guiding and supporting community efforts to maintain and improve the health of Napa County's watershed lands by coordinating and facilitating partnerships among the individuals, agencies, and organizations involved in improving watershed health and restoration; supporting watershed research activities; and providing watershed information and education. Since 2011, the WICC has received presentations and briefings on the County's comprehensive groundwater studies. Since 2014, the WICC has effectively served as the County BOS advisory committee on groundwater. At the WICC's public meetings, updates and status reports were provided on the County's groundwater program and SGMA implementation.

With input from the WICC and the public in recent years, the County has coordinated the regulation of groundwater use and land use through the General Plan, last updated in 2008. The Conservation Element of the General Plan contains goals, policies, and action items that establish County objectives for the sustainable management of natural resources.

In 2011, the County BOS appointed 15 Napa County residents to the Groundwater Resource Advisory Committee (GRAC) to assist the County with implementing the General Plan with input from diverse environmental, agricultural, and community interests. In 2014, prior to the passage of SGMA, the GRAC was responsible for developing a sustainability goal and sustainability objectives for Napa County. These sustainability criteria were later revised in 2016 based on additional requirements applied by SGMA, which were then presented in the Napa Valley Subbasin Basin Analysis Report (LSCE, 2016).

In Napa County, watershed stewardship is supported by partnerships developed to protect and restore the landscape, guided by the best available science and public input. These stewardship efforts reflect a growing awareness of ecosystem needs. As the understanding of ecosystem needs has improved, the County and its partners have responded by changing how land and water resources are managed. As California's watersheds continue to face pressures from population growth and climate change, watershed management approaches will remain an integral part of maintaining whole system balance, including sustaining natural resource ecosystems. Now acting as a GSA, Napa County remains committed to stakeholder collaboration and advancing science-based sustainable watershed management to enhance watershed resilience and protect multiple beneficial uses of water for people and ecosystems. Resilience-focused approaches include ongoing restoration efforts along the Napa River and its tributaries, drought contingency planning, and groundwater sustainability planning.

3.2.2. Napa County General Plan

The California Government Code (§65350-65362) requires that each county and city in the state develop and adopt a General Plan. The General Plan consists of a statement of development policies and includes a diagram or diagrams and text setting forth objectives, principles, standards, and plan proposals. It is a comprehensive long-term plan for the physical development of the county or city. In addition to having a General Plan, GSP Regulations §354.8(f) requires the GSA to provide a plain language description of the land use elements or topic categories of applicable general plans governing the Subbasin.

The Napa County General Plan, adopted in 1969, was last updated in 2008 and consists of 8 main topics, or elements, of which the Napa Valley Subbasin GSP is subject to the rules and regulations that cover Agricultural Preservation and Land Use, Community Character, Conservation, Circulation, Economic Development, Housing, Recreation and Open Space, and Safety. The plan was prepared with a time horizon of at least 20 years, providing a blueprint for land use and future development. The following policies set forth under the Conservation element of the General Plan are key focuses in implementing the Napa Valley Subbasin GSP:

The County coordinates the regulation of groundwater use and land use through its General Plan. Most recently updated in 2008, the Conservation Element of the General Plan, contains goals and policies and action items that serve to establish County objectives for the sustainable management of natural resources, including groundwater and surface water resources.

As part of the Conservation Element, six goals are stated relating to the County's water resources, including surface water and groundwater. Complementing these goals are twenty-eight policies and ten water resources action items. The County's six water resources goals and six related action items are included below.

Goal CON-8: Reduce or eliminate groundwater and surface water contamination from known sources (e.g., underground tanks, chemical spills, landfills, livestock grazing, and other dispersed sources such as septic systems).

Goal CON-9: Control urban and rural storm water runoff and related non-point source pollutants, reducing to acceptable levels pollutant discharges from land-based activities throughout the county.

Goal CON-10: Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations.

Goal CON-11: Prioritize the use of available groundwater for agricultural and rural residential uses rather than for urbanized areas and ensure that land use decisions recognize the long-term availability and value of water resources in Napa County.

Goal CON-12: Proactively collect information about the status of the County's surface and groundwater resources to provide for improved forecasting of future supplies and effective management of the resources in each of the County's watersheds.

Goal CON-13: Promote the development of additional water resources to improve water supply reliability and sustainability in Napa County, including imported water supplies and recycled water projects."

Action Item CON WR-1*: Develop basin-level watershed management plans for each of the three major watersheds in Napa County (Napa River, Putah Creek, and Suisun Creek). Support each basin-level plan with focused sub-basin (drainage-level) or evaluation area-level implementation strategies, specifically adapted and scaled to address identified water resource problems and restoration opportunities. Plan development and implementation shall utilize a flexible watershed approach to manage surface water and groundwater quality and quantity. The watershed planning process should be an iterative, holistic, and collaborative approach, identifying specific drainage areas or watersheds, eliciting stakeholder involvement, and developing management actions supported by sound science that can be effectively implemented. [Implements Policies 42 and 44]*

Action Item CON WR-4*: Implement a countywide watershed monitoring program to assess the health of the County's watersheds and track the effectiveness of management activities and related restoration efforts. Information from the monitoring program should be used to inform the development of basin-level watershed management plans as well as focused sub-basin (drainage-level) implementation strategies intended to address targeted water resource problems and facilitate restoration opportunities. Over time, the monitoring data will be used to develop overall watershed health indicators and as a basis of employing adaptive watershed management planning. [Implements Policies 42, 44, 47, 49, 63, and 64]*

Action Item CON WR-6*: Establish and disseminate standards for well pump testing and reporting and include as a condition of discretionary projects that well owners provide to the County upon request* *information regarding the locations, depths, yields, drilling and well construction logs, soil data, water levels and general mineral quality of any new wells. [Implements Policy 52 and 55]*

Action Item CON WR-7*: The County, in cooperation with local municipalities and districts, shall perform surface water and groundwater resources studies and analyses and work toward the development and implementation of an integrated water resources management plan (IRWMP) that covers the entirety of Napa County and addresses local and state water resource goals, including the identification of surface water protection and restoration projects, establishment of countywide groundwater management objectives and programs for the purpose of meeting those objectives, funding, and implementation. [Implements Policy 42, 44, 61 and 63]*

Action Item CON WR-8*: The County shall monitor groundwater and interrelated surface water resources, using County-owned monitoring wells and stream and precipitation gauges, data obtained from private property owners on a voluntary basis, data obtained via conditions of approval associated with discretionary projects, data from the State Department of Water Resources, other agencies and organizations. Monitoring data shall be used to determine baseline water quality conditions, track groundwater levels, and identify where problems may exist. Where there is a demonstrated need for additional management actions to address groundwater problems, the County shall work collaboratively with property owners and other stakeholders to prepare a plan for managing groundwater supplies pursuant to State Water Code Sections 10750-10755.4 or other applicable legal authorities. [Implements Policy 57, 63 and 64]*

Action Item CON WR-9.5*: The County shall work with the SWRCB, DWR, CDPH, CalEPA, and applicable County and City agencies to seek and secure funding sources for the County to develop and expand its groundwater monitoring and assessment and undertake community-based planning efforts aimed at developing necessary management programs and enhancements.*

Under the Napa County General Plan, the Subbasin is coarsely designated to include "Cities", "Agricultural Resource", "Agriculture, Watershed, and Open Space", "Industrial", "Mineral Resources", "Public Institutional", and "Rural Residential" land classes (**Figure 3-10**). None of the land use designations in the General Plan will change water demands that will inhibit the NCGSA to achieve sustainable groundwater management over the planning and implementation horizon.

3.2.3. Municipal General Plans and Relevant Ordinances

3.2.3.1. City of Napa

Napa City Council adopted a comprehensive update of the General Plan in 1998 that outlines policies, standards, and programs regarding development in the City of Napa through the year 2020. Much of the remaining developable land within the Rural Urban Limits (RUL) of the city has one or more environmental constraints. These constraints limit the opportunities for development and affect the City's land use planning. These land use constraints are designated in flood prone areas, hillsides, wetlands and important habitats, and agricultural resources. The City of Napa General Plan provides protection to sensitive riparian corridors and hillsides from overdevelopment while the RUL protects agricultural land and open spaces. These protections are addressed through the following objectives:

- New development and redevelopment that enhance connections between the built and natural environments.
- The Napa River as a natural corridor and recreational spine connecting neighborhoods and providing a focus for downtown.
- An open space frame that includes views of the natural environment, including agriculture, the hills, water courses and wetlands.
- An accessible array of protected natural amenities both within and beyond the confines of the city.

The City of Napa has implemented several municipal codes (provided below) which are consistent with the goals outlined in the General Plan. The City of Napa General Plan can be accessed at https://www.cityofnapa.org/259/General-Plan.

Storm Water Quality Control Ordinance, Chapter 8.36

This ordinance provides the city with legal authority to implement the requirements of Section 402(p)(3) of the Clean Water Act and the Porter-Cologne Water Quality Control Act, California Water Code Section 13000 et seq., as embodied in the city's current NPDES permit. This ordinance sets forth the protection of public health, safety and general welfare; to protect water resources and to improve storm water quality; to cause the use of management practices by the city and its residents that will reduce the adverse effects of polluted runoff discharges on waters of the state; to secure benefits from the use of storm water as a resource; and to ensure the city is compliant with applicable state and federal law. In addition to streams, rivers, and lakes, groundwater is considered a receiving water of storm water and is protected under this provision.

Public Services Ordinance, Title 13, Chapter 13.04 – 13.12

This series of ordinances outline the requirements and authority of water service systems, and also the regulations regarding water contamination prevention, permanent water conservation, moderate water conservation, and severe water shortage.

Sewer Service System Ordinance, Chapter 13.16

This ordinance outlines the policies regarding sewer system connections, updating sewage facilities, developing sewer connections, and the use of septic tanks and chemical toilets.

Zoning Ordinance, Title 17, Chapter 17.38 – 17.42, Chapter 17.50

This series of ordinances define the criteria behind designating land use areas as floodplain management overlay districts, hillside overlay districts, planned development overlay districts, and water setback overlay districts, and outline the land use regulations associated with each. These provisions provide a mechanism for preserving open space, natural and historic features, minimizing runoff and soil erosion problems, and controlling the alteration of natural floodplains to accommodate flood waters.

Water Efficient Landscaping Ordinance, Chapter 17.52.520

Discussed in **Section 3.1.1.2**, this ordinance provides guidelines for efficient water use in new and rehabilitated landscaping through soil preparation, plant selection, and irrigation system design. This section serves to protect local water supplies through the implementation of a whole systems approach to design, construction, installation, and maintenance of the landscape resulting in water conserving climate-appropriate landscapes, improved water quality, and the minimization of natural resource inputs.

Wetlands/Marshes Ordinance, Chapter 17.52.530

This ordinance provides for the protection and restoration of wetland areas and outlines general provisions that apply to properties containing wetlands when a discretionary development permit is proposed. Such provisions include attaining a wetlands biologist assessment of the boundaries, wetland replacement or restoration, and protections through measures as buffer areas and wetland management plans that identify ways to maintain water flows and monitor wetland health following development activities.

3.2.3.2. Town of Yountville

Updated in 2019, the Town of Yountville General Plan lays out the community’s vision for the town and provides a framework for achieving the goals set forth. The plan is the Town’s primary governing document that determines future jobs, housing, and growth in the community. Goals and policies set forth by the plan include land use and open space and conservation. The Land Use Element of the plan outlines the Town’s approach to manage future growth and development, maintain land use and design standards, and continue to support agricultural uses in the Napa Valley. Although Yountville owns only one groundwater well for use in emergencies or drought situations, the town acknowledges the importance of maintaining the quality their available water resources and the overall environment. The Open Space and Conservation Element of the general plan provides goals, policies, and programs that will protect and preserve open space to protect habitat, watercourses, riparian corridors, native vegetation, agricultural land, as well as provide adequate water supply and protect water quality.

The Town of Yountville has implemented several municipal codes (provided below) which are consistent with the goals outlined in the General Plan. The Town of Yountville General Plan can be accessed at https://www.townofyountville.com/departments-services/planning-building/general-plan.

Water Conservation Ordinance, Chapter 13.20

This ordinance outlines the prohibitions and limitations, guidelines, and civil fines authorized by the town to conserve water provided by the public distribution system. Conservation measures to apply to new development and existing developments through retrofitting are outlined in the ordinance as well.

Water Shortage Emergencies Ordinance, Chapter 13.24

This ordinance outlines the regulations surrounding four phases of water shortage emergencies, including the criteria used to define each emergency, which evaluates current and projected available water supplies and the projected demand. Water shortage emergencies progress from voluntary conservation measures to mandated measures enforced by the town. The Town is authorized to terminate all nonessential water service contracts that are terminable. Notwithstanding any provision of this code to the contrary, the provisions of CWC §377 shall be applicable to any violation of this chapter. Any person violating any of the provisions of this chapter shall be guilty of a misdemeanor.

Sewer System Ordinance, Title 13, Division 2

This ordinance outlines the general provisions, construction criteria, sewer use regulations, and the fees and charges that apply to the Town's sewer system. In compliance with Section 13267 of the CWC, this ordinance provides guidelines for the proper management of sewer collection and treatment in a manner that avoids overflows of untreated sewage or partially treated wastewater effluent. The Town is given legal authority to disconnect any user from the system for any violation of the provisions defined in the ordinance.

Stormwater Discharge System Ordinance, Title 13, Division 5

This ordinance establishes local regulations, mandated by the Federal Water Pollution Control Act (i.e. Clean Water Act), 33 U.S.C. Section 1251, et seq. and the California Water Code, to prohibit certain acts and reduce the adverse effects of non-stormwater discharges into the storm drain system and watercourses, as well as protect water resources to improve water quality, protect the health and safety of residents, secure benefits from the use of stormwater as a resource, and reduce discharge of pollutants in stormwater to the maximum extent possible. This ordinance also implements regulations to control urban runoff, which includes enforcement of NPDES permit compliance. The Town is authorized to file a citizen suit to any person acting in violation of this division, who may also be acting in violation of the Federal Clean Water Act or the State Porter-Cologne Act and other laws and may be subject to sanctions including civil liability. Citizen suits are pursuant to the Federal Clean Water Act Section 505(a), seeking penalties, damages, and orders compelling compliance, and other appropriate relief. The Town may notify EPA Region IX, the Regional Board, or any other appropriate State or local agency, of any alleged violation of this division.

3.2.3.3. City of St. Helena

Updated in 2019, the City of St. Helena's General Plan outlines policies to guide future land use decisions and provides a framework to preserve existing development through the year 2040. The Land Use and Growth Management Element of the plan presents a framework for governing future decisions about allowable, context-appropriate land use and desired development patterns, whereas the Open Space and Conservation Element of the plan guides future decisions regarding how the City will sustain a healthy network of open spaces and protect natural resources for today's residents, as well as future generations. Element goals, policies, and implementing actions are designed to protect, maintain, and enhance St. Helena’s biological, ecological, and agricultural resources, while balancing current community resource needs with conservation endeavors to benefit the common good. These elements are addressed through the following plan goals:

- Manage growth and maintain community character
- Promote high-quality and sustainable development
- Preserve, enhance, and restore natural resources
- Ensure stewardship of water resources
- Expand sustainable agricultural practices

The City of St. Helena has implemented several municipal codes (provided below) which are consistent with the goals outlined in the General Plan. The City of St. Helena General Plan can be accessed at https://www.cityofsthelena.org/planning/page/general-plan.

Water Use Efficiency and New Development Ordinance, Chapter 13.12

This ordinance addresses the limited supply of water, which the St. Helena City Council has found to exist. This ordinance applies to both land and water development, and allows for the management, control and use of the municipal water department, and penalties for the violation thereof.

Water Wells Ordinance, Chapter 13.16

This ordinance is intended to regulate all water wells within the incorporated limits of the City and to protect and preserve surface waters and groundwater in and around the City. Standards for well construction, placement, maintenance and destruction of water wells are outlined in the ordinance, in which a new provision to meter and report water levels of all newly permitted wells was adopted in 2012.

Pollution of City Reservoirs, Chapter 13.04.190

To protect the City’s water supply, this ordinance bans all wading, swimming, fishing, cutting of wood, and all other forms of pollution in and around City reservoirs and watercourses supplying such reservoirs.

Water Shortage Emergencies, Drought and Water Conservation, Article 2, Chapter 13.04.220- Chapter 13.04.310

Provisions outlined in these ordinances establish a procedure for determining water shortage emergencies and the phases of water conservation to implement. Such notice shall set forth the limitations of water use applicable to the particular phase being established and further declares that violations of such limitations are punishable in accordance with the provisions of Sections 13.04.230 and 13.04.310. The establishment of a particular phase shall be completed and effective as described in the resolution adopting the water shortage phase.

Sewer Service System, Chapter 13.20

This chapter outlines requirements to sewer charges/fees, use of funds, sewer main connection capacity, providing compulsory connections, and adopting standard sewer construction details and specifications. The provisions outlined in this chapter are intended to protect surrounding watercourses and water supplies from sewer contamination.

Wastewater Discharge, Chapter 13.24

This provision defines uniform requirements for discharges into the wastewater collection and treatment system and enables the agency to comply with the administrative provisions of the Clean Water Grant Regulations, the water quality requirements set by the regional water quality control board and the applicable effluent limitations, national standards of performance, toxic and pretreatment effluent standards, and any other discharge criteria which are required or authorized by state or federal law, and to derive the maximum public benefit by regulating the quality and quantity of waste-water discharged into those systems.

Stormwater and Runoff Pollution Control, Chapter 13.32

This purposes of this chapter are to protect the health, safety and general welfare of city of St. Helena residents; to protect water resources and to improve water quality; to protect and enhance watercourses, fish, and wildlife habitat; to cause the use of management practices by the City and its citizens that will reduce the adverse effects of polluted runoff discharges on waters of the state; to secure benefits from the use of stormwater as a resource; and to ensure the City is compliant with applicable state and federal law. The provisions in this chapter promote these purposes by prohibiting illicit discharges to the stormwater conveyance system; establishing minimum requirements for stormwater management, including source control requirements, to prevent and reduce pollution; establishing requirements for development project site design, to reduce stormwater pollution and erosion; establishing requirements for the management of stormwater flows from development projects, both to prevent erosion and to protect and enhance existing water-dependent habitats; and establishing standards for the use of off-site facilities for stormwater management to supplement on-site practices at new development sites.

3.2.3.4. City of Calistoga

The City of Calistoga's general plan is the framework directing land use and development policies and shows how the City will grow and conserve its resources. Released in 2003, the purpose of the general plan is to guide development and conservation in the City through 2020. Updated in 2015, the Land Use Element of the plan provides policies and action items set forth with to ensure new development mitigates significant environmental, design and infrastructure impacts, and maintains the rural qualities of the unincorporated part of the Calistoga Planning Area. Last updated in 2003, the Open Space and Conservation Element of the plan provides similar items in response to goals set forth to conserve the value and function of Calistoga's open space as a biological resource, conserve the Napa River, its tributary drainages and associated riparian habitat, and to protect open space important for the managed production of resources in the Planning Area, including agriculture and viticulture.

The City of Calistoga has implemented several municipal codes (provided below) which are consistent with the goals outlined in the General Plan. The City of Calistoga General Plan can be accessed at http://www.ci.calistoga.ca.us/city-hall/departments-services/planning-building-department/plans-programs-and-land-use-regulations/calistoga-general-plan/calistoga-general-plan.

Water Shortages Ordinance, Article VII, Chapter 13.04

The purpose of this ordinance is to prohibit an increase in the use of the City's water supply, to eliminate all nonessential water usage, and to provide for an allocation of existing water resources to ensure a sufficient water supply for human consumption, sanitation and fire protection, in the event of a water shortage. This article can be liberally construed to effectuate its purpose, in which any violation can be a misdemeanor. There are three stages of water shortages outlined in the provision, implementing voluntary restrictions of water use to mandated restrictions in the most severe case. The City is authorized through this ordinance to apportion water among consumers.

Pollution of City Reservoirs Ordinance, Article IX, Chapter 13.04

To protect the water quality of the City's reservoirs, this ordinance outlines the regulations protecting against the pollution of water in reservoirs supplying drinking water and the water courses supplying such reservoirs. This ordinance also prohibits fishing and picnicking on reservoir properties.

Sewer Service Ordinance, Chapter 13.08

This ordinance provides the rules and regulations for the use, maintenance, construction, alteration and repair of all sanitary sewer facilities within the City. This provision applies to all sanitary sewer facilities now and hereafter in use within the City of Calistoga and authorizes the City of Calistoga to require permits for installation or repair of sewer lines. The discharge of rainwater, stormwater, groundwater, street drainage, subsurface drainage, yard drainage, water from yard fountains, geothermal well water, ponds or lawn sprays or any other uncontaminated water into any sewer system facility which directly or indirectly discharges to facilities owned by the City. The City is authorized to fine and prosecute any person in violation of the provision and may disconnect any user from the sewer system for violations.

Resource Management System Ordinance, Chapter 13.16

This ordinance outlines the operating standards of the City's resource management system, which is under the responsibility of the Director of Planning and Building to allocate water in accordance with the provisions of Chapter 19.02 Calistoga Municipal Code. Water and sewer services shall be monitored to establish a water and wastewater baseline on an annual basis for all nonresidential users which are connected to the City sewer and/or water system regardless of whether the connections were made under the resource management system or not. Quantities established for the baseline shall be based on past use and anticipated demand of these systems as determined by the Director of Public Works. Any water use or wastewater discharge exceeding the established baseline shall be subject to a surcharge fee for the use beyond the established baseline.

Watercourses Ordinance, Chapter 19.04

This ordinance outlines the requirements necessary for attaining a permit with the intent of performing any alterations on a watercourse. Acts prohibited without a permit include the deposit or removal of any material within a watercourse, the excavation of a watercourse, the construction or alteration or removal of any structure within, up, or across a watercourse, the planting or removal of any vegetation within a watercourse, and the alteration of any embankment within a watercourse.

<u>Stormwater Runoff Pollution Control Ordinance, Chapter 19.05</u>

The purposes of this ordinance is to protect the health, safety and general welfare of City of Calistoga residents; to protect water resources and to improve water quality; to protect and enhance watercourses, fish, and wildlife habitat; to cause the use of management practices by the City and its citizens that will reduce the adverse effects of polluted runoff discharges on waters of the State; to secure benefits from the use of stormwater as a resource; and to ensure the City is compliant with applicable State and Federal law. Regulations provided in this ordinance outline the following:

- Prohibits illicit discharges to the City's stormwater conveyance system.
- Establish authority to adopt minimum requirements for stormwater management, including source control requirements to prevent and reduce pollution.
- Establish authority to adopt requirements for development project site design, to reduce stormwater pollution and erosion both during construction and after project is complete.
- Establish authority to adopt requirements for the management of stormwater flows from development projects, both to prevent erosion and to protect and enhance existing water-dependent habitats.
- Establish authority to adopt standards for the use of off-site facilities for stormwater management to supplement on-site practices at new development sites.

<u>Cold Water Wells Ordinance, Chapter 19.06</u>

The purpose of this ordinance is to protect and preserve the cold water aquifers lying under and adjacent to the City through implementing limitations on well drilling permits, issuing penalties in the case of any violation, and requiring the maintenance of any existing wells within the City. The requirements of this ordinance only apply to permits issued for cold water wells drilled after 1998, the effective date of this provision.

<u>Conservations Regulations Ordinance, Chapter 19.08</u>

The purpose and intent of this ordinance is to protect the public health, safety, and community welfare and to otherwise preserve the natural resources of the City of Calistoga. These regulations have been developed in general accord with the policies and principles of the General Plan, as specified in the land use permit and the open space and conservation element. These regulations intend to minimize land modifications and soil erosion; maintain and improve, to the extent feasible, existing water quality by regulating the quantity and quality of runoff entering local watercourses; preserve riparian areas and other natural habitat by controlling development near streams and rivers; encourage development which minimizes impacts on existing land forms, avoids steep slopes, and preserves existing vegetation and unique geologic features; and preserve fish and wildlife resources, pursuant of Section 1600 of the California Fish and Game Code.

3.3. Additional GSP Elements (§354.8 e and g)

The additional GSP elements considered by the NCGSA to be relevant to the Napa Valley Subbasin are presented below. Some elements are introduced below and addressed in greater detail in related GSP Sections.

3.3.1. Description of Other GSP-Related Elements (§354.8 g)

All additional GSP elements provided by SGMA were considered for their applicability in the Napa Valley Subbasin. The additional elements deemed applicable are described hereinafter.

3.3.1.1. Well Permitting, Well Construction, Well Destruction, and Abandonment Policies

Napa County Department of Planning, Building, and Environmental Services provides information regarding well permitting, construction, destruction, and abandonment on its website, accessible at https://www.countyofnapa.org/1923/Environmental-Health-Documents. Well standards defined in Napa County Code of Ordinances Title 13.12 are consistent with California Well Standards (Bulletins 74-81 and 74-90). Permits are required to construct, reconstruct, repair, deepen existing wells, and destroy abandoned wells. Well permit forms must be submitted to Napa County's Environmental Health Division, in which wells must follow the provisions defined in Title 13.12.

Forms and guidelines regarding the construction and destruction of wells provided by Napa County are included in **Appendix 3D**.

Well Permitting

In order to obtain a permit to drill a groundwater well in Napa County GSA, applicant must fill out the Groundwater Permit Application form and also submit a Water Availability Analysis, if required to obtain a use permit (described in **Section 3.1.1.1**). The County is required by CEQA (Public Resources Code 21000–21177) and the CEQA Guidelines (CCRs, Title 14, Division 6, Chapter 3, Sections 15000–15387) to conduct an environmental analysis of all discretionary permits submitted for approval. CEQA requires analysis of several environmental aspects, including groundwater supplies, recharge interference, and local groundwater level impacts. If successful completion of a WAA determines that the proposed uses of groundwater will not result in impacts to neighboring wells, surface waters, or on the overall aquifer system, then an applicant can move forward with paying the applicable fees and hiring a properly licensed contractor.

The NCGSA is currently developing appropriate well testing standards that will be applied under specific circumstances[7]. These new well testing standards are required when new production wells are constructed in areas where hydraulic conductivity and other aquifer parameters are less well known,

[7] Consistent with recommendations provided in the Amendment to the Basin Analysis Report and its approval by the Napa County BOS in 2018 (LSCE, 2018).

including the Northeast Napa Management Area east of the Napa River and in deeper geologic units throughout the rest of the Subbasin. Because older and less productive geologic formations occur near ground surface in the northeast Napa area east of the Napa River, pump tests are necessary for all new production wells in that area**.** Similar pump testing are planned to be required for non-domestic production wells, and for wells that are completed in deeper geologic units below the Quaternary alluvium throughout the Subbasin.

<u>Well Construction</u>

Well construction standards are consistent with the California Well Standards, Bulletin 74-81 and 74-90 (**Appendix 3E**). Bulletin 74-81 was published by DWR in December 1981 which sets the minimum standards for well construction throughout the State of California. These standards were supplemented by Bulletin 74-90, which was published by DWR in June 1991 to include additional information on the construction of monitoring and cathodic protection wells. The State of California is currently revising Bulletin 74 as a replacement for Bulletin 74-90. Below is a list of the topics covered in each of these bulletins regarding the construction standards used for well installation in the Subbasin.

- Well location with respect to pollutants and contaminants
- Sealing the upper annular space
- Surface construction features
- Disinfection
- Casing
- Sealing-off strata
- Well development
- Water quality sampling
- Special provisions for large diameter shallow wells
- Special provisions for driven wells
- Rehabilitation, repair and deepening of wells
- Borehole temporary cover

In addition to California Well Standards, Napa County's WAA provides guidance for wells that fall under discretionary permits. The WAA may also apply when a discretionary Groundwater Permit is required by the Groundwater Conservation Ordinance, Section 13.15.010 of the Napa County Code.

<u>Well Abandonment</u>

In accordance with Section 115700 of the California Health and Safety Code, an inactive water well is considered abandoned if it has not been used for a period of one year and must be destroyed by a licensed C-57 Water Well Contractor unless the owner demonstrates an intention to use the well again. The intention to use an inactive well again shall be demonstrated by the well owner by properly maintaining an inactive well for future use in such a way the following requirements are met:

- The well shall not impair the quality of water in the well and groundwater encountered by the well.

- The top of the well or well casing will be provided with a cover that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well.
- The cover will be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover will be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface features of a well, when in compliance with the above provisions, shall suffice as a cover.
- The well will be marked so as to be easily visible and located and labeled so as to be easily identified as a well.
- The area surrounding the well will be kept clear of brush, debris, and waste materials.

Well Destruction

The following well destruction standards are based on California Well Standards Bulletins 74-82 and 74-90, in which only those with an active C-57 Water Well Contractors License may perform well destructions (CWC §13750.5; Well Standards §2.4.3). Well destruction performed as an "incidental part" of a larger job by a contractor not possessing a C-57 license is not allowed.

No person shall destroy any well without first applying for and receiving a permit issued by the Napa County Department of Planning, Building & Environmental Services (Napa County Code §13.12.240 and 13.12.480). All available well construction data shall be submitted with the application for a well destruction permit. All well destructions shall be performed according to Part III, Sections 20-23, Bulletin 74-81 and 74-90 (Napa County Code §13.12).

- A hole shall be excavated around the well casing to a depth of 5 feet (ft) below the ground surface (bgs) and the well casing removed to the bottom of the excavation (a variance to not excavate the casing may be requested for special circumstances).
- The sealing material used for the upper portion of the well shall be allowed to spill over the casing into the excavation to form a cap.
- After the well has been properly filled, including sufficient time for the sealing material in the excavation to set, the excavation shall be filled with native soil.
- A State of California Well Completion Report ("Well Log") shall be submitted to the Napa County Department of Planning, Building & Environmental Services within 60 days of the completion of any well destruction (CWC §13751).
- Materials used for sealing and fill materials are as follows:
    - Impervious Sealing Materials. Approved impervious materials include neat cement, sand-cement.
    - Grout, concrete, and bentonite clay.
    - Filler Material. These include clay, silt, sand, gravel, crushed stone and clean native soils.

3.3.1.2. Impacts on Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined as ecological communities of plant and animal species that require groundwater to meet some or all of their water needs. These ecosystems rely on groundwater especially during dry summers and periods of drought, in which they provide important benefits such as providing habitat for animals, water supplies, water purification, flood mitigation, erosion control, and recreational activities. Potential GDEs in the Subbasin are typically located in the vicinity of major tributaries and streams throughout the Napa Valley and wetlands in the southernmost extent of the Plan Area. The GDE mapping and analysis included in this GSP reflects guidance from TNC, California Department of Fish and Wildlife (CDFW), and others on approaches that consider the dependence on groundwater by endangered, threatened, and sensitive species present in the Subbasin (Rohde et al., 2019). Additional information about GDEs and environmental users of groundwater is provided later in this Section and in **Sections 6, 8, and 9**.

3.3.1.3. Control of Saline Water Intrusion

The seawater/freshwater interface occurs south of the Subbasin outside of the Plan area boundaries; its specific location has not yet been determined. The spatial distribution of saline groundwater south of the Subbasin is assessed primarily through examination of available chemical indicators, including chloride, TDS, EC, and sodium concentrations in groundwater. The highest historically observed concentrations of each of these constituents are observed in the three groundwater subareas south of the Subbasin in the Napa River Marshes, Jameson/American Canyon, and Carneros Subareas. Additional information on the influence of seawater on groundwater conditions in the Subbasin is provided in **Section 6**. Management criteria and management actions related to seawater intrusion are presented in **Sections 9 and 11**, respectively.

To better understand the conditions of the seawater/freshwater interface and its possible effects on the Subbasin, a series of nested monitoring well clusters have been recommended for installation near the southern boundary of the Subbasin to improve the capability to monitor salinity conditions.

3.3.1.4. Wellhead Protection and Recharge Areas

Through an amendment passed in 1986, Section 1428 of the Safe Drinking Water Act established the Federal Wellhead Protection Program, which defined Wellhead Protection Areas (WHPA) as the sensitive zones surrounding a water well that can act as pathways for groundwater supply contamination. The program introduced preventative measures, including the concept of land use controls, to protect groundwater quality. Amended once again in 1996, the Safe Drinking Water Act then required states to develop and implement a Source Water Assessment Program, which resulted in the passing of California Health and Safety Code Section 11672.60, requiring the Department of Health Services to protect drinking water sources through issuing a source water assessment program and a wellhead protection program. By 1999, the California Department of Health Services developed the Drinking Water Source Assessment and Protection Program (DWSAP), which aimed to focus on the management of the resource rather than act as a regulatory framework.

In addition to the DWSAP, the NCGSA follows the Napa County General Plan, WAA, and State Well Construction Standards, in accordance with DWR Bulletin 74-81 and 74-90, to provide standard wellhead protections. **Section 4.2.6** describes the recharge areas in the Napa Valley Subbasin.

3.3.1.5. Migration of Contaminated Groundwater

Active and closed groundwater remediation sites are generally located in and near municipalities in the Subbasin (**Figure 3-11**). That pattern reflects the greater occurrence of facilities more likely to be regulated by existing point-source groundwater quality protection programs. Additional information on groundwater quality conditions is provided in **Section 6**.

3.3.1.6. Relationship with State and Federal Agencies

<u>California Department of Fish and Wildlife</u>

Purchased in 1976, the Napa River Ecological Reserve (NRER) is approximately 73 acres of valley oak-bay riparian forest and hosts approximately 150 bird species, various mammals, and a diverse plant population, including the federal and state endangered Sebastopol meadowfoam (*Limnanthes vinculans*). The NRER is located within the Plan area boundaries and is owned and predominantly managed by the CDFW. In the past, however, Napa County Public Works has assisted in the maintenance of the reserve area and has provided assistance with special projects.

<u>California Department of Parks and Recreation</u>

Although just a small portion of the park resides within the Plan area boundaries, Bothe-Napa Valley State Park was established in 1960 and covers approximately 1,900 acres. The park contains the farthest inland Coast Redwoods among California state parks. Due to a lack of funds in 2011, the state targeted Bothe-Napa Valley State Park and its adjacent park, Bale Grist Mill State Historic Park, for permanent closure, but this was evaded due to petitions from the Napa Valley State Park Association. As of 2012, both parks are jointly managed between Napa County Regional Park and Open Space District and the Napa Valley State Parks Association.

<u>California Department of Water Resources</u>

In addition to cooperation between DWR and the County of Napa to collect groundwater level data, the County was approved in 2010 by the Napa County BOS to serve as a functioning groundwater monitoring entity, in accordance with Water Code Section 10927. Following guidance from DWR, the County has assumed monitoring of a number of CASGEM sites within the County, reporting measurements to DWR. Additionally, DWR has awarded the County of Napa funding to construct what is now the Plan area's Groundwater/Surface Water monitoring network through their Local Groundwater Assistance Grant Program. In 2020, DWR awarded the NCGSA approximately $2 million in assistance to support the development of a GSP for the Napa Valley Subbasin. DWR and the NCGSA plan to continue cooperation through the development and implementation of a GSP for the Napa Valley Subbasin.

U.S. Geological Survey

Various geologic studies conducted by the USGS in the Napa Valley region have been prepared in cooperation with the NCFCWCD and the Napa County Department of Public Works. These past studies have included geologic mapping, hydrogeologic characterization, and water well locating. The County of Napa has provided funding and assistance in data collection for these studies through providing semiannual monitoring, land surface altitude surveillance, and additional mapping services.

National Marine Fisheries Service

The National Marine Fisheries Service (NOAA Fisheries) is an Office of the National Oceanic and Atmospheric Administration with responsibilities including the "protection, conservation, and recovery or marine and anadromous species under the (federal) Endangered Species Act" (NOAA Fisheries, 2020). In this capacity NOAA Fisheries assesses threats to species survival, develops recovery plans, and designates critical habitat for endangered and threatened species. NOAA Fisheries has provided various forms of support to the NCRCD and its river and fisheries monitoring programs, including funding and technical guidance. A majority of the NCRCD monitoring efforts occur along the Napa River and its tributaries. NOAA Fisheries has mapped critical habitat for Central California coast winter steelhead (*Oncorhynchus mykiss - CCC winter*) throughout the Napa River mainstem and many of its tributaries within the Napa Valley Subbasin (**Figure 3-12**).

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) within the Department of Interior is responsible for implementing federal Endangered Species Act for terrestrial and freshwater species. The role of the USFWS is similar to that of NOAA Fisheries for the species that is charged with conserving. USFWS develops biological assessments, habitat conservation plans, recovery plans, and designates critical habitat for endangered and threatened species. The USFWS has mapped critical habitat for Contra Costa goldfields (*Lasthenia conjugens*) along part of the southern boundary of the Napa Valley Subbasin (**Figure 3-12**).

3.3.1.7. Considerations of Existing Land Use Policies

The NCGSA considered the Land Use policies outlined in the Napa County 2008 General Plan that are relevant to the Napa Valley Subbasin. Policies considered in the General Plan regard zoning, agricultural preservation, land use designations, and development standards. Future water budgets and other scenarios presented in this Plan were evaluated using land use and zoning measures consistent with the Napa County General Plan.

3.3.1.8. Measures to Enhance Groundwater Supply and Support Efficient Water Management

Although current groundwater conditions in the Subbasin indicate that storage capacity is limited, the County and NCGSA understand that groundwater supply enhancements may still be able to provide benefits, particularly with respect to the timing and rate of streamflow depletion. The benefits of groundwater supply enhancement may also become more pronounced in future years. SGMA briefly references several additional GSP elements which GSAs may include in their GSPs to address:

- Replenishment of groundwater extraction
- Activities to remove impediments to, or otherwise support conjunctive use or underground storage
- Measures addressing recharge, diversions to storage, conservation, recycling, etc.
- Efficient water management practices.

These topics are addressed in this GSP as part of the presentation of projects and management action to promote sustainability in **Section 11**.

3.4. Notice and Communication (§354.10, 10723.4)

3.4.1. Beneficial Uses and Users (§354.10 a, b, and c)

GSP Regulation §354.10 requires the GSA to provide a description of the beneficial uses and users of groundwater in the subbasin, including land uses and property interests potentially affected by the use of groundwater in the subbasin. In accordance with CWC §10723.3, the NCGSA considers the interests of all beneficial uses and users of groundwater, as well as those involved with implementing the GSP. Generally, beneficial uses of groundwater include domestic, agricultural, municipal, and environmental uses. In conformance with CWC §10723.2, the NCGSA has identified interested parties whose interests and beneficial uses will be considered during GSP development. These interested parties and beneficial users are discussed below.

3.4.1.1. Holders of Overlying Groundwater Rights

Holders of overlying groundwater rights includes domestic well owners and agricultural users such as farmers, ranchers, and dairy professionals. Domestic and agricultural wells make up a large portion of Plan area's total groundwater well type. Both groundwater rights holders and agricultural interests are represented through members of the Groundwater Sustainability Plan Advisory Committee (GSPAC). Additionally, the NCGSA provides opportunities for well owners to engage in groundwater planning and management efforts in the Plan area through meetings, surveys, and Plan review and comment.

3.4.1.2. Municipal Well Operators and Public Water Systems

Municipal and public water systems within the Plan area include the Cities of Calistoga, Napa, and St. Helena and Town of Yountville, and other non-community water systems. Non-community water systems include many wineries in the Plan Area along with and also account for schools, hospitals, and other businesses. Municipal well operators and public water systems are represented through members of the GSPAC who represent cities and towns, non-community water systems, and wine industry groups.

3.4.1.3. Local Land Use and Planning Agencies

Local land use and planning agencies within the Plan area includes the County of Napa and also cities with land use authority, such as the City of Napa, Town of Yountville, City of St. Helena, and City of

Calistoga. These entities are represented by several members of the GSPAC who represent the City of Napa, City of St. Helena, Town of Yountville, City of Calistoga, St. Helena Planning Commission, and others.

3.4.1.4. Environmental Users of Groundwater

Environmental users of groundwater within the Plan area include GDEs in the Subbasin and species that rely on interconnected surface waters. Additionally, environmental users of groundwater and interconnected surface water include entities that represent the interests of environmental users of groundwater, such as CDFW, USFWS, NOAA Fisheries, and non-governmental organizations. The interests of environmental users of groundwater and interconnected surface water are represented through members of the GSPAC that are members of or otherwise associated several groups including the Sierra Club, Water Audit California, the Napa County Resource Conservation District, and other organizations.

The NCGSA reviewed guidance documents and reference materials provided the stakeholder groups including The Nature Conservancy (TNC), CDFW, NOAA Fisheries, UC-Davis, and Audubon to inform mapping of GDEs within the Subbasin and to identify particular species known to be groundwater dependent for all or part of their life cycle. (Matsumoto, 2019, Klausmeyer et al., 2019, and Rhode et al., 2019).

Location information indicating the distribution of environmental users of groundwater, including potential GDEs and groundwater dependent freshwater species, show that they area present throughout the Subbasin including the Napa River and many of its tributaries (**Figure 3-12**). Through outreach to state and federal resources agencies and a review of reference materials including an excerpt of the California Freshwater Species Database for species identified in the Napa Valley Subbasin, the NCGSA identified 12 potentially groundwater dependent freshwater species and 9 additional species of special concern (**Table 3-4**). Species identification is an initial step towards considering the reliance on groundwater by environmental users of groundwater. Additional information about the distribution of GDEs and environmental users of groundwater is provided in **Section 6**. Additional information about the potential effects of Subbasin management on these beneficial users is presented in **Section 9**. Projects and management actions to avoid significant and unreasonable effects on beneficial users are presented in **Section 11**.

Table 3-4: Plan Area Environmental Users of Groundwater

Taxonomic Group	Scientific Name [1]	Common Name [1]	Potentially Groundwater Dependent [3]	Species of Special Concern [3]
Birds	*Agelaius tricolor*	Tricolored Blackbird	Yes	Yes
Herps	*Rana draytonii*	California Red-legged Frog	Yes	Yes

Taxonomic Group	Scientific Name [1]	Common Name [1]	Potentially Groundwater Dependent [3]	Species of Special Concern [3]
Plants	*Plagiobothrys strictus* [2]	Calistoga popcornflower	Yes	No
Plants	*Poa napensis* [2]	Napa blue grass	Yes	No
Birds	*Haliaeetus leucocephalus*	Bald Eagle	Yes	No
Birds	*Riparia riparia*	Bank Swallow	Yes	No
Crustaceans	*Syncaris pacifica*	California Freshwater Shrimp	Yes	No
Fishes	*Acipenser medirostris ssp. 1*	Southern green sturgeon	Yes	No
Fishes	*Oncorhynchus mykiss - CCC winter*	Central California coast winter steelhead	Yes	No
Fishes	*Spirinchus thaleichthys*	Longfin smelt	Yes	No
Plants	*Lasthenia conjugens*	Contra Costa Goldfields	Yes	No
Plants	*Limnanthes vinculans*	Sebastopol Meadowfoam	Yes	No
Birds	*Aythya americana*	Redhead	-	Yes
Birds	*Geothlypis trichas sinuosa*	Saltmarsh Common Yellowthroat	-	Yes
Birds	*Icteria virens*	Yellow-breasted Chat	-	Yes
Birds	*Pelecanus erythrorhynchos*	American White Pelican	-	Yes
Birds	*Piranga rubra*	Summer Tanager	-	Yes
Birds	*Setophaga petechia*	Yellow Warbler	-	Yes
Herps	*Dicamptodon ensatus*	California Giant Salamander	-	Yes
Herps	*Rana boylii*	Foothill Yellow-legged Frog	-	Yes
Herps	*Taricha torosa*	Coast Range Newt	-	Yes

1 Klausmeyer K., et al. 2015. California Freshwater Species Database, Version 2.0.9.
2 *Plagiobothrys strictus* and *Poa napensis were identified through input from CDFW staff.*
3 Rohde MM, Seapy B, Rogers R, Castañeda X, editors. 2019. Critical Species LookBook: A compendium of California's threatened and endangered species for sustainable groundwater management. The Nature Conservancy, San Francisco, California

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3.4.1.5. Surface Water Users

With over 300 registered surface water diverters within the Plan area, surface water users are those recorded within the eWRIMS database as a registered Point of Diversion with associated surface water rights. Conjunctive use of groundwater and surface water is a common practice within the Plan area to meet agricultural demands. Therefore, these interests are represented by GSPAC members who are surface water rights holders and affiliated with agricultural interest groups.

3.4.1.6. Disadvantaged Communities

Disadvantaged communities (DACs) within the Plan Area Include, but are not limited to, those served by private domestic wells or small community water systems. Disadvantaged communities generally refer to areas where inhabitants suffer from a combination of economic, health, and environmental burdens. These burdens may include poverty, high unemployment, air and water pollution, presence of hazardous wastes, as well as high incidence of asthma and heart disease. DACs are defined as a community with an annual median household income (MHI) that is less than 80 percent ($51,026) of the Statewide annual median household income ($63,783) (CWC §79505.5). In addition, communities identified as severely disadvantaged (SDAC) are those with an MHI less than 60 percent of the of the Statewide annual MHI. Proposition 1 also defines economically distressed areas (EDA) as municipalities with a population of 20,000 persons or less, a rural county, or a reasonably isolated and divisible segment of a larger municipality where the segment of the population is 20,000 persons or less, with an annual MHI that is less than 85 percent of the statewide MHI, and with one or more of the following conditions as determined by DWR: 1) financial hardship; 2) unemployment rate at least 2 percent higher than the statewide average, or 3) low population density (CWC §79702(k)) . DACs, SDACs, and EDAs, are collectively referenced here as Disadvantaged Areas (DAs).

The NCGSA utilized data provided by DWR to map DAs within the Subbasin (**Figure 3-13**). Those data show that DAs are scattered throughout the Subbasin, including areas in the north and central Subbasin, and in the south on the outskirts of the City of Napa. An important subset of DAs are SDACs that cover about 2.4% of the Subbasin and include areas near and within the Cities of Calistoga and St. Helena. **Figure 3-13** shows the location and extent of DACs and SDACs, mapped by the U.S. Census Bureau, and Farm Labor Camps, mapped by the County. The NCGSA will continue to work towards addressing the interests of disadvantaged communities within the Plan Area.

Table 3-5: Plan Area Disadvantaged Communities

	Percent of Plan Area
Disadvantaged Community	
Census Block	
Severely Disadvantaged Community	2.40%
Disadvantaged Community	2.36%
Economically Distressed Areas	
Tract	
MHI and Population Tract (<85% MHI and Population ≤ 20,000)	3.73%
Place	
Low Population Density (Less than or equal to 100 persons per sq. mile)	2.32%
DISADVANTAGED AREA TOTAL	**10.81%**

3.4.2. Public Notices and Opportunities for Public Engagement

Coordination with stakeholders, including outreach and solicitation of input, has been the foundation of transparent and stakeholder-driven water resource management in the Napa Valley Subbasin and continues to be a priority for SGMA implementation. The NCGSA posts the agendas of meetings, all of which are open to the public and publicized on the County website. Also on the County website, interested persons may sign up for the NCGSA email list to receive SGMA and GSP related updates. A total of X public meetings took place during the development of this Plan (**Table 3-6**). Meetings were structured to address one or more Sections of the GSP and provide progress updates on GSP development. Draft GSP Sections were released according to a publicly posted schedule for public comment beginning in July 2020. The release of GSP sections and scheduled meetings were staggered to provide time for stakeholder review of GSP sections and to allow for a question and comment period at subsequent public meetings.

To encourage the active involvement of social, cultural, and economic elements within the Subbasin boundaries, public meetings were held to inform the public of the status of GSP development and how the public could be involved in the process. The NCGSA will continue to inform the public regarding the progress of Plan implementation on its website (https://www.countyofnapa.org/1238/Groundwater-Sustainability-Planning).

Table 3-6: Opportunities for Public Engagement

Event Name	Date	Location
Groundwater Sustainability Plan Advisory Committee Regular Meeting #1	7/9/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	7/21/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #2	8/13/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	8/18/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	9/1/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #3	9/10/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	10/6/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #4	10/8/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #5	11/12/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	11/17/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #6	12/10/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Napa County GSA Meeting	12/15/2020	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #7	1/14/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #8	2/11/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #9	3/11/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #10	4/12/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #11	5/13/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #12	6/10/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #13	7/8/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #14	8/12/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559
Groundwater Sustainability Plan Advisory Committee Regular Meeting #15	9/9/2021	Via Zoom Meeting Conference 1195 Third St. Suite 305, Napa CA 94559

3.4.3. Comments on the Plan

The NCGSA solicited input on the GSP Draft Table of Contents and released draft GSP sections incrementally throughout the GSP development process. With each new release of a GSP section, the public and all other interested parties were given an initial x-day comment period. In addition to ongoing comments with each draft GSP section, the public was given x days to comment on a fully assembled draft GSP prior to its adoption. Comments received on draft sections and the complete draft GSP and responses from the NCGSA are included in **Appendix 3F**. In addition to providing valuable feedback on individual GSP sections, public comment guided the direction in which the Plan focused its main topics of discussion and management efforts to reflect the interests of the stakeholders.

3.4.4. GSA Decision-Making Process (§354.10 d)

Public notices, GSPAC meetings, and the NCGSA meetings presented a number of opportunities for stakeholders to provide feedback on current issues and GSP draft sections. With constant feedback from stakeholders, the NCGSA developed a robust GSP driven by the priorities of Napa Valley Subbasin stakeholders. As stated above, the NCGSA posted the agendas of meetings on the Napa County website and maintained an interested parties email list that provided SGMA and GSP related updates. Any persons interested in receiving these updates were able to do so by signing up on the email list. Stakeholders who wished to review and provide comments on draft GSP sections did so at meetings and electronically where GSP sections were posted online, at [insert link].

The methodology outlined below was utilized in the review of comments received on the GSP to determine its viability for inclusion:

- Compliance with the GSP Emergency Regulations;
- Viability of implementing the comment in the GSP;
- Benefit to the beneficial users and interested parties in the Subbasin (see **Section 3.4.1**; and
- Impacts on achieving sustainability by 2042.

The GRAC developed a Communication and Education Plan to serve as a strategic guide for their public communication and education activities. The communication goal of the plan was to ensure that interested parties and Napa County residents as a whole are well-informed of the deliberations and activities of the GRAC. The education goal of the plan was to increase the understanding of groundwater resources so these audiences also have a factual basis for discussion and decision making. The plan prioritized the development of informational brochures, fact sheets, and community outreach by GRAC members themselves. To further enhance stakeholder communication, the plan identified potential audiences and partners and other key elements, and prioritized actively reaching out to well owners to encourage participation in voluntary groundwater level monitoring.

Many aspects of the GSP were determined through coordination with stakeholders, the NCGSA's consultant, the GSP Advisory committee (GSPAC), and the NCGSA Board of Directors. Monthly meetings in a public forum including by video conference were conducted by the GSPAC and provided the platform for stakeholders and representatives of special interest groups throughout the Subbasin to give feedback regarding components of the GSP. The GSPAC consisted of 25 members who represented public interests in the Plan area and provided recommendations to the Napa County BOS. Any action or recommendation of the GSPAC required a quorum present (at least 13 members) and approval by a two-thirds vote. All items of the Subbasin GSP were approved by the NCGSA GSPAC. The bylaws of the NCGSA's GSPAC are attached as **Appendix 3G**.

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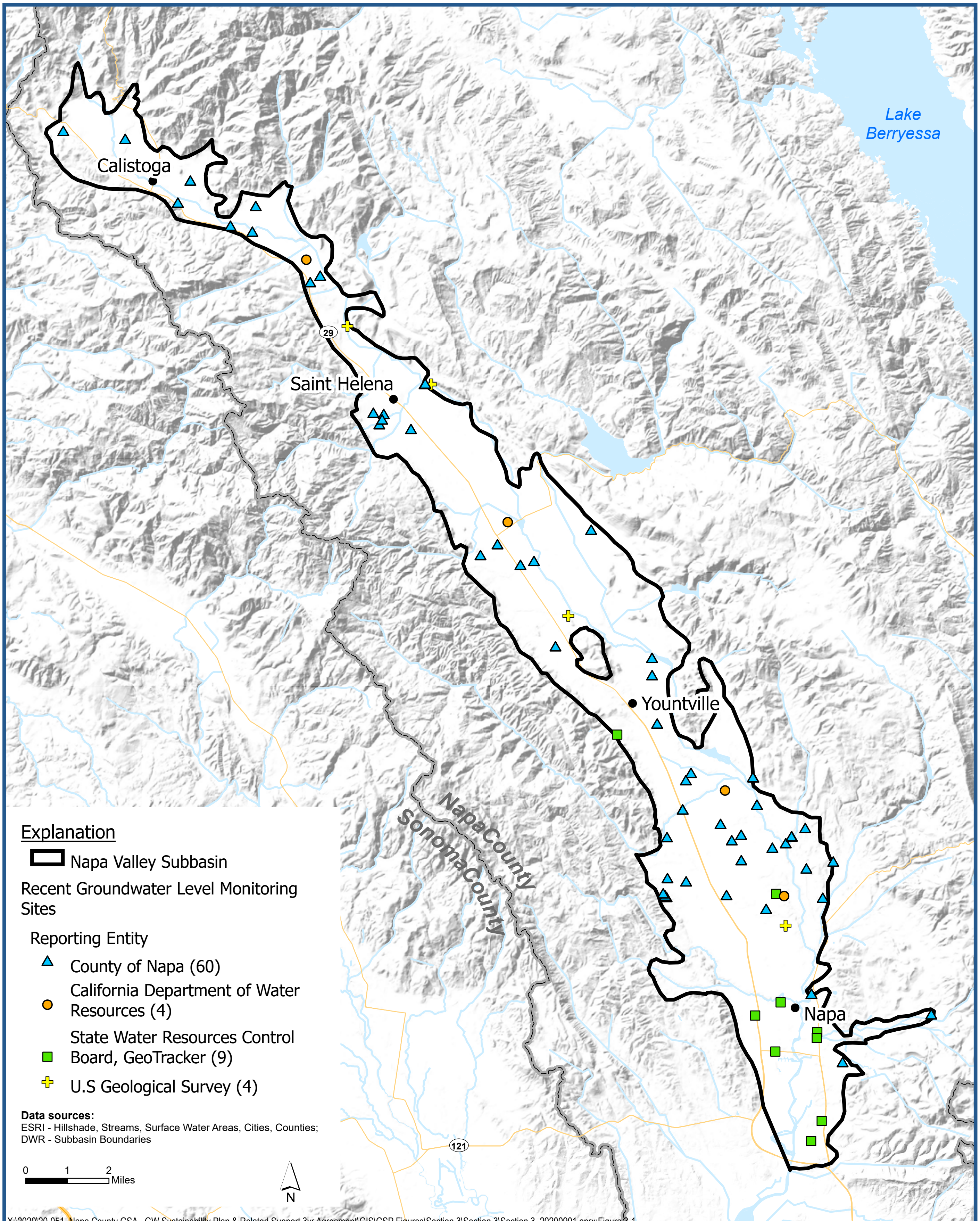
FIGURES

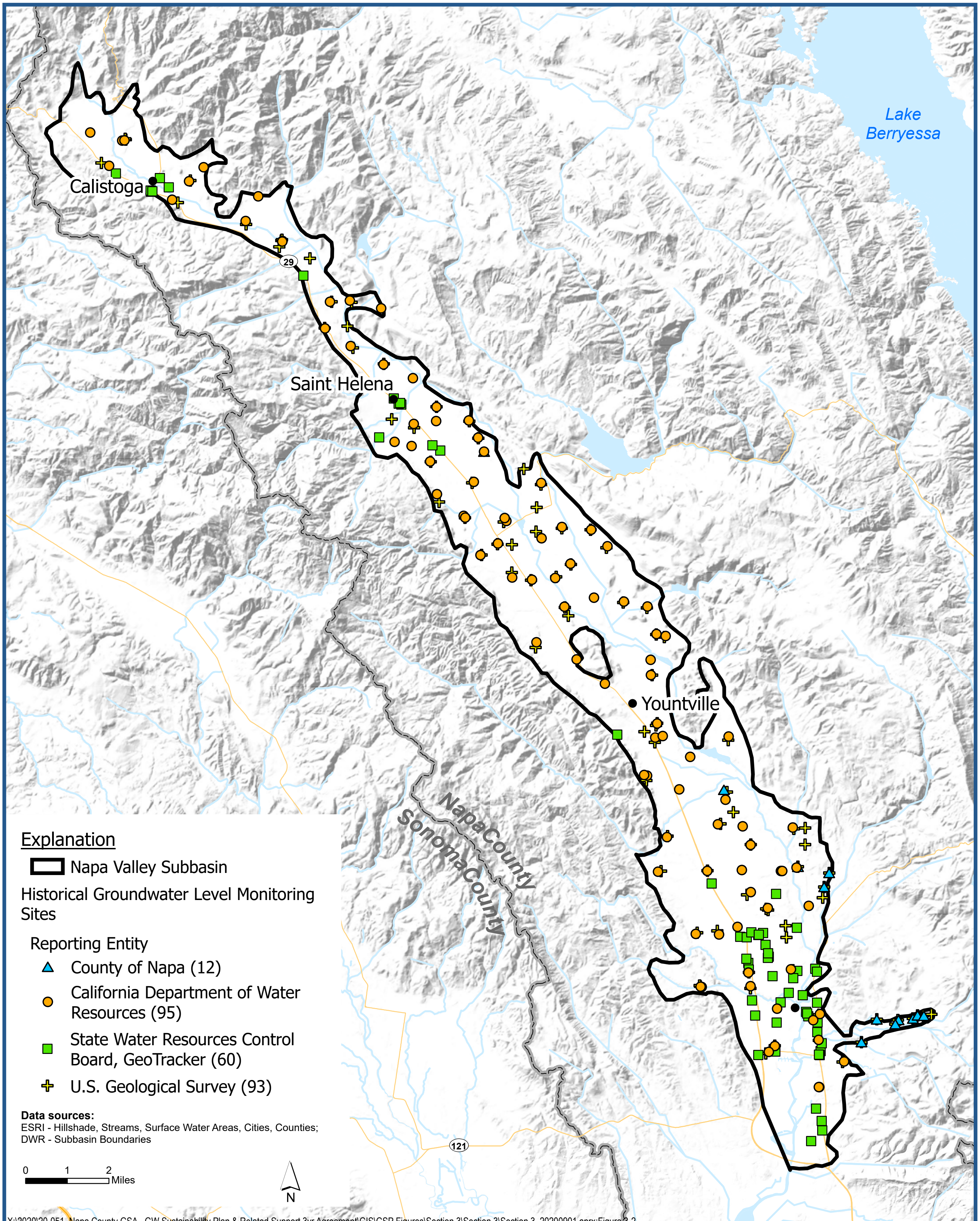


Luhdorff & Scalmanini
Consulting Engineers

Recent Groundwater Level Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-1

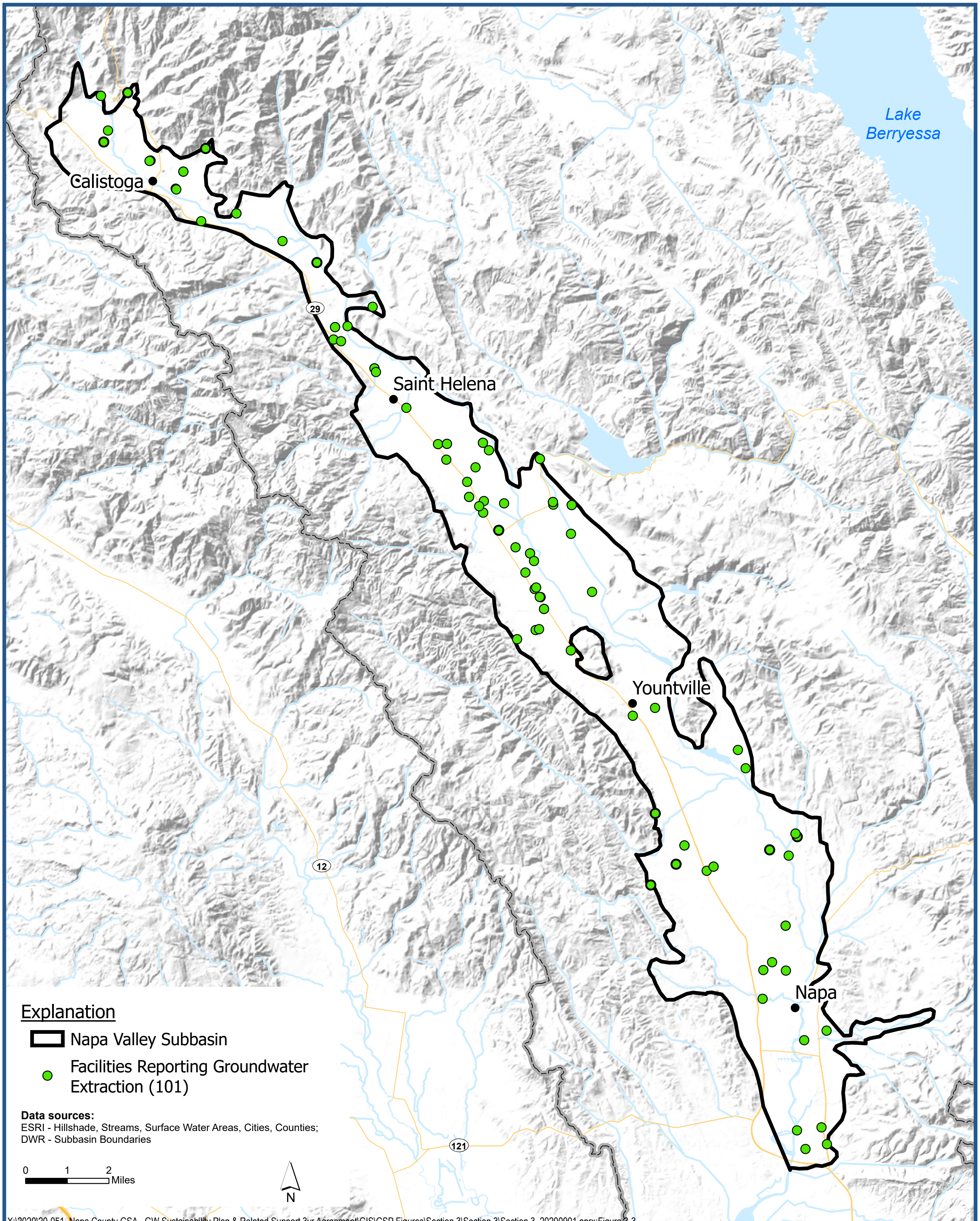


Luhdorff & Scalmanini Consulting Engineers

Historical Groundwater Level Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-2



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Consulting Engineers

Facilities Reporting Groundwater Extraction

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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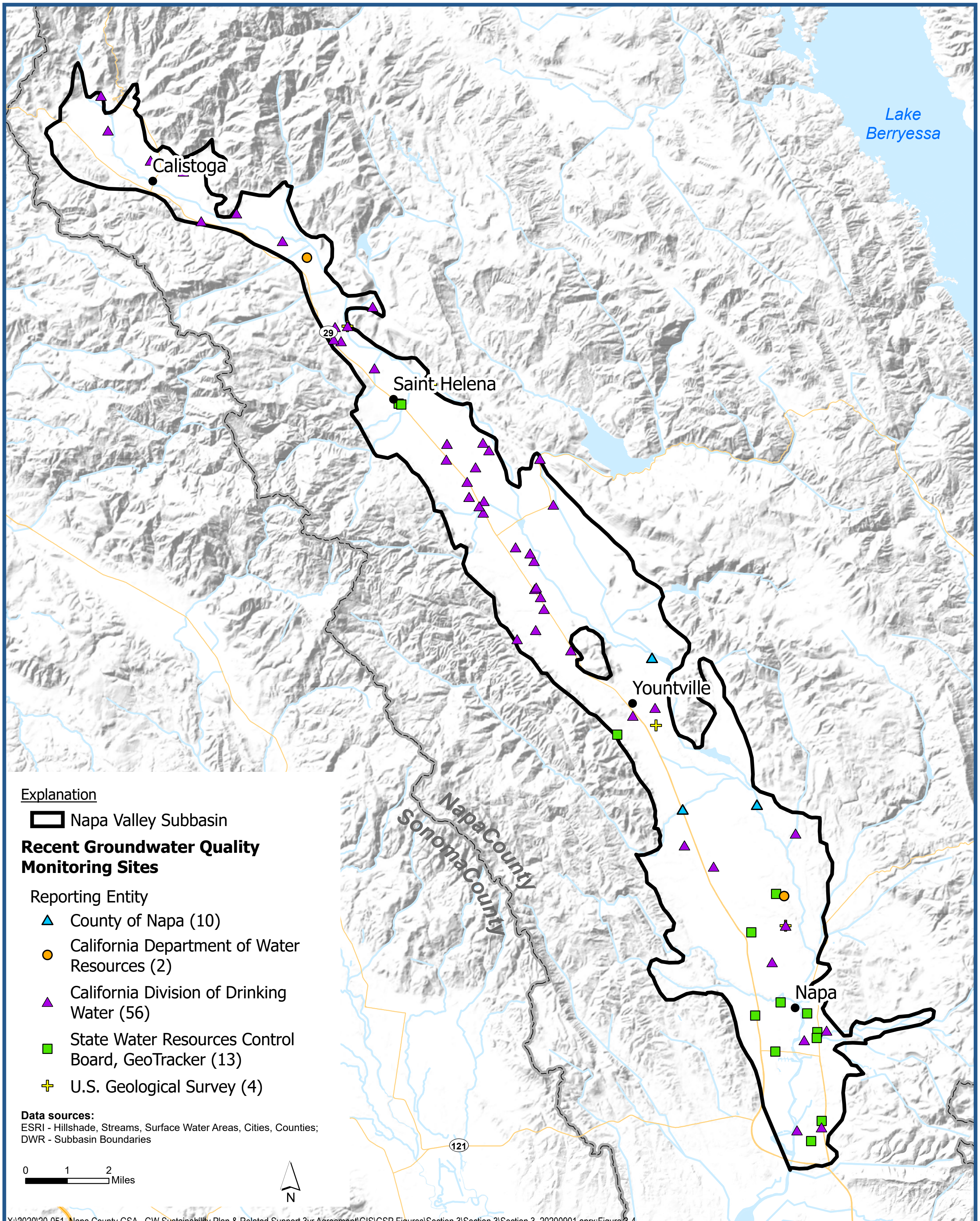
Figure 3-3



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Recent Groundwater Quality Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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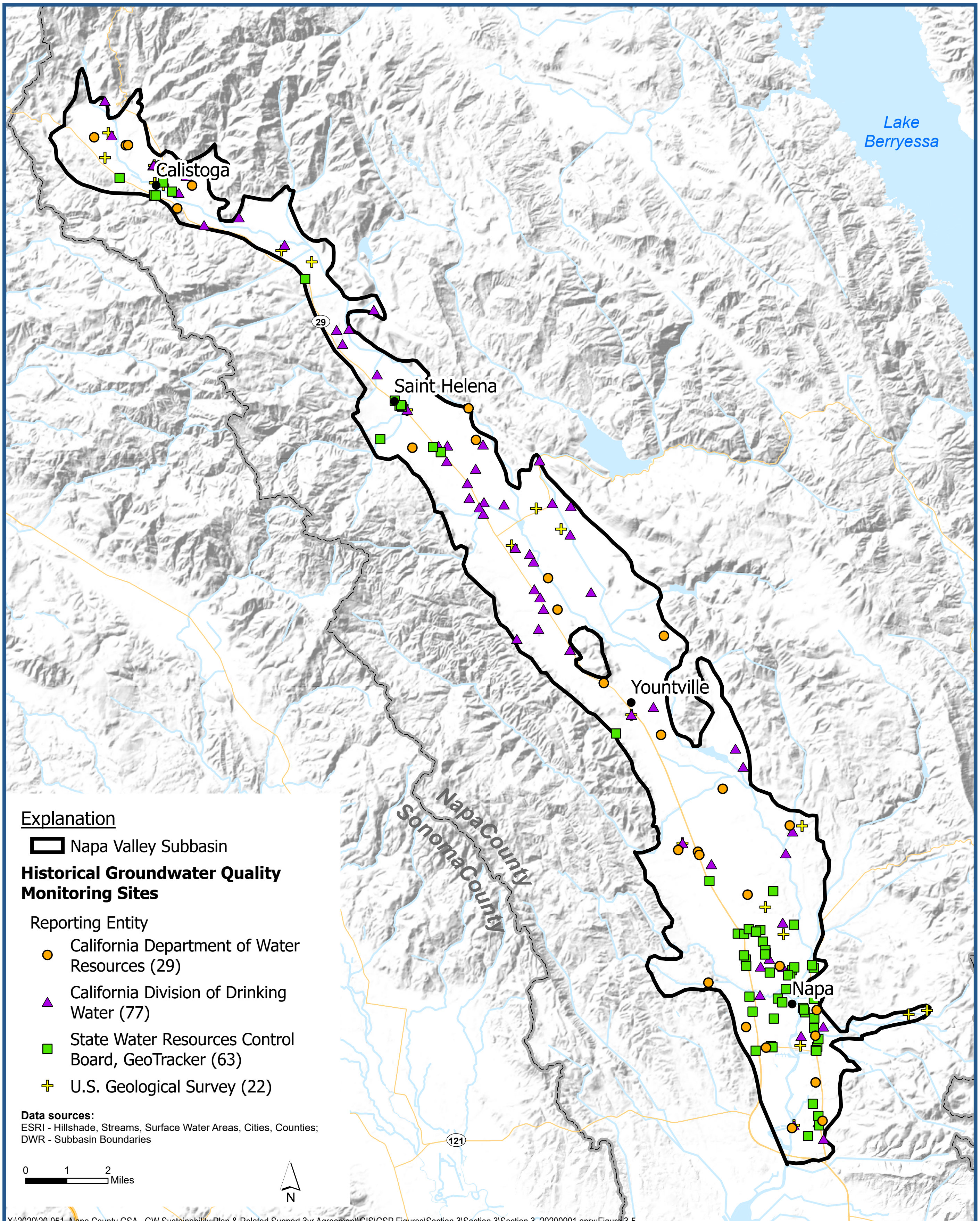
Figure 3-4



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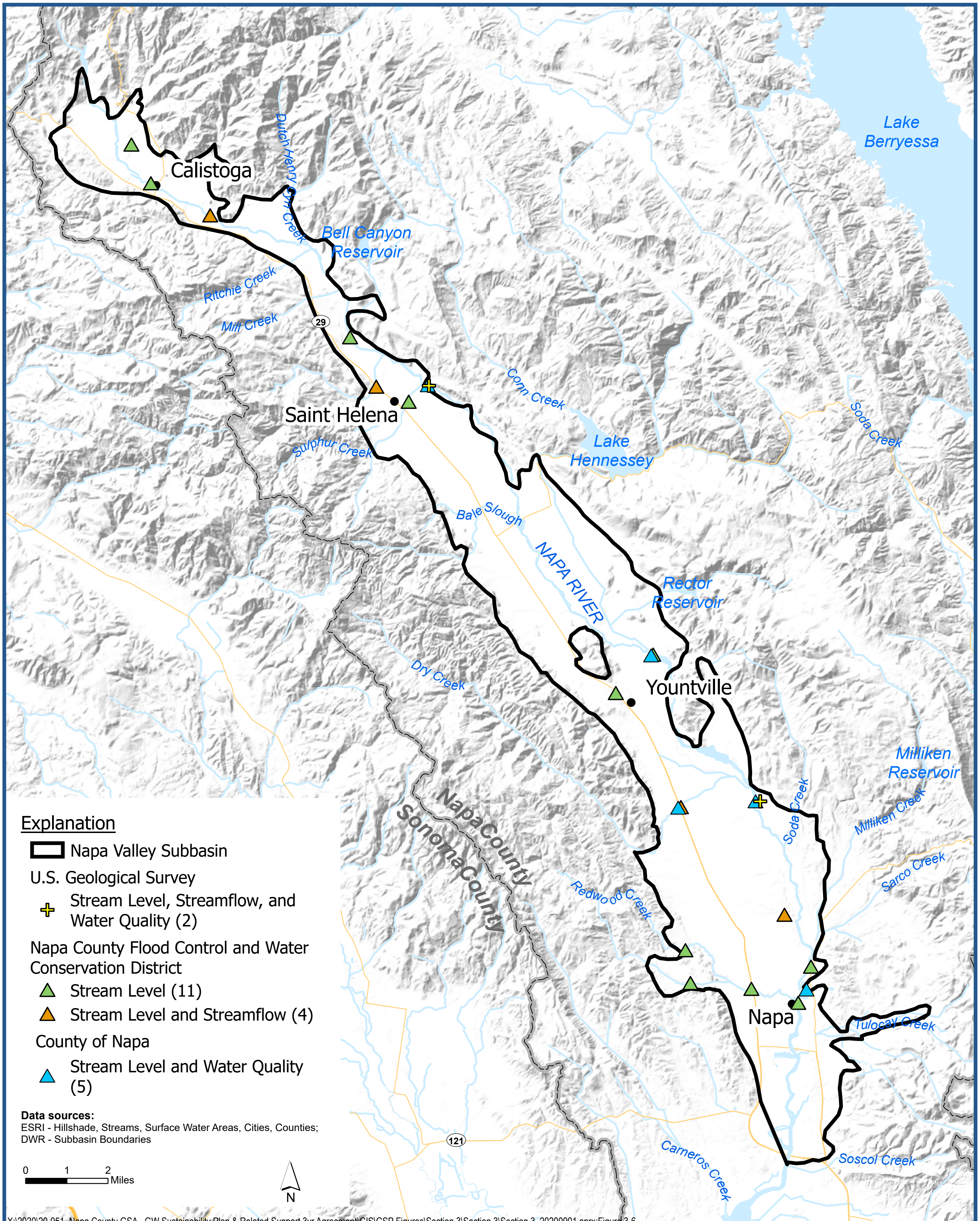
Historical Groundwater Quality Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-5



Luhdorff & Scalmanini
Consulting Engineers

Recent Surface Water Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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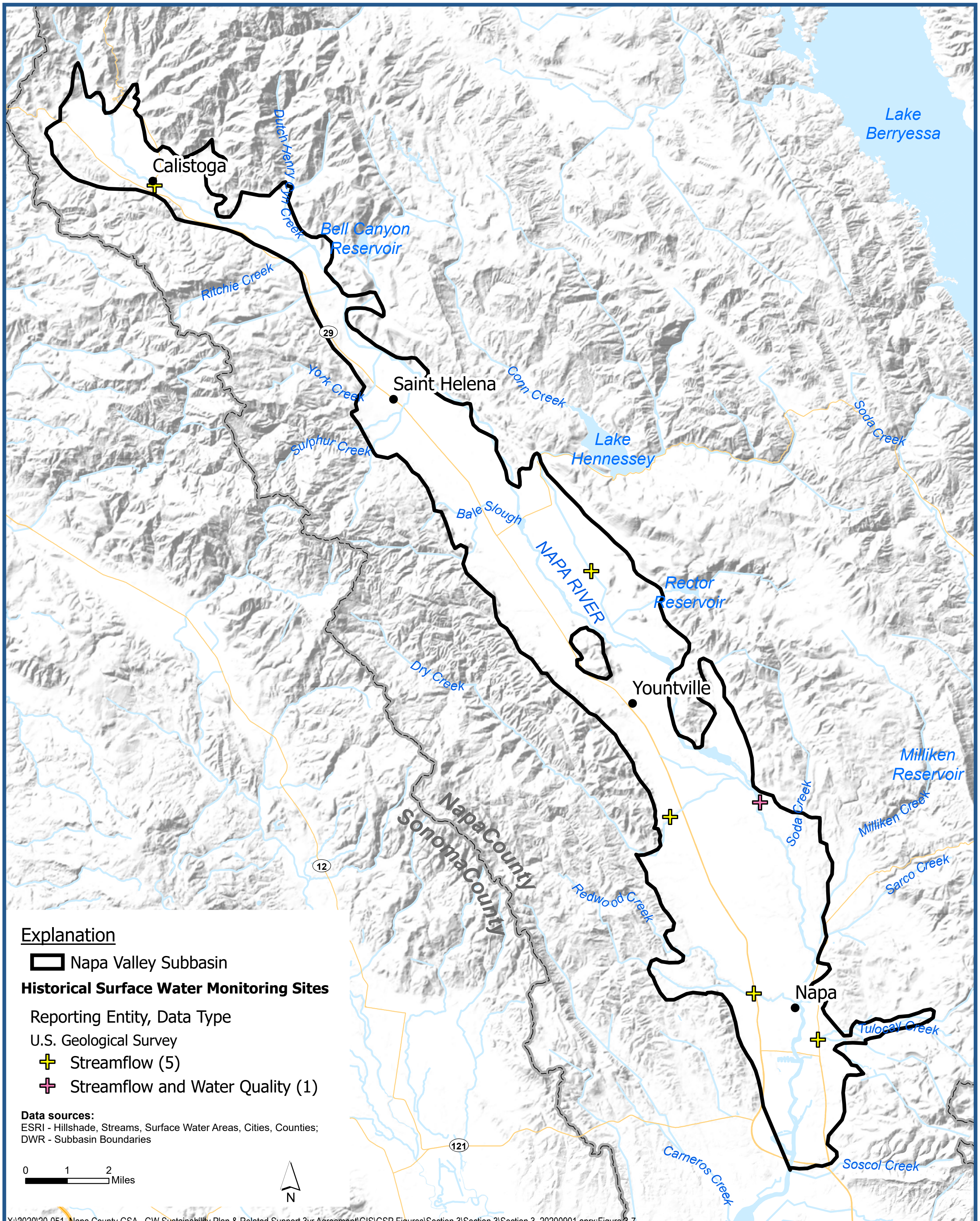
Figure 3-6



Luhdorff & Scalmanini
Consulting Engineers

Historical Surface Water Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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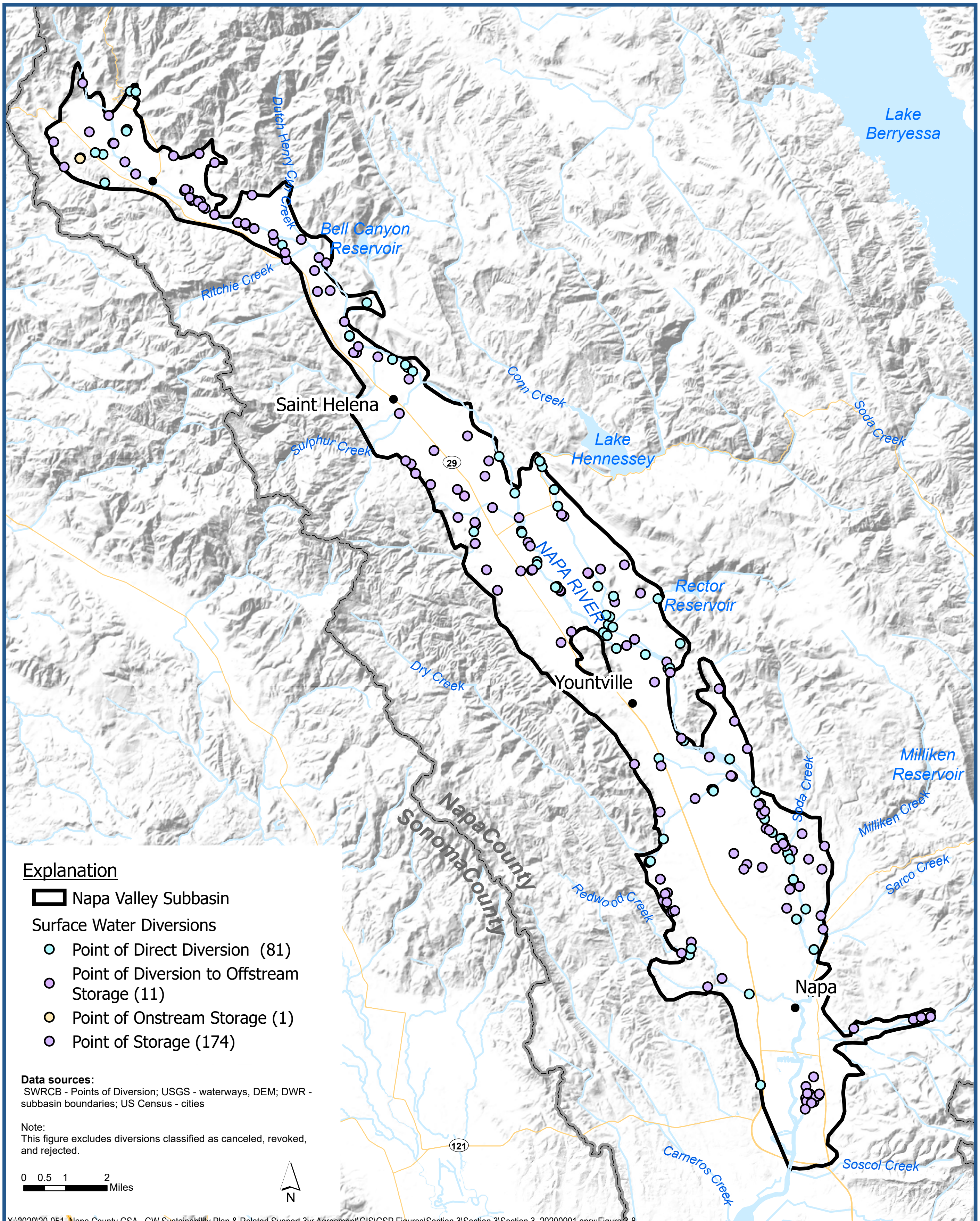
Figure 3-7



Luhdorff & Scalmanini
Consulting Engineers

Surface Water Points of Diversion

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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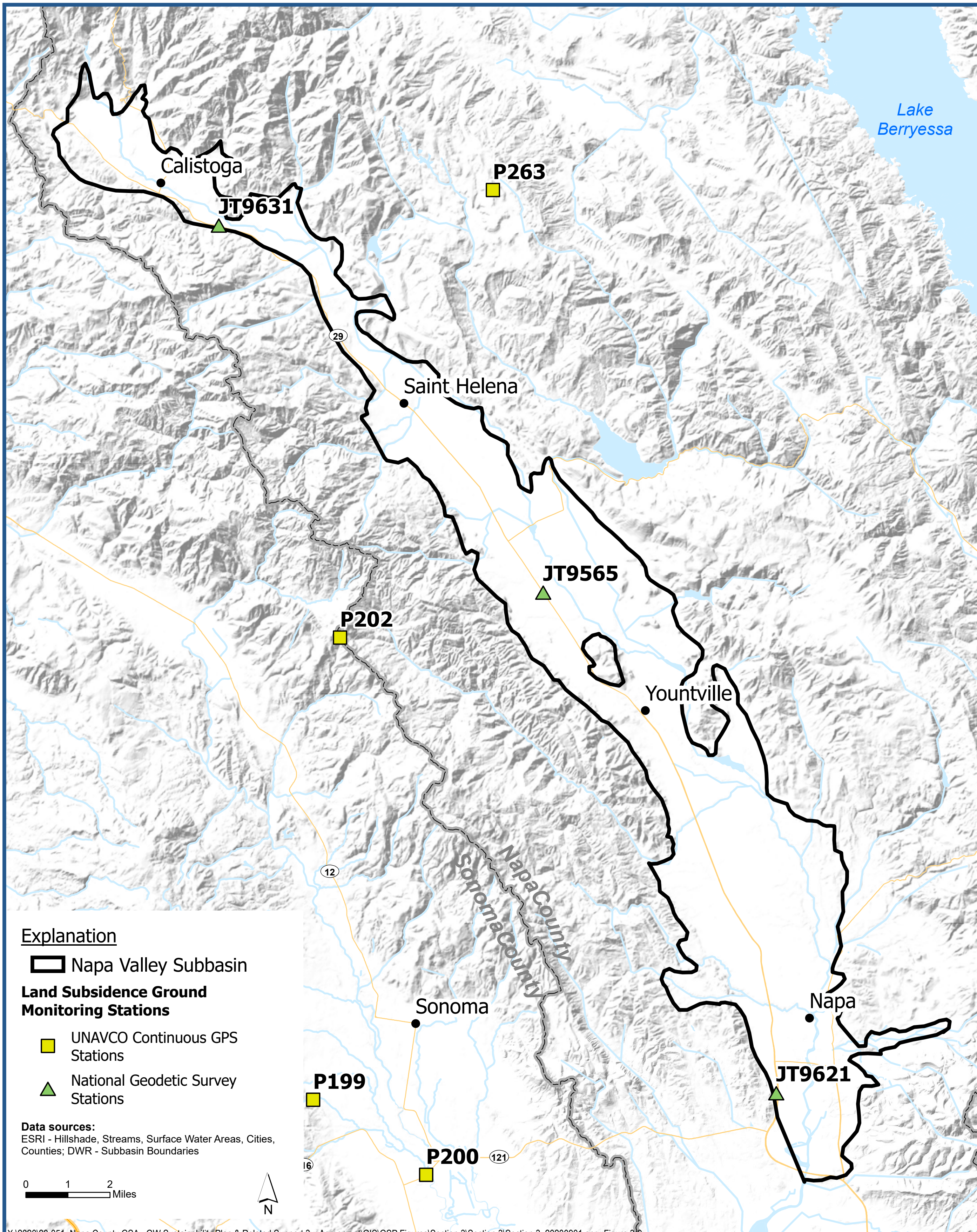
Figure 3-8



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Land Subsidence Ground Station Monitoring Sites

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

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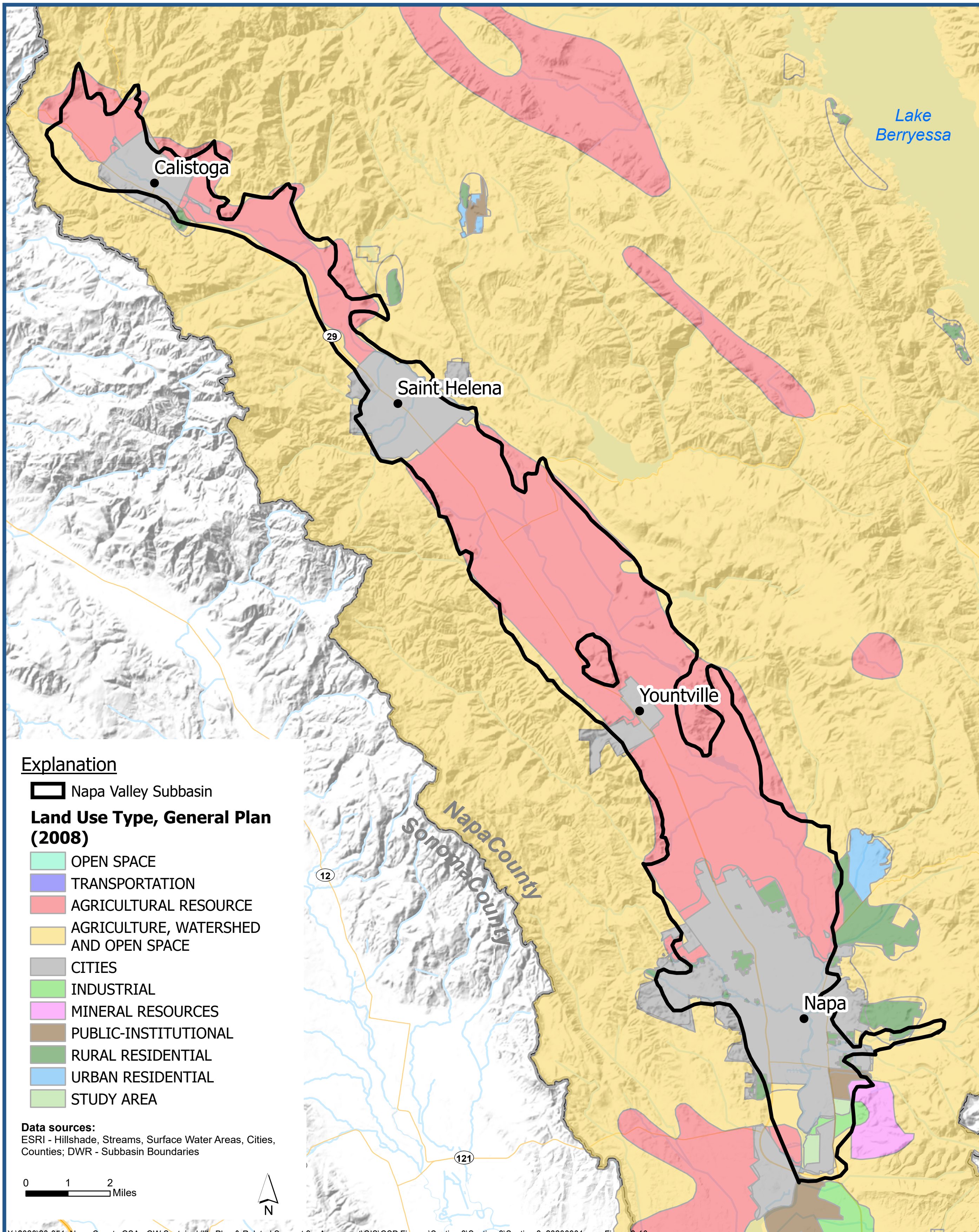
Figure 3-9



X:\2020\20-051 Napa County GSA - GW Sustainability Plan & Related Support 3yr Agreement\GIS\GSP Figures\Section 3\Section 3\Section 3_20200901.aprx:Figure 3-10

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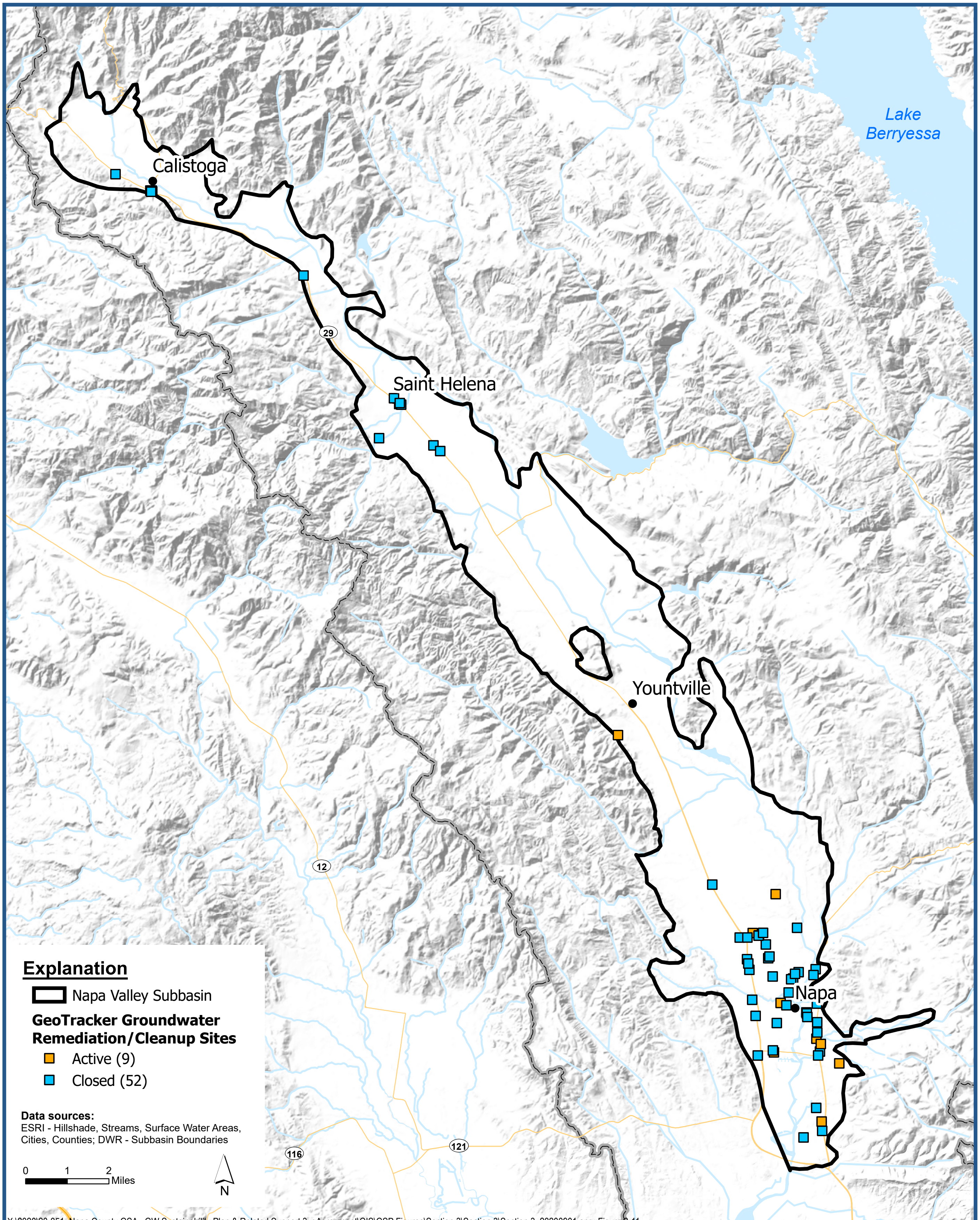
Consulting Engineers

Napa County 2008 General Plan Land Use Designations

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-10



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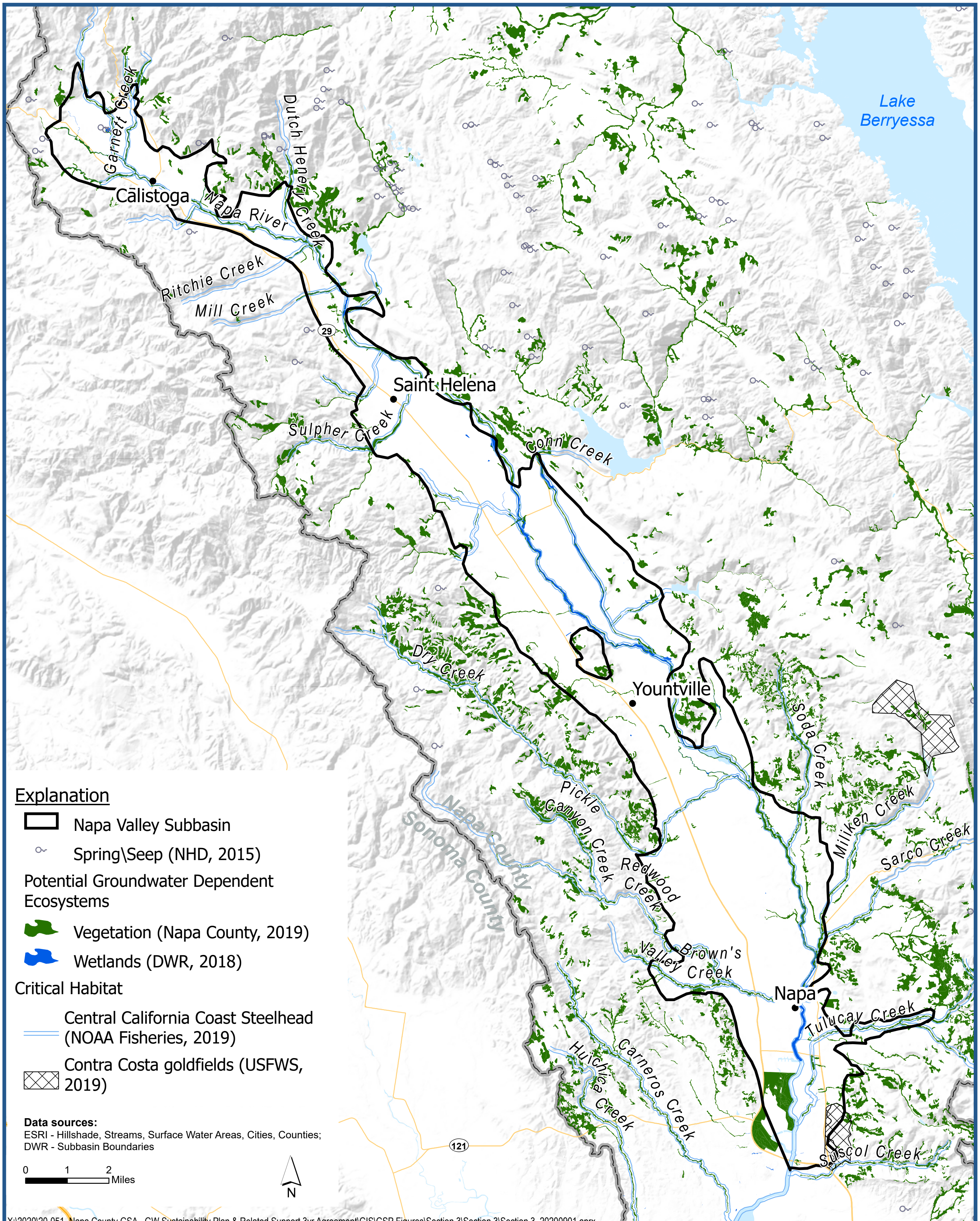
Consulting Engineers

GeoTracker Active and Closed Groundwater Remediation/Cleanup Sites in Plan Area

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-11

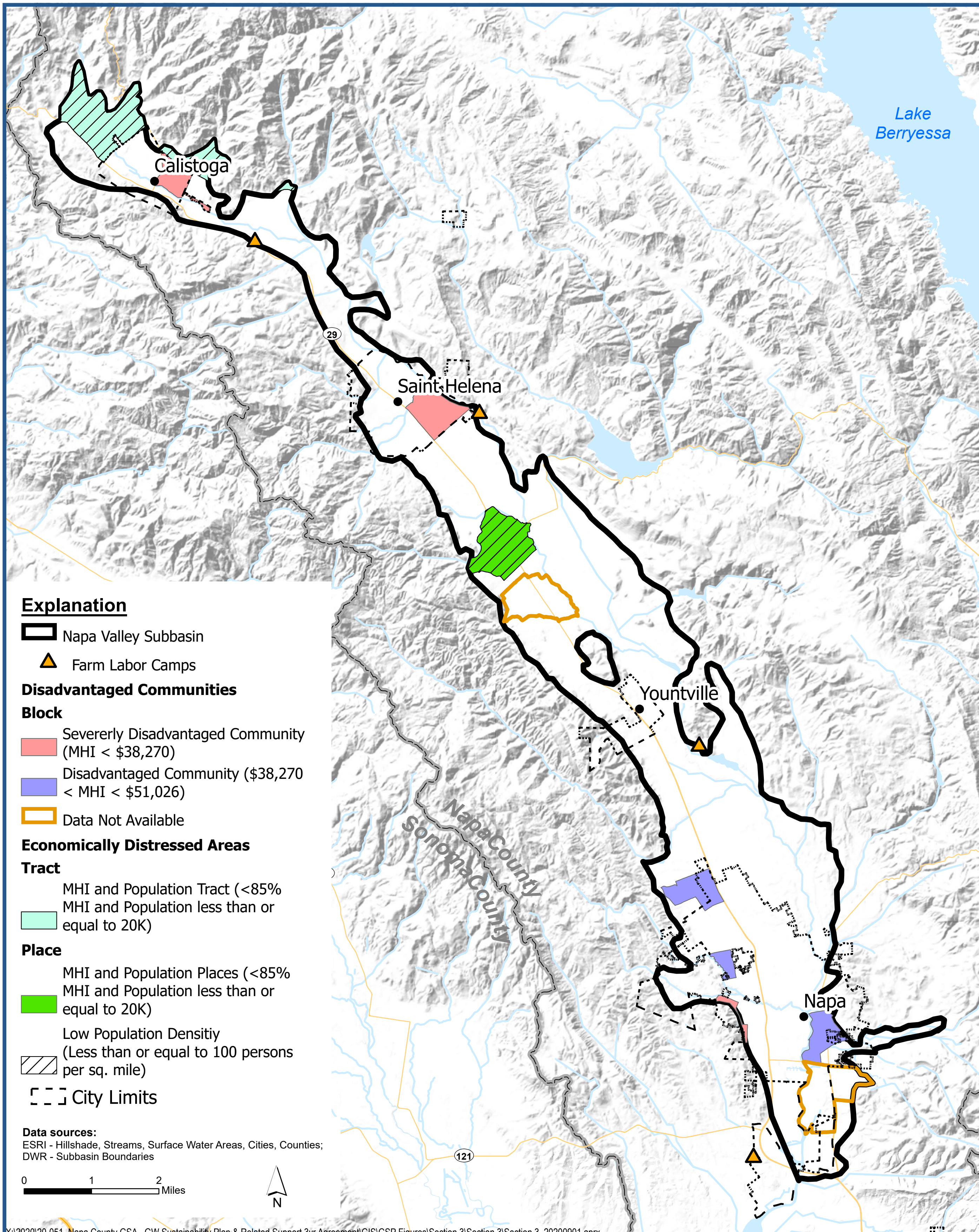


Luhdorff & Scalmanini Consulting Engineers

Environmental Users of Groundwater

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-12



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Consulting Engineers

Disadvantaged Community Tracts (DACs) and Farm Labor Camps

Napa Valley Subbasin Groundwater Sustainability Plan
Napa County, California

DRAFT
Figure 3-13

APPENDIX 3A

Water Availability Analysis Policy 1991

AGENDA ITEM # 11

NAPA COUNTY

CONSERVATION — DEVELOPMENT
AND PLANNING DEPARTMENT

1195 THIRD STREET, ROOM 210 • NAPA, CALIFORNIA 94559-3092
AREA CODE 707/253-4416

JEFFREY R. REDDING
Director

MEMORANDUM

TO: Conservation, Development and Planning Commission

FROM: Jeffrey R. Redding, Director

SUBJECT: Public Works Department Report on Water Availability Analysis

DATE: February 27, 1991

In response to the Commissions concerns regarding water availability, the Department of Public Works has prepared a report outlining a three phase process. (see attached) The three phases are 1) a reconnaissance report required at the application stage for all use permits and parcel/subdivision maps; 2) study of the effects of additional water consumption on surounding users based on a threshold level of water consumption; and 3) development of a contingency plan.

The report outlines the content of the Phase 1 Reconnaissance Report and the Phase 3 Contingency Plan; however, additional description is required for the Phase 2 Study. The water consumption thresholds need to be refined and criteria and guidelines must be developed for the the study content and methodology. Based on comments from the Commission and the Departments of Conservation, Development and Planning and Environmental Management, Public Works will proceed with these changes.

RECOMMENDATIONS

1. **The Commission approve, as an interim policy, the recommendations by Public Works for a three phase process to determine water availability for all use permits and parcel/subdivision maps.**

2. **The Commission direct staff to refine the water consumption threshholds and develop criteria and guidelines for the Phase 2 study.**

st\f\water

NAPA COUNTY DEPARTMENT OF PUBLIC WORKS

1195 THIRD STREET • ROOM 201 • NAPA, CALIFORNIA 94559-3082
AREA CODE 707/253-4351

HARRY D. HAMILTON
Director of Public Works
County Surveyor — County Engineer
Road Commissioner

STAFF REPORT
Water Availability Analysis

As a result of the environmental review process and the current drought conditions, the Napa County Planning Commission has expressed concern over water availability for Use Permit and Parcel Map applications. The availability of groundwater and the effects of pumping projected water demands of proposed facilities on the neighboring wells is of ultimate concern to both the Commission, neighbors and the applicant. In an effort to adress these concerns, the Public Works Department has attempted to establish criteria by which the applicant can perform well tests to satisfactorily evaluate the effects of projected water use on the local groundwater aquifer. This Department contracted with J.M.Montgomery, the County's consultant for the Water Resources Study currently in progress, to help establish these criteria. The resulting letter report submitted by Montgomery engineers has revealed two basic flaws in this approach:

1 - The general nature of the criteria to include all types of applications may not give specific enough direction to the applicant or his consultant resulting in a general evaluation of the aquifer no more informative to the Commission than current information presently provided;

2 - The cost of such well studies may be prohibitive to applicants of small wineries or parcel maps.

While this Department is working to bring local experts together to refine these criteria and provide a more definitive result, it is apparent that some form of interim guidelines are required. Therefore, this staff report has been put together to provide the Commission with some basic information pertaining to water use, available groundwater, existing information and interim recommendations to assist the Commission's decision-making process. This report is comprised of the following sections:

I. Existing Groundwater Studies and General Evaluation of Aquifers for Various Areas

II. Projected Water Use of Various Applications

III. Recommendations

I. Existing Groundwater Studies and General Evaluation of Aquifers for Various Areas

The most comprehensive study of groundwater in Napa County was done by the USGS in 1973. This study involved extensive monitoring of hundreds of wells within the Napa Valley floor from Calistoga south to the Oak Knoll Avenue. The Napa County Flood Control and Water Conservation District contracted the study and provided the monitoring program of these selected wells from 1962 to about 1975. The report concluded that the main Napa Valley aquifer was quite large, relatively stable and not in an overdraft situation. It was estimated that the basin contained about 200,000 acre-feet of water of which 24,000 acre-feet per year can be safely withdrawn without overdrafting the aquifer. The 1991 Montgomery study is suggesting a slightly lower "safe yield" for the basin of 22,000 acre-feet per year. Current usage is estimated at 16,000 acre-feet per year available befor an overdraft occurs.

In 1972 a prior USGS study investigated the groundwater basin for the Lower Miliken-Sarco-Tulucay Creeks area east of the City of Napa. Based upon this study, the usable storage capacity of that basin is approximately 20,000 acre-feet per year. The aquifer in this area is considerably more confined than the main Valley floor with lower tranmission rates (slower recharge of wells), fractured rock formations (segmenting of the aquifer) and generally a lower annual yield than the Valley floor. This annual yield is estimated at 3,000 acre-feet and pumpage at times is thought to exceed this amount.

Although no other extensive groundwater studies have been completed in the County, certain lesser investigations have been performed by the Flood Control and Water Conservation District. These investigations are primarily centered in areas with known groundwater problems and relative concentrated use. These areas are: Carneros, Coombsville (area discussed above), Dry Creek, Angwin, Mt. Veeder (and similar mountainous areas in volcanic formations), Pope/Chiles Valley, and Calistoga (mainly from a water quality standpoint). While no estimate of annual yield from these areas has been determined, they have been labeled as areas with groundwater problems that should be dealt with cautiously.

II. Projected Water Demand of Various Applications

It is extremely difficult to apply "across the board" criteria for evaluating water demand without first considering the relative consumptions of various uses for proposed sites. Some of these uses are currently regulated by the Planning Commission while some are not. Following is a table of various uses, their current average water demand and the County process, if any, that regulates that use.

USE	Projected Water Demand, (note units)	County Process
Residential:		
-primary residence	0.75 AC-FT/YR	BP
-secondary res.	0.33 AC-FT/YR	UP,BP
-farm labor dwell.	1.0 AC-FT/YR(6people)	UP,BP
Agricultural:		
-vineyards	1.0 AC-FT/AC-YR	None
-irrigated pasture	4.0 AC-FT/AC-YR	None
-orchards	4.0 AC-FT/AC-YR	None
-livestock (sheep or cows)	0.01 AC-FT/AC-YR	None
Winery:		
-process water	2.15 ac-ft/100kgalwine	UP,BP
-domestic & land.	0.5 " "	UP,BP
Industrial:		
-food processing	31.0 ac-ft/employee-yr	UP,BP
-Printing/Publishing	0.6 "	UP,BP
Commercial:		
-office space	0.01 ac-ft/employee-yr	UP,BP
-warehouse	0.05 "	UP,BP

From these estimated water usage numbers we can consider typical and "worst" case scenarios. For example, consider an 80 acre parcel currently in non-irrigated pasture land. If this parcel is used for grazing cattle or sheep, the water consumption will be approximately 1 ac-ft/yr for 320 head of sheep (or 80 cattle) on non-irrigated pasture. The parcel may also be irrigated to provide grazing for the same number of sheep and require 320 ac-ft/yr for irrigated pasture land. Either of these situations would not require any County permit or land division process. The same 80 acre parcel planted in vineyard would require about 80 ac-ft/yr of water and would likewise not require County approval. A third scenario would be the split of the 80 acre parcel into two 40 acre pieces requiring the owner to apply for a parcel map with the County. If the proposed purpose was to construct two single family dwellings, the resulting water consumption would be approximately 2 ac-ft/yr. All three of these scenarios would most likely rely on groundwater for their water supply though cattle and vineyard operations many times build reservoirs to store surface waters. To take the worst case possible in these three development scenarios let's add a primary residence, secondary residence and farm labor residence all with ample landscaping. Then the water consumption may be as shown in the following table.

SCENERIO	DESCRIPTION	ANNUAL WATER USE ac-ft/yr
#1	320 sheep irrigated pasture primary residence secondary res. farm labor dwell.	324
#2	80 acre vineyard primary residence secondary res. farm labor dwell. 50,000 gal winer	83.5
#3	primary residence secondary res.	1.2

It is apparent from this analysis that certain unregulated uses of parcels can utilize far more groundwater than regulated parcel splits confined to permitted dwelling units. While water consumption for industrial and commercial uses vary greatly and are supplied almost exclusively by M & I suppliers, they do have an overall effect on water supply for the County and during drought periods such as the current one, will cause a shift from imported water to groundwater, the impact of which is difficult to gage.

III. Recommendations

In an effort to provide the Commission with an interim, workable evaluation procedure the Public Works Department proposes the following recommendations:

1. Establish a three phase policy at the aplication stage for all use permit and parcel/subdivision map applications. The initial phase would be a reconnaisance level letter report which would include;

A. Site Map including
   - property boundaries
   - proposed building facilities
   - proposed agricultural development
   - existing and/or proposed water systems
   - adjoining neighbors
   - adjoining water systems

B. Narrative on the proposed project with description of processes or land use intended. This should include
   - acreage of vineyard/agricultural development
   - gallons of wine to be produced
   - homesites and number of occupants
   - potential for future development

C. Projected water consumption to include
  - total water requirement in acre-feet per year
  - peak demands and time of year
  - water source and delivery facilities

D. Summary of available information on groundwater for the specific site and general evaluation of the groundwater basin to include
  - list of available published information
  - available history of wells or water service for site
  - probable effects on surrounding wells
  - proposed mitigation measures

2. Establish a threshold level of acceptance for various permit processes that would determine the need for further study by the applicant. This threshold level of water consumption would be expressed in acre-feet per year and could be on a sliding scale depending on the hydrologic conditions for that period of time. For example, during the current drought period an appropriate threshold level might be 1 acre-foot per year on the Napa Valley floor. This is the expected demand of an average vineyard. This consumption would have relatively little effect on neighboring wells. In hillside areas, where the aquifer is more fractured, an appropriate threshold level might be 1/2 acre-foot per year. The applicant would then be able to design their facilities to that level of water usage without having to provide a more extensive well study involving the drilling and testing of wells on the site. Applicants wishing to exceed these threshold levels, whether use permit, parcel map or building permit, could provide the phase two study to inform the Commission on the effects of additional water consumption on surrounding users. This concept during the current drought conditions could be applied to all applications including building permits, subdivision development, industrial use permits, etc. with a more extensive study being required for exceeding the threshold levels. In years of average or above rainfall, these thresholds could be adjusted upward and as such be less restrictive on water use. The applicants would have to make certain assumptions for land use of their development and may wish to provide two different scenarios: the most probable use of the property and the worst case (greatest water consumption) for the property. Certain standards for testing of wells for the phase two studies would be necessary and could be developed by this Department in cooperation with the Environmental Management Department which administers the County well ordinance.

Based upon the estimated water usage described in II above, the following threshold levels are suggested:

	Acceptable Water Usage ac-ft/ac-year Below Average Rainfall (Current 1991) Applications AREAS*			Rainfall at Average or Above AREAS*		
	1	2	3	1	2	3
USE PERMIT						
M&I Supplied**	1	.5	Ø	3	2	Ø
Well	1	.5	Ø	3	2	Ø
PARCEL MAP						
M&I Supplied**	1	.5	Ø	3	2	Ø
Well	1	.5	Ø	3	2	Ø
Building Permits						
M&I Supplied**	1	.5	Ø	3	2	Ø
Well	1	.5	Ø	3	2	Ø

*AREAS: 1-valley floor
2-hillside
3-historically poor water areas as identified by maps and records on file with the Department of Public Works

**Water supplied thru municipality or District

3. Develop a contingency for water supply. Even the most exhaustive hydrogeologic study contains assumptions and evaluations which may or may not prove correct. In instances where the study does not accurately evaluate the effects of project water usage on surrounding wells or users, a contingency plan would be required. This may be as simple as implementation of water conservation measures on a permanent basis to adding storage facilities for use during peak demands. Implementation of this contingency plan would be achieved in one of a few different ways:

- application for modification of the permit use
- verified recordings of negative effects on neighboring uses as presented to the Commission through a formal complaint process simular to an appeal
- static well level deterioration documented by Flood Control District monitoring program
- determination by the Board of Supervisors as to a state of emergency requiring severe measures.

At the application stage, the initial phase one study would be required to be submitted to the Department of Public Works for review prior to public hearing or permit issuance. This Department would review the letter report to determine the accuracy of the proposed water usage and it's initial evaluation of the water source and, if acceptable, compare to the threshold levels appropriate at the time and location. The applicant would then be advised to either submit additional study (phase two) or the probable acceptance by the Commission. The phase one study could be performed by the applicant or his representative depending on its complexity. The phase two study would require hiring a professional groundwater expert from a list available in the Department or submit qualification of their chosen expert for prior Department approval. The content of the phase two studies would meet certain minimum requirements by this Department, as outlined by the JMMontgomery letter report attached, with the primary purpose to measure the effects of proposed well pumping or water use on surrounding existing users. Should the phase two study result in "significant" effects on surrounding users, then the applicant would be expected to mitigate to an acceptable level. If the study results in "possibly significant" effects, then the applicant would be required to do the phase three study and develop a contigency plan as described in paragraph #3 above. Implementation of this proposal could occur immediately after establishment of acceptable threshold levels of water use. These levels would be established by this Department after receiving imput from the Departments of Conservation, Development and Planning and Environmental Management.

APPENDIX 3B

Water Availability Analysis Guidance 2015

WATER AVAILABILITY ANALYSIS (WAA)

Adopted May 12, 2015

Contents

Introduction and Purpose

The County is required by the California Environmental Quality Act (CEQA) (Public Resources Code 21000–21177) and the CEQA Guidelines (California Code of Regulations, Title 14, Division 6, Chapter 3, Sections 15000–15387) to conduct an environmental analysis of all discretionary permits submitted for approval. CEQA requires analysis of literally dozens of environmental aspects, including the following:

"Would the project substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?"

The purpose of this document, the Water Availability Analysis (WAA), is to provide guidance and a procedure to assist county staff, decision makers, applicants, neighbors, and other interested parties to gather the information necessary to adequately answer that question. The WAA is not an ordinance, is not prescriptive, and project specific conditions may require more, less, or different analysis in order to meet the requirements of CEQA. However, the WAA is used procedurally as the baseline to commence analysis of any given discretionary project.

A Water Availability Analysis is required for any discretionary project that may utilize groundwater or will increase the intensity of groundwater use of any parcel through an existing, improved, or new water supply system[1]. As such, it will most commonly be used for discretionary development applications using groundwater such as wineries and commercial uses. Since CEQA does not apply to non-discretionary ("ministerial") projects, it does not apply to projects such as building permits, single family homes, track II replants, etc. While discretionary vineyard projects are welcome to borrow from the WAA, such vineyard projects, due to their size and scope, generally receive a much more exhaustive analysis under longstanding processes managed by the Conservation Division of the Planning Building & Environmental Services (PBES) Department.

The WAA may also apply when a discretionary Groundwater Permit is required by the Groundwater Conservation Ordinance, Section 13.15.010 of the Napa County Code. The ordinance's provisions are summarized below. (Should there be any conflict between the summary below and the Ordinance, the Ordinance shall prevail).

Outside of Designated Groundwater Deficient Areas

Most non-discretionary development in any area of the county, except for designated groundwater deficient areas, is exempt from the need to secure any type of groundwater permit. This includes projects to develop an on-site or off-site water source serving agriculture, projects to construct or develop rainwater harvesting or graywater recycling systems and minor and convenience water supply system improvements (see definitions in 13.15.010). Other

[1] The Groundwater Conservation Ordinance (Section 13.15.010) defines a water supply system as "any system including the water source the purpose of which is to extract and distribute groundwater".

exemptions outside groundwater deficient areas include projects such as building permits, well and septic permits, lot line adjustments, track II replants, etc. The following, however, are not exempt:

- Projects to develop or improve a water supply to serve *more* than a single contiguous parcel (agricultural development for multiple contiguous parcels is eligible for an exemption under certain conditions) or
- Projects that can be served by a public water supply.

Within Designated Groundwater Deficient Areas

Most any type of development in groundwater deficient areas (as defined in Napa County Code, Section 13.15.010.C) will trigger the need for a discretionary groundwater permit unless specifically exempted or unless eligible for a ministerial groundwater permit (see 13.15.030C). Ministerial groundwater permits are specifically for (1) a single family residence with associated well and landscaping when no other uses exist on the property, or (2) for agricultural re-plants. Specific exemptions include applications to construct or develop rainwater harvesting or graywater recycling systems and minor and convenience improvements (see definitions in 13.15.010) which include:

- Changes to existing water supply systems for the purposes of repair or rendering a system more efficient or to add to or improve existing legal uses on a property such as swimming pools (if provided with a cover and initially filled with trucked in water),
- Replacement dwellings (when an existing legal dwelling unit had previously existed on the property),
- Additional potential bedrooms whether or not attached to the single-family dwelling, and replacement of a site's existing well (provided the old well is destroyed and the new well is drilled to the same or smaller diameter as the existing well) are all exempt.

WAA Procedure

The Water Availability Analysis (WAA) uses a screening process for discretionary permit applications (both for new projects and for project modifications that change groundwater use) and determines if a proposal may have an adverse impact on the groundwater basin as a whole or on the water levels of neighboring non-project wells or on surface waters.[2] The WAA also provides procedures for further analysis when screening criteria are exceeded. An important sidelight to the process is public education and awareness. The WAA is based on an application which requires the applicant to gather information about existing non-project groundwater wells and water uses at the applicant's site, to describe planned project well operations, to document existing uses of groundwater on the property, and to estimate future water

[2] For the purposes of this procedure, surface waters are defined to include only those surface waters known or likely to support special status species or surface waters with an associated water right; however, as with all of the procedures in this WAA, there may be unique circumstances that require additional site-specific analysis to adequately evaluate a project's potential impacts on surface water bodies.

demands associated with the proposed project. In addition, other information relating to the geology, proximity to surface water bodies (e.g., river, creeks, etc.), and the location and construction of existing non-project wells located near the applicant's property or project well(s) will also be important to evaluate, as warranted, for the potential for well interference and effects on surface water. County staff can provide assistance to the applicant in obtaining and reviewing the latter information as part of the application data collection process.

WAA Application Procedure

A WAA groundwater permit application may be prepared by the applicant or their agent. (NOTE TO PUBLIC: PBES WILL CREATE/UPDATE AN APPLICATION FORM BASED ON THIS DOCUMENT ONCE APPROVED). **It must be signed by the applicant. If prepared by the applicant's agent, it must contain the letterhead of the agent, the name of the agent, and the agent's signature.** The WAA application contains the following information:

1. The name and contact information of the property owner and the person preparing the application.

2. Site map of the project parcel and adjoining parcels. The map should include: Assessor's Parcel Number (APN), parcel size in acres, location of existing or proposed project well(s) and other water sources, general layout of structures on the subject parcel, location of agricultural development and general location within the county. Approximate locations of existing non-project wells on other parcels within 500 feet of the existing or proposed project well(s) should also be identified based on the applicant's knowledge and available public information. All surface waters within 1500 feet of the existing or proposed project well(s) should also be identified, based on the applicant's knowledge and available public information. County staff can provide assistance to the applicant in obtaining adjacent well location, APNs and parcel size information.

3. A narrative on the nature of the proposed project, including all land uses on the subject parcel, projected future water uses in normal and dry years, details of current and proposed operations related to water use, description of interconnecting plumbing between the various water sources and any other pertinent information.

4. Tabulation of existing water use compared to projected water use for all land uses current and proposed on the parcel. Should the water use extend to other parcels, they should be included in the analysis (see Appendix E for additional information on determining water use screening criteria when multiple parcels are involved). **These estimates should reflect the specific requirements of the applicant's operations.** Guidelines attached in **Appendix B** are an example of one way to calculate projected water demand. The applicant shall use these, other publicly available guidelines, other guidelines that may be provided by the Department of Planning, Building, and Environmental Services (PBES), or project specific estimates, whichever best approximate the proposed water use for the specific project and account for all other existing water uses at the subject parcel(s).

PBES and Public Works (PW) staff will review the application for completeness and reasonableness, review the County's groundwater data management system for additional information about the characteristics of the areas/basin and nearby wells, compare the analysis to the screening criteria, and determine if additional analysis is required. In reviewing available information, County staff will consider:

1. The characteristics of the groundwater area or basin (such as confined or unconfined aquifer system; alluvial or hard rock geological setting) and related aquifer properties; and,
2. The location and present use of all existing non-project wells that are within 500 feet of the project well(s), identifying well depths and construction information for existing wells, if known; and,
3. The distance to surface waters within 500 feet of any Very Low pumping capacity project well(s) or 1500 feet of project well(s) with a capacity greater than 10 gallons per minute (gpm). [3]

Screening Criteria

Applications will be evaluated based on project information, to be provided by the applicant, and available geologic and hydrologic information, to be provided by County staff. As shown in **Table 1,** projects on the Napa Valley Floor and the Milliken-Sarco-Tulucay (MST) that meet the Tier 1 criteria (water use) will generally not be subject to second tier criteria evaluation, unless substantial evidence[4] in the record indicates the need to do so. Parcels in all other areas will generally be required to conduct a Tier 2 evaluation. Projects will be subject to Tier 3 criteria and analysis only when substantial evidence in the record determines the need for such analysis. All criteria are based on information outlined in this procedure, as well as a detailed conceptualization of hydrogeologic conditions in the Napa Valley and substantial evidence in the form of monitoring and hydrologic data, past studies, and well drillers' logs. Procedures for three tiers of screening criteria will be used on each project as designated herein and as needed for projects with unique issues:

[3] For the purposes of this WAA, "very low pumping capacity wells" are defined as wells with a casing diameter of six inches or less and an installed pump capable of producing less than 10 gallons per minute (gpm). Pumping capacities referenced throughout this WAA were developed as part of a separate analysis of potential streamflow depletion in unconsolidated alluvial settings. Details of this analysis are provided in a separate Technical Memorandum (LSCE, 2013).

[4] Substantial evidence is defined by case law as evidence that is of ponderable legal significance, reasonable in nature, credible and of solid value. The following constitute substantial evidence: facts, reasonable assumptions predicated on facts; and expert opinions supported by facts. Argument, speculation, unsubstantiated opinion or narrative, or clearly inaccurate or erroneous information do not constitute substantial evidence.

Table 1: Project Screening Criteria Applicability

Tier	Criteria Type	Napa Valley Floor	MST	All Other Areas
1	Water Use	Yes	Yes	Yes
2	Well and Spring Interference	No[1]	No[1]	Yes
3	Groundwater/Surface Water Interaction	No[1]	No[1]	No[1]

1. Further analysis may be required under CEQA if substantial evidence, in the record, indicates a potentially significant impact may occur from the project.

The three tiers of screening criteria are discussed below. **Appendices B-F** provide additional detail.

Tier 1--Water Use Criteria

For projects on the Napa Valley Floor and in the MST, water use criteria will be compared to the water use estimate provided by the applicant in the WAA application. Water use criteria vary according to the location of the project parcel(s). As such, projects must meet the applicable water use criterion, through project revisions or water use estimate refinements, if necessary and reasonable, in order to be considered in compliance with this criterion.

Table 2A presents the water use criteria. Napa Valley Floor areas include all locations that are within the Napa Valley except for areas specified as groundwater deficient areas. Groundwater deficient areas are areas that have been so designated by the Board of Supervisors. PBES staff can assist the applicant with determining which area a project is located in.

Currently the only designated groundwater deficient area in Napa County is the MST Subarea. Areas of the county not within the Napa Valley Floor or the MST Groundwater Deficient Area are classified as All Other Areas. Public Works can assist applicants in determining the correct classification for project parcel(s). **Appendix B** contains a discussion of the origins of these water use criteria.

Table 2A: Water Use Criteria

Project parcel location	Water Use Criteria (acre-feet per acre per year)
Napa Valley Floor	1.0
MST Groundwater Deficient Area	0.3 or no net increase, whichever is less [1]
All Other Areas	Parcel Specific [2]

1. Does not apply to the Ministerial Exemption as outlined in the Groundwater Conservation Ordinance
2. Water use criteria for project shall be considered in relation to the average annual recharge available to project property, as calculated by the applicant or their consultant.

In general, the acceptable water use screening criterion for parcels located on the Napa Valley Floor is 1 acre-foot per acre of land per year (an acre-foot of water is the amount of water it takes to cover one acre of land to a depth of one foot, or 325,851 gallons). Therefore, a 40-acre parcel will meet this criterion if the projected groundwater use would not exceed 40 acre-feet per year.

Areas designated as groundwater deficient areas as defined in the Groundwater Conservation Ordinance will have criteria established for that specific area. For example, the MST Subarea screening criterion is 0.3 acre-feet per acre per year or "no net increase" over existing conditions, whichever is less (see **Appendices B and C**).

Water Use Criterion including Estimated Recharge

The water use criterion for parcels termed All Other Areas (i.e. not located in the Napa Valley Floor or a groundwater deficient area), will be determined on a parcel specific basis. No single criterion can be established for "All Other Areas" due to the uncertainty of the geology, and the increasingly fractured rock aquifer systems in the mountainous and non-Napa Valley areas, including Carneros, Pope Valley, Wooden Valley, and Capell Valley. The project applicant will need to estimate the average annual recharge occurring on the project parcel(s) and consider the amount of recharge relative to the estimation of project water use (e.g., all current and projected water demands for the property on which the planned project is located). The estimate of average annual recharge can be made by various methods including water balance methods. The selected method should be based on data from the parcel or watershed where the proposed project is located. The estimated project water use, including existing and proposed uses of water on the project parcel(s), shall include estimates for normal and dry water years. If an alternative water source will be used for dry years (e.g. trucked in water for non-potable uses), that information shall be provided by the applicant along with the alternate source location and estimated water volume.

Projects on the Napa Valley Floor and in the MST that meet the Tier 1 screening criteria are considered to be in compliance with the standards of the WAA, unless other substantial evidence in the record indicates the need for further evaluation. Projects in "All Other Areas" shall complete Tier 1, and then proceed to Tier 2.

Tier 2--Well and Spring Interference Criterion

When applicable (see **Table 1**), the Tier 2 well interference criterion is presumptively met if there are no non-project wells located within 500 feet[5] of the existing or proposed project well(s). For those projects with neighboring wells located within 500 feet of the project well(s), additional evaluation will be required to assess the potential drawdown in those existing wells resulting from project well operation relative to the Tier 2 criterion described below. Though highly recommended, if the neighboring well is located on a parcel that is also owned by the applicant, the Tier 2 evaluation for that well may be waived, however certain safeguards must be in place to ensure that the water allotment and transfer between parcels is clearly documented and

[5] Distance is measured horizontally from the well.

recorded, especially in cases where the water from more than one parcel will ultimately serve a use on a single parcel (see **Appendix E**).

The potential interference will be determined based on data including the distance between the project well(s) and the neighboring non-project well(s), the hydrogeologic setting, and well construction information and operational configurations for the project well(s). Well construction information and operational configurations provided by the applicant will include:

- the planned pumping rate of well(s)[6],
- well depth(s),
- well screen intervals and
- well seal locations.

Table 2B presents default well interference criteria that the County may apply in the determination of significant adverse effects. The minimum significant drawdown values presented in **Table 2B** are intended for use in cases where information about existing non-project wells is limited or non-existent. However, when the status and configuration of an existing non-project well are known, for example the depths of screen intervals, locations of any annular seals, and/or water levels in the well and the pump depth setting, then site-specific measures of significance should be used. Site-specific measures of significance should also account for known seasonal variations[7] in groundwater elevations in the vicinity of the proposed project and mutual well interference (i.e., interference between the planned project well usage (new and/or existing) and one or more neighboring wells. County staff shall inform the applicant of the site-specific Tier 2 well interference criteria that will be applied in the evaluation of a project before the applicant conducts a site-specific analysis.

Table 2B. Default Well Interference Criteria

Type of wells within 500 ft. screened within the same aquifer as project well	**Estimated Drawdown at Neighboring Non-Project Wells**
Wells with a casing diameter of six inches or less	10 feet
Wells with a casing diameter greater than six inches	15 feet

[6] Estimates of well yield shown on driller's logs are not sufficient for this purpose. The planned pumping rate should be determined based on the pump and related equipment installed, or planned to be installed, in the well and, if available, constant rate aquifer test data for tests conducted for a minimum of 8 hours.

[7] As used here, seasonal variations refer to typical changes over the course of a year.

Low pumping capacity project wells in unconfined aquifers will typically require a minimum amount of information due to the limited drawdown that they induce. [8]

Springs

Napa County enjoys the occurrence of many natural springs, and the potential for planned projects to affect spring flow has been considered. A spring is defined as: "A place where groundwater flows naturally from a rock or the soil onto the land surface or into a body of surface water. Its occurrence depends on the nature and relationship of rocks, esp. permeable and impermeable strata, on the position of the water table, and on the topography" (Jackson, J. 1997. *Glossary of Geology*. American Geological Institute). Springs can be formed by multiple causes, including the interception of groundwater by the land surface; permeability differences that can cause groundwater to emerge; flow from faults or fractures; and drainage from landslides. Springs are ephemeral geologic features which may cease to flow due to natural causes such as changes to flow paths, water level declines, porosity lost by mineral precipitation, or sediment plugging.

Because springs originate as groundwater, springs are eligible for WAA Tier 2 analysis. It is required that any proposed project wells within 1,500 feet[9] of natural springs that are being used for domestic or agricultural purposes be evaluated to assess potential connectivity between the part of the aquifer system from which groundwater is planned to be produced and the spring(s). Springs exist in complex hydrogeologic environments. Other substantial evidence in the record may result in the need for such an analysis even though the spring(s) is located a greater distance from the planned well site. Where evaluation of potential connectivity between the project well(s) and springs is required, site-specific spring interference criteria will be established as appropriate for the springs(s) under consideration.

Although the Tier 2 analyses described above relate to mutual well interference and the avoidance of significant interference, potential pumping effects on springs may result in spring flow depletion. Springs are also commonly observed in locations where little to no quantitative records have been kept relating to the spatial occurrence or temporal variability of spring flow. Therefore, projects located in the vicinity of springs, where potential impacts of pumping are possible but unknown, may require monitoring and further analysis.

Tier 3--Groundwater/Surface Water Interaction Criteria

Tier 3 analysis is only conducted when substantial evidence in the record determines the need for such an analysis.

The groundwater/surface water criteria are presumptively met if the distance standards and project well construction assumptions are met (see **Tables 3, 4, and 5).** The distance standards vary according to groundwater pumping capacity, well construction information and operational

[8] For the purposes of this WAA, low pumping capacity wells are defined as wells with a casing diameter of six inches or less and an installed pump capable of producing between 10 gpm up to 30 gpm. As shown in Appendix F, Table F-6, a well pumping 30 gpm continuously for one day in an unconfined aquifer, even in an aquifer with a low hydraulic conductivity, is expected to induce a drawdown of two feet or less at radial distances as small as 25 feet.

[9] Distance is measured horizontally from the well.

configurations for the project well(s), and aquifer properties as described in **Appendix F**. The criteria are also based on a 140-day period to account for the effect of groundwater withdrawal on surface waters throughout the dry season (typically late May through early October).

The distance standards and construction assumptions in **Tables 3, 4, and 5** are provided as examples of conditions that, if applicable, would be expected to preclude any significant adverse effects on surface waters. The distance standards and construction assumptions in **Tables 3, 4, and 5** were developed as part of a separate analysis of streamflow depletion for surface waters and wells in unconsolidated alluvial geologic settings (LSCE, 2013). Project wells located in other geologic settings, particularly consolidated formations more common in locations deemed All Other Areas, will be subject to other distance standards based on site-specific aquifer conditions. Distance standards for project wells completed in consolidated formations will generally be no more restrictive than those shown in **Tables 3, 4, and 5** for hydraulic conductivity values of 0.5 ft/day.

The distance standards and construction assumptions in **Tables 3, 4, and 5** are not intended to serve as absolute setback criteria. Instead, if the proposed project is located in an equivalent geologic setting but does not meet the distance standards and conform to the associated well construction assumptions (See **Tables 3, 4, and 5)**, then additional analysis will be required to determine project impacts relative to site-specific criteria. The site-specific groundwater/surface water interaction criteria will be established as appropriate for the surface water(s) under consideration[10] (see **Appendix F**).

Additional evaluation will be required to identify the potential for impacts of very low pumping capacity wells within 500 feet[11] of surface waters, low pumping capacity wells within 1000 feet of surface waters, and moderate to high pumping capacity wells within 1500 feet of surface waters, as described in **Appendix F**.[12] The potential impacts will be determined based on data including distance(s) between the project well(s) and the surface water features of concern, the hydrogeologic setting, the streambed (or equivalent feature) hydraulic properties, and well construction information and operational configurations for the proposed project wells. Well construction information and operational configurations provided by the applicant will include:

- the planned pumping rate of well(s) [13],
- well depth(s),
- well screen intervals and
- well seal locations.

[10] Site-specific criteria will be developed to address project impacts on beneficial uses of affected surface waters.

[11] Distance is measured horizontally from the well.

[12] For the purposes of this WAA, moderate to high pumping capacity wells are defined as wells with a casing diameter greater than six inches and an installed pump capable of producing more than 30 gpm

[13] Estimates of well yield shown on driller's logs are not sufficient for this purpose. The planned pumping rate should be determined based on the pump and related equipment installed, or planned to be installed, in the well and, if available, constant rate aquifer test data for tests conducted for a minimum of 8 hours.

Very low pumping capacity wells in unconfined aquifers will typically require a minimum amount of information due to the limited potential for surface water flow depletion. Other well types located at distances of 1500 feet or greater from surface waters will also likely require a minimum amount of information, particularly when it can be shown that the project well targets aquifer units not hydraulically connected to surface water.

Table 3. Well Distance Standards and Construction Assumptions; Very low capacity pumping rates (i.e., less than 10 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	**Acceptable Distance from Surface Water Channel**			**Minimum Surface Seal Depth (feet)**	**Depth of Uppermost Perforations (feet)**
	500 feet	1000 feet	1500 feet		
80	✓			50	100
50	✓			50	100
30	✓			50	100
0.5	✓			50	100

Table 4. Well Distance Standards and Construction Assumptions; Low capacity pumping rates (i.e., between 10 gpm and 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	**Acceptable Distance from Surface Water Channel**			**Minimum Surface Seal Depth (feet)**	**Depth of Uppermost Perforations (feet)**
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5		✓		50	100

Table 5. Well Distance Standards and Construction Assumptions; Moderate to high capacity pumping rates (i.e., greater than 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	**Acceptable Distance from Surface Water Channel**			**Minimum Surface Seal Depth (feet)**	**Depth of Uppermost Perforations (feet)**
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5			✓	50	100

If distance standards and construction criteria in **Tables 3, 4, and 5** above are not met, project approval may still be possible pending additional analysis (see below).

If the minimum surface seal depth is not met, and if available information does not indicate a hydraulic separation provided by geologic conditions at the site, then these cases would require additional analysis by the applicant. Shorter seals can allow for significant flow into the well from shallow portions of an aquifer, even if the screens are at greater depths.

Additional Analysis Required

If the proposed project exceeds one or more of the screening criteria and the applicant is unable to modify the project (i.e., different location, well construction, water usage, or operations) to meet the screening criteria, then further analysis will be required (see **Appendix F**). Additional analysis will also be required if insufficient information exists in the project application to evaluate conformance with the criteria.

The applicant or the applicant's agent should consult with County staff regarding the required scope of the analysis, which is likely to include consultation with a professional hydrologist, geologist, or engineer, and may include field testing. Projects requiring additional analysis regarding Tier 2 or Tier 3 criteria may be subject to state requirements for preparation by a California registered professional geologist or professional engineer. **Appendix F** describes the additional analyses that will be required if the project screening criteria are applicable and are not met or if substantial evidence in the record indicates that a potentially significant impact may result from the project.

The geology of many areas of Napa County is very complex (LSCE and MBK, 2013). Accurate determination of hydrologic parameters (See **Appendix F**) is important to the additional analyses that may be necessary to evaluate potential well interference or impacts on surface water. Several approaches may be considered. One approach, applicable in areas with unconsolidated aquifer materials, is to estimate aquifer hydraulic conductivity values, based on evaluation and interpretation of lithologic data reported for wells drilled in the vicinity of project or well(s) and published hydraulic conductivity values for similar aquifer materials. This method may be applicable in areas of the Napa Valley Floor where the unconsolidated aquifer system has been previously characterized (LSCE and MBK, 2013). This method is not applicable in areas with consolidated or hard rock aquifer materials, including the MST subarea and All Other Areas, due to the increased likelihood of significant variations in aquifer characteristics over relatively small distances.

The County's preferred method for determining the aquifer hydraulic conductivity or other parameters is by conducting an aquifer test and analyzing aquifer test data. In some cases, pump test data may be recorded by a well driller at the time of well construction and included as part of the Well Completion Report submitted to the California Department of Water Resources. However, these tests are not always conducted to standards that result in meaningful aquifer parameters (i.e., the pumping rate may not be constant, the pumping rate may not be large enough to analyze aquifer parameters, the test may be of too short a duration, and groundwater level measurements may not have been made during the test in the pumped well and one or more observation wells, etc.). If adequate aquifer test data are not available, and there is substantial evidence in the record that the project (including the proposed location, construction and operation of any project wells) regarding potential impacts on neighboring non-project wells or nearby surface waters, then an aquifer test may be required of the applicant's project well(s). A constant rate aquifer test is generally required for projects in All Other Areas, if acceptable test data are not already available. Interpretation of pump test data provided in driller's logs is not intended for consolidated aquifers. Pending the proposed project details, the County may also require installation of a monitoring well or monitoring of a nearby existing non-project well.

As described in the Groundwater Conservation Ordinance, the County may require applicants in groundwater deficient areas to install a water meter to verify actual groundwater usage. In addition to the above screening criteria, if the actual usage exceeds the projected use, or the screening criteria, the applicant may be required to reduce groundwater consumption and/or find alternate water sources (See **Appendix D**).

WAA Application Submittals

WAA applications for all use permits and parcel divisions, as well as for all Groundwater Conservation Ordinance permits must be submitted to the Department of Planning, Building and Environmental Services (PBES), which will consult with the Department of Public Works, and be the conduit for communication between the County and the applicant. All subsequent communication should likewise pass through PBES. Any mitigation measures identified via the additional analysis will become either project modifications to, or conditions of approval for, the proposed project. Details of the use permit, land division, or groundwater ordinance can be obtained from PBES, along with mapping of groundwater deficient areas.

Conclusions

The Napa County Board of Supervisors has long been committed to the preservation of groundwater for agriculture and rural residential uses within the County. It is their belief that through proper management, the excellent groundwater resources found within the County can be sustained for future generations. Several conclusions can be drawn from application of the Water Availability Analysis process to date:

- In the process of conducting the analysis, applicants develop a greater awareness of water use by their project, providing a higher level of awareness and potentially leading to more efficient use of the resource.
- Information submitted by applicants has led to a broader database for future study and management.
- Groundwater use can vary widely depending upon its availability, local hydrogeologic constraints, and periodic hydrologic constraints which may affect the recharge and replenishment of the aquifer system.
- On the Napa Valley Floor and in the MST, the practice of evaluating an applicant's WAA by using screening criteria is an accepted method for making groundwater determinations. Based on the significant information available on Napa County groundwater basins, the screening criteria present a reasonable approach to the process. Because of the variability in parcel conditions in "All Other Areas", these parcels warrant a site-specific analysis, as discussed elsewhere in this document.
- The Water Availability Analysis is based upon the basic premise that each landowner has equal right to the groundwater resource below his or her property, so long as it doesn't significantly impact others. Furthermore, the WAA provides sufficient information and supporting documentation to enable the County to determine whether a proposed project may significantly affect groundwater resources and the reasonable and beneficial uses in the proposed area. By implementing policies to prevent wasteful or harmful use of groundwater, it is intended that sufficient groundwater will be available for both current and future property owners. Ensuring wells are located and constructed so as to avoid impacts on neighboring wells and surface water bodies will minimize neighbor disputes and avoid significant environmental impacts. In summary, this WAA implements a process that recognizes:
    - The current understanding of the occurrence and availability of the County's groundwater resources,
    - The hydrogeologic constraints that can locally affect the utilization of those resources, and
    - The periodic hydrologic constraints that may also affect the utilization of the resource and replenishment of the aquifer system.

Appendix A: Water Availability Analysis Background

At the height of the 1990 drought in Napa County, the Napa County Board of Supervisors and the Napa County Planning Commission became very concerned with the approval of use permits and parcel divisions that would cause an increased demand on groundwater supplies within Napa County. During several Commission hearings, conflicting testimony was entered as to the impact of such groundwater extraction on water levels in neighboring wells. The Commission asked the Department of Public Works to evaluate what potential impact an approval might have on neighboring wells and on the groundwater system as a whole. In order to simplify a very complex analysis, the Department developed a three phase Water Availability Analysis to provide a cost-effective answer to the question.

On March 6, 1991 an interim policy report, prepared by County staff, was presented to and approved by the Commission requiring use permit and parcel division applicants to submit a Water Availability Analysis with their application. The staff policy report provided a procedure by which applicants could achieve compliance with the Commission policy. Oversight of groundwater development within the County's jurisdiction was later refined by the Board of Supervisors approval of Napa County Ordinance No.1162 (Groundwater Conservation Ordinance) on August 3, 1999. A revised staff policy report was subsequently adopted by the Board of Supervisors in August 2007. The 2007 Policy Report updated the Water Availability Analysis procedure and restated the purpose and functionality of the analysis relative to the Groundwater Conservation Ordinance.

In January 2011, as part of the County's Comprehensive Groundwater Monitoring Program initiated in 2009, the County's technical consultant, Luhdorff & Scalmanini, Consulting Engineers, completed a review of the County's Groundwater Conservation Ordinance and procedures, and recommended updating the staff policy report and Water Availability Analysis procedure. The consultant's review found that the initial "phase one" analysis was valuable as a screening process, but that the pump test envisioned in "phase two" was not the best way to assess whether projects exceeding the screening criteria would have detrimental groundwater impacts.

On September 11, 2011, the Board of Supervisors appointed a Groundwater Resources Advisory Committee (GRAC) to assist with development of a groundwater monitoring program, and to recommend updates to the Groundwater Conservation Ordinance, as needed. As part of their work, the GRAC also reviewed changes to this Water Availability Analysis policy report in late 2013.

Appendix B: Estimated Water Use for Specified Land Use

Each project applicant is responsible for determining estimated water usage for their proposed project. While some guidelines are provided below, other industry standards exist, PBES may be able to provide data based on previous applications, and each project has its own unique characteristics. The most appropriate data should be used by the applicant to estimate water use for their specific project.

Guidelines for Estimating Residential Water Use:

The typical water use associated with residential buildings is as follows:

Primary Residence	0.5 to 0.75 acre-feet per year (includes minor to moderate landscaping)
Secondary Residence or Farm Labor Dwelling	0.20 to 0.50 acre-feet per year

Additional Usage to Be Added

1. Add an additional 0.1 acre-feet of water for each additional 1000 square feet of drought tolerant lawn or 2000 square feet of non-xeriscape landscaping above the first 1000 square feet.
2. Add an additional 0.05 acre-feet of water for a pool with a pool cover.
3. Add an additional 0.1 acre-feet of water for a pool without a cover.

Residential water use can be estimated using the typical water uses above. All typical uses are dependent on the type of fixtures and appliances, the amount and type of landscaping, and the number of people living onsite. If a residence uses low-flow fixtures and has appliances installed, is using xeriscape landscaping, and is occupied by two people, the water use estimates will be on the low side of the ranges listed above.

Examples of Residential Water Usage:

Residential water use can vary dramatically from house to house depending on the number of occupants, the number and type of appliances and water fixtures, the amount and types of lawn and landscaping. Two homes sitting side by side on the same block can consume dramatically different quantities of water.

Example 1:

Home #1 is 2500 square feet. Outside the house there is an extensive bluegrass lawn, a lot of water loving landscaping, and a swimming pool with no pool cover. Inside the house all the appliances and fixtures, including toilets and shower-heads, are old and have not been upgraded or replaced by water saving types. The owners wash their cars weekly but they don't have nozzles or sprayers on the hose. They do not shut off the water while they are soaping up the vehicles, allowing the water to run across the ground instead. Water is commonly used as a broom to wash off the driveways, walkways, patio, and other areas. The estimated water usage for Home #1 is 1.2 acre-feet of water per year

Example 2:

Home #2 is also 2500 square feet. Outside of the house there is a small lawn of drought tolerant turf, extensive usage of xeriscape landscaping, and no swimming pool. Inside the house all of the appliances and fixtures, including toilets and showerheads, are of the low flow water saving types. The owners wash their cars weekly, but have nozzles or sprayers on the hose to shut off the water while they are soaping up the vehicles. Driveways, walkways, patios, and other areas are swept with brooms instead of washed down with water. Estimated water usage for Home #2 is 0.5 acre-feet of water per year.

The above are only examples of unique situations. The estimated water use for each project will vary depending on existing parcel conditions.

Guidelines For Estimating Non-Residential Water Usage:

Agricultural:

Vineyards	
Irrigation Only	0.2 to 0.5 acre-feet per acre per year
Heat Protection	0.25 acre-feet per acre per year
Frost Protection	0.25 acre-feet per acre per year
Irrigated Pastures	4.0 acre-feet per acre per year
Orchards	4.0 acre-feet per acre per year
Livestock (sheep or cows)	0.01 acre-feet per acre per year

Winery:

Process Water	2.15 acre-feet per 100,000 gal. of wine
Domestic and Landscaping	0.50 acre-feet per 100,000 gal. of wine
Employees	15 gallons per shift
Tasting Room Visitation	3 gallons per visitor
Events and Marketing, with on-site catering	15 gallons per visitor

Industrial:

Food Processing	31.0 acre-feet per employee per year
Printing/Publishing	0.60 acre-feet per employee per year

Commercial:

Office Space	0.01 acre-feet per employee per year
Warehouse	0.05 acre-feet per employee per year

Estimates of water use for other categories are available in the technical literature from sources such as the American Water Works Association's Water Distribution Systems Handbook (Mays, 2000).

Parcel Location Factors:

The water use screening criterion for each parcel is based on the location of the parcel. There are three different location classifications: Napa Valley Floor, MST Groundwater Deficient Area, and All Other Areas. Napa Valley Floor areas include all locations that are within the Napa Valley excluding areas designated as groundwater deficient areas. Groundwater deficient areas are areas determined by the Department of Public Works as having a history of insufficient or declining groundwater availability or quality. At present the only designated groundwater deficient area in Napa County is the MST Subarea. Areas of the County not within the Napa Valley Floor and MST Groundwater Deficient Area are classified as All Other Areas. Public Works can assist applicants in determining the appropriate classification for project parcel(s).

Project Parcel Location	Water Use Criteria
Napa Valley Floor	1.0 acre feet per acre per year
MST Groundwater Deficient Area	0.3 acre feet per acre per year or no net increase, whichever is less*
All Other Areas	Parcel Specific
* Does not apply to the Ministerial Exemption as outlined in the Groundwater Conservation Ordinance	

The criterion for the Napa Valley Floor Area was agreed to 1991 by the Board of Supervisors. The criterion of 0.3 acre feet per acre per year for the MST Groundwater Deficient Area was determined using data from the 1977 USGS report on the Hydrology of the MST Subarea (Johnson, 1977). The value is calculated by dividing the "safe annual yield," as determined by the USGS (Johnson, 1977), by the total acreage of the affected area (10,000 acres). The addition of the "no net increase" standard reflects the County's obligation to assess potential cumulative impacts under CEQA. In a groundwater deficient area, any discretionary project that increases groundwater use may contribute to the declining groundwater levels in the aquifer.

No single criterion can be established for "All Other Areas" due to the uncertainty of the geology, and the increased complexity of the fractured rock aquifer systems in the mountainous and non-Napa Valley areas, including Carneros, Pope Valley, Wooden Valley, and Capell Valley. The project applicant will need to estimate the average annual recharge occurring in the project area and consider the amount of recharge relative to the estimation of project water use (e.g., all current and projected water demands for the property on which the planned project is located). The estimated project water use shall include estimates for normal and dry water years for both current and proposed water uses. If an alternative water source will be used for dry years (e.g.

trucked-in water for non-potable uses), that information shall be provided by the applicant including the source and estimated water volume.

The criteria above were reviewed by the County's groundwater consultants in 2011-2013 and are considered to be reasonable indicators on a watershed scale of the levels below which significant environmental impacts would be unlikely to occur. The review was based on existing monitoring data and an updated hydrogeologic conceptualization of the Napa Valley aquifer system (LSCE and MBK, 2013) and is consistent with the County's experience since establishment of the water use criteria in 1991. In addition, these criteria have been successfully applied as part of the WAA procedure since their establishment.

Appendix C: Guidance for MST Subarea Permit Applications

Historical data collected from the monitoring of wells within the MST Subarea over many decades indicate that it may be in overdraft, leading to the conclusion that the existing water users within the basin historically pumped more water from the ground than is being naturally replaced each winter season. To offset the overdraft trend, a recycled water pipeline is being installed, and once operating, its beneficial effects will be measured. However, as no other reasonable water resources currently exist in the MST, to avoid a ban on all new construction, the County has permitted each property owner to develop their property with the uses involving ministerial approvals under Section 13.15.030(C) of the groundwater ordinance, which are limited to a "reasonable" level of water use that may reduce the rate at which the groundwater levels are being lowered.

Single Family Dwellings on Small Parcels In the MST Subarea: The average, single family dwelling will likely use between 0.5 and 0.75 acre-feet of groundwater per year. Using a criterion of 0.3 acre-ft/year/acre, the minimum parcel size able to support the above range is between 1.5 to 2.5 acres. However, in order to ensure that all property owners have viable use of their land, applications for the construction of a single family home in these instances can be approved ministerially if the owner agrees to the conditions outlined in the Groundwater Ordinance. If the conditions are not agreed upon, or if the project involves a secondary dwelling or other groundwater uses not consistent with a single family dwelling, then the project would be subject to the analysis outlined in the WAA report. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share"[14] water use screening criterion is met.

Agricultural Development In the MST Subarea: Agriculture in the MST Subarea is not exempt from the groundwater permit process. In these cases, such development will require an application for a groundwater permit and a WAA detailing the existing and proposed water use(s) on the project parcel(s). All new agricultural development in the MST will be required to meter all wells supplying water to the property with periodic reports to the County. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share" water use screening criterion is met.

Existing Vineyard, New Primary or Secondary Residence In the MST Subarea: On an application related to a new residence on a parcel with an existing vineyard or residence, the WAA shall include all water use on the property, both existing and proposed. Projects on parcels with an established vineyard will be required to meter all wells supplying water to the property with periodic reports to the County. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share" water use screening criterion is met.

Wineries and Other Use Permits In the MST Subarea: On a use permit application, the applicant is required to provide a WAA. Should the application be approved, a specific condition

[14] The "fair share" allotment for water use is based on the parcel(s) location in the Napa Valley Floor, MST Groundwater Deficient Area or All Other Areas (see additional information in Appendix B).

of approval will be required to meter all wells supplying groundwater to the property with periodic reports to the County. It is also possible that water conservation measures will be a condition of approval. All new use permits must meet the criterion for water use for the project parcel. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the “no net increase” and “fair share” water use screening criterion is met.

Appendix D: Water Meters (in Groundwater Deficient Areas Only)

If required, water meters shall measure all groundwater used on the parcel. Additional meters may also be required for monitoring the water use of individual facilities or operations, such as a winery, residence, or vineyard located on the same parcel. If a meter(s) is installed, the applicant shall read the meter(s) and provide the readings to the County Engineer at a frequency determined by the County Engineer. The applicant shall also convey to the County Engineer, or his designated representative, the right to access and verify the operation and reading of the meter(s) at any time.

If the meters indicate that the water consumption of a parcel in the MST Subarea exceeds the fair share amount, the applicant will be required to submit a plan which will be approved by the Director of Public Works to reduce water usage. The applicant may be required to find additional sources of water to reduce their groundwater usage. Additional sources may include using water provided by the City of Napa, the installation of water tanks which are filled by water trucks, or other means which will ensure that the groundwater usage will not exceed the fair share amounts.

The readings from water meters may also be used to assist the County in determining trends in groundwater usage, adjusting baseline water use estimates, and estimating overall groundwater usage in the MST Subarea.

Appendix E: Determining water use numbers with multiple parcels

The Water Availability Analysis is based on the premise that each landowner has equal right to the groundwater resource below his or her property. There will be cases where one person or entity owns multiple contiguous parcels and requests that the total water allotment below all of his or her parcels be considered in the Water Availability Analysis. Determining the total water demand based on multiple contiguous parcels is acceptable; however, to protect future property owners, certain safeguards must be in place to ensure that the water allotment and transfer between parcels is clearly documented and recorded, especially in cases where the water from more than one parcel will ultimately serve a use on a single parcel.

When multiple parcels are involved, the parcels for which the total water usage is being based on must be contiguous and clearly identified on a site plan with the Assessor's parcel numbers noted. The transfer of water from these parcels to the parcel on which the requested use is located must be documented using the form provided by the Department of Public Works. The form must be approved by the County and subsequently recorded by the applicant prior to commencement of any activity authorized by the groundwater permit or other county permit or approval. A condition requiring such will be placed on the use permit, groundwater permit or other permit for approval.

Alternatively, if the method above is not feasible, the applicant may provide an additional analysis for each project parcel, with the understanding that the water use on each individual parcel must not exceed the water use screening criterion for that parcel (see additional information in Appendix B).

Appendix F: Water Availability Analysis Tiers 2 & 3 Screening Criteria & Additional Analysis

County staff will conduct, or require the applicant to conduct, additional analysis of the proposed project according to any screening criteria that are not met. Additional analysis is required for projects that are not located on the Napa Valley Floor or in the MST (i.e. “All Other Areas”). Additional analysis will also be required if insufficient information exists in the project application to judge conformance with one or more of the criteria.

Water Use Evaluation (Tier 1)

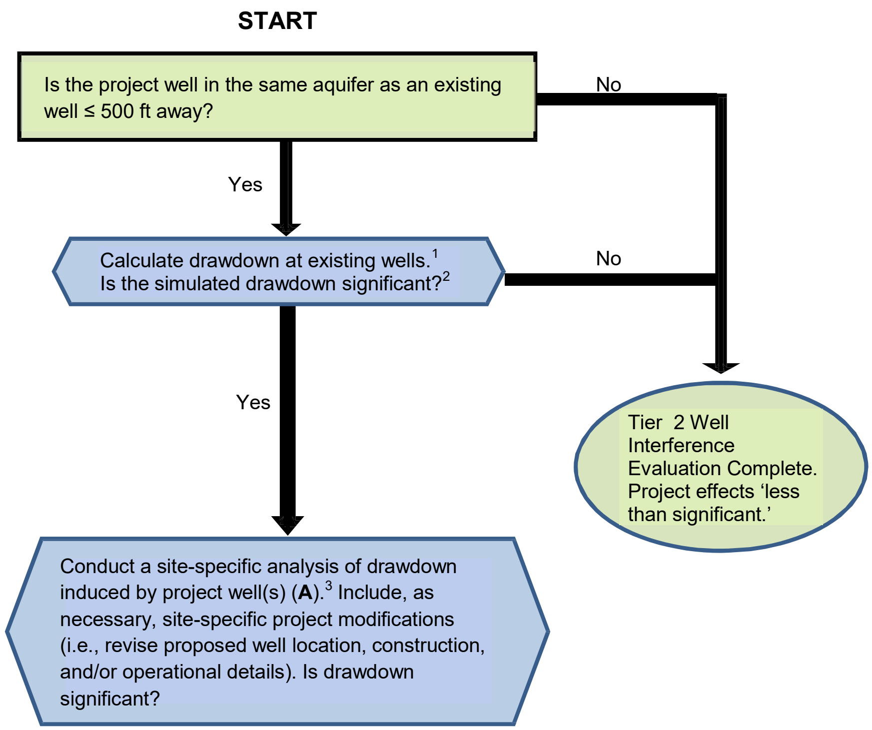
When the proposed project’s estimated water demand does not meet the applicable water use criterion, the applicant will be encouraged to first revise the project and/or refine the water use estimate based on project details not adequately reflected in the water use screening criterion. County staff will then review the revised estimate and determine if the acceptable water use criterion has been met.

Well and Spring Interference Evaluation (Tier 2)

The Tier 2 well interference criterion is presumptively met if there are no non- project wells located within 500 feet of the existing or proposed project well(s). When a project well is within 500 feet of a neighboring non-project well(s) additional analysis of well interference will be required (see **Figure F-1**) for projects located in “All Other Areas”. It may also be required for the Napa Valley Floor and the MST when substantial evidence in the record indicates the need to do so under CEQA. The analysis will first determine whether the existing or proposed project and non-project wells are, or are proposed to be, screened in the same aquifer unit and, if so, whether any drawdown induced in the non-project well(s) may constitute a significant adverse effect. **Table F-1** provides standard well interference criteria for induced drawdown in a non-project well that will be used in the absence of site-specific information regarding the susceptibility of existing non-project wells to drawdown induced by project well(s). Site-specific susceptibility information would include the pump depth setting and construction of project and non-project wells.

The Tier 2 spring interference criterion is presumptively met if no natural springs in use for domestic or agricultural purposes are located within 1,500 feet of any proposed project wells. When a project well is within 1,500 feet of a natural spring additional analysis of connectivity between the part of the aquifer system from which groundwater is planned to be produced and spring(s). When additional analysis is required, site-specific spring interference criteria will be established as appropriate for the springs(s) under consideration.

FIGURE F-1. WAA Additional Analysis Decision Tree (as shown, for well interference evaluation), where designated A = applicant responsibility, C = County staff responsibility



[1] Drawdown to be calculated using industry standard method(s) appropriate to the aquifer under consideration, such methods include the Theis Equation applicable for confined or unconfined aquifers (**A** or **C**).

[2] See Table F-1 or similar, superseding criteria provided by County staff (C).

[3] This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations and must include details of the project well(s) construction and operation relative to the site hydrogeology and any known information concerning the construction of any existing non-project wells under consideration (**A**).

The additional analysis will consider site-specific information including:

- the distance between the project well(s) and any existing non-project wells within 500 feet or natural springs within 1,500 feet;
- depth, screen intervals, and pump design flow rate for project well(s);
- depth, screen intervals, and pumping capacity/well type for the existing non- project well(s) or elevation and historical records of spring production;
- site hydrogeology (including aquifer units accessed by the project well and by existing non-project well(s) or natural springs and aquifer hydraulic properties (see **Tables F-2 and F-3**).

Data collected for the analysis will initially come from the WAA application, including information about existing non-project wells and site hydrogeology provided by County staff. These data will be used to calculate drawdown at any existing non-project wells, completed in the same aquifer unit, resulting from planned operation of the project well(s). Drawdown will be calculated using industry standard methods appropriate to the aquifer unit under consideration; such methods include the Theis Equation applicable for confined or unconfined aquifers (Theis, 1935).

If the initial calculated drawdown exceeds the Tier 2 well interference criteria, the applicant shall be required to submit a site-specific analysis prepared by a qualified professional demonstrating that the proposed project will not have an adverse effect (direct, indirect, or cumulative), on groundwater resources or neighboring non-project wells. This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations. The site-specific analysis may also demonstrate less than significant impacts by proposing modifications to the location, construction, or operation of project well(s).

If available data indicate a possible hydraulic connection between the project well(s) and any identified springs, an analysis of the hydraulic connection induced by the project well(s) will be conducted. Potential spring flow depletion induced by the project well(s) will be compared to site-specific spring interference criteria to determine if they constitute a significant adverse effect. The site-specific spring interference criteria will be established as appropriate for the spring(s) under consideration. Depending on site-specific concerns, more or less restrictive criteria may be required.

Table F-1 presents well interference criteria that the County may apply in the determination of significant adverse effects. The minimum significant drawdown values presented in **Table F-1** are intended for use in cases where information about existing non-project wells is limited or nonexistent. However, when the status and configuration of an existing non-project well are known, for example the depths of screen intervals, locations of any annular seals, and/or water levels in the well and the pump depth setting, then site-specific measures of significance should be used. Site-specific measures of significance should also account for known seasonal variations[15] in groundwater elevations in the vicinity of the proposed project and mutual well interference (i.e., interference between the planned project well usage (new and/or existing) and one or more neighboring wells). County staff shall inform the applicant of the site-specific Tier 2 well interference criteria that will be applied in the evaluation of a project before the applicant conducts a site-specific analysis.

[15] As used here, seasonal variations refer to typical changes over the course of a year.

Table F-1. Default Well Interference Criteria

Type of wells within 500 ft. screened within the same aquifer as project well	Estimated Drawdown at Neighboring Non-Project Wells
Wells with a casing diameter of six inches or less	10 feet
Wells with a casing diameter greater than six inches	15 feet

Groundwater/Surface Water Interaction Evaluation (Tier 3)

When Tier 3 analysis is required[16], it shall be conducted as described below. The analysis will first determine whether the project well(s) are, or are proposed to be, screened in an aquifer unit hydraulically connected to the surface water(s) within the applicable distance specified by **Tables 3, 4, and 5** for unconsolidated aquifers (see also Figure F-2). If a hydraulic connection does exist, even one of limited temporal extent, then an analysis of the streamflow or surface water depletion induced by the project well(s) will be conducted. The streamflow depletion induced by the project well(s) will be compared to site-specific groundwater/surface water interaction criteria to determine if they constitute a significant adverse effect. The site-specific groundwater/surface water interaction criteria will be established as appropriate for the surface water(s) under consideration. Depending on the temporal extent of hydraulic connection and the special status species and/or surface water rights under consideration, more or less restrictive criteria may be required, up to and including no measurable streamflow depletion.

The additional analysis will consider site-specific information including:

- the distance between the proposed well and naturally-present surface water bodies within 1500 feet;
- depth, screened intervals, seal depths, and pumping capacity of applicant's well(s);
- site hydrogeology (including aquifer zones accessed by proposed well and existing wells and aquifer hydraulic properties (see **Tables F-2, F-3 and F-4**); and
- streambed (or equivalent feature) hydraulic properties.

Data collected for the analysis will initially come from the WAA application, including information about existing non-project wells and site hydrogeology provided by County staff. The evaluation will include calculation of streamflow depletion due to planned operation of the project well(s). Streamflow depletion will be calculated using industry standard methods appropriate to the

[16] Tier 3 analysis may be required under CEQA if substantial evidence, in the record, indicates a potentially significant impact may occur from the project.

aquifer under consideration; such methods include the Hantush Equation applicable for aquifers hydraulically connected with surface waters (Hantush, 1965).[17] If the initial calculated streamflow depletion exceeds the groundwater/surface water interaction criteria, the applicant shall be required to submit a site-specific analysis prepared by a qualified professional demonstrating that the proposed project will not have an adverse effect (direct, indirect, or cumulative), on surface water resources. This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in streamflow depletion calculations. The site-specific analysis may also demonstrate less than significant impacts by proposing modifications to the location, construction, or operation of project well(s).

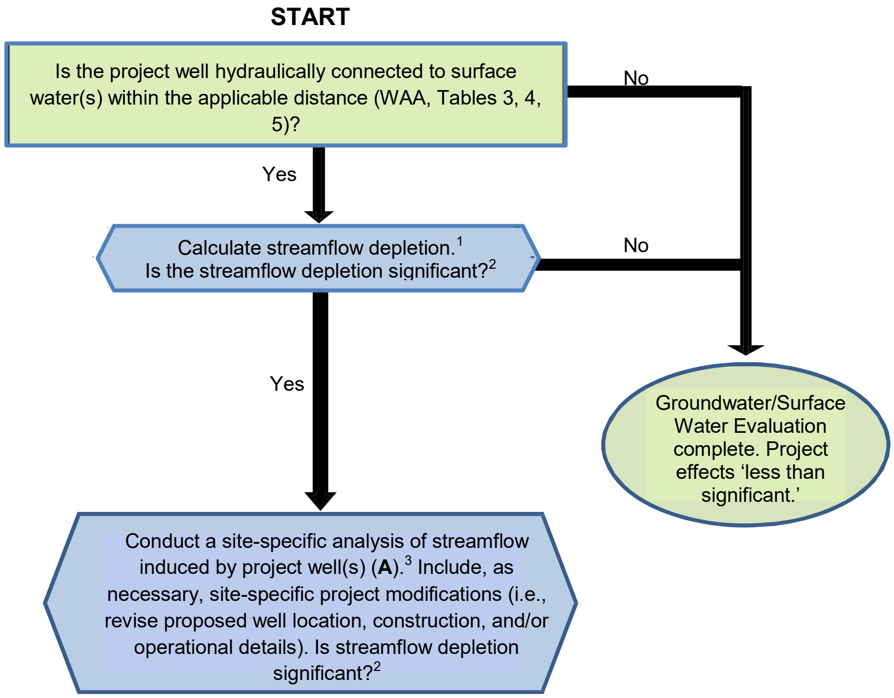
Modifications to the proposed project will be considered acceptable in satisfying the criteria where project well(s) can be shown to have a sufficient geologic or hydraulic separation from the surface water(s) that would prevent the well from causing streamflow depletion at least as much as would be expected at the minimum distance specified by the WAA Tables 3, 4, and 5. The California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (USBR) allow for similar exemptions when considering the potential effect on surface water flows of groundwater pumping proposed for water transfers involving groundwater substitution pumping in the Sacramento Valley. Some example circumstances for exception to the stated criteria (based on DWR and USBR, 2013) include:

- Sufficient information, including site-specific geologic or hydrologic data, is provided to demonstrate that the well does not have significant hydraulic connection to the surface water system;
- The well's uppermost perforations are planned to be deeper than recommended (see **Tables 3, 4, 5**) and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 20 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, pending the well type and planned well operations;
- The well's uppermost perforations are planned to be shallower than recommended (see **Tables 3, 4, 5**) and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 40 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, pending the well type and planned well operations;
- The project well is a moderate to high pumping capacity well and the uppermost perforations are located no shallower than 150 feet deep, the perforations may be shallower (e.g., 100 feet deep), if there is a total of at least 50 percent fine-grained

[17] Streamflow depletion is to be calculated using industry standard method(s) appropriate to the aquifer and surface water source under consideration, such methods include the Hantush Equation applicable for unconfined aquifers with a direct hydraulic connection to a surface water body (Hantush, 1965).

materials in the interval above 100 feet below ground surface (bgs), and at least one fine-grained layer that exceeds 40 feet in thickness in the interval above 100 feet bgs.

FIGURE F-2. WAA Additional Analysis Decision Tree (as shown, for groundwater/surface water evaluation), where designated A = applicant responsibility, C = County staff responsibility



[1] Streamflow depletion to be calculated using industry standard method(s) appropriate to the aquifer under consideration, such methods include the Hantush Equation applicable for aquifers hydraulically connected with surface waters (**A** or **C**).

[2] Streamflow depletion criteria will be determined according to site-specific conditions (C).

[3] This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations and must include details of the project well(s) construction and operation relative to the site hydrogeology and any known information concerning the surface water(s) under consideration (**A**).

Data Needs for Additional Analysis

Hydrogeologic information at or in the vicinity of the subject parcel may be available from previous activities, or may be reasonably estimated from prior work conducted by the County. Previous activities may include (but are not limited to) aquifer tests, well completion reports with lithologic logs, water level, and well yield data collected on the parcel, and water level data collected as part of other groundwater monitoring activities. County staff will determine whether and how to best include such data in the WAA evaluation process. If no geologic information exists in the vicinity of the subject parcel, additional analysis may be required of the applicant.

The hydrogeologic information needed for WAA evaluation may include the aquifer storage coefficient, specific yield, hydraulic conductivity, transmissivity, and aquifer thickness. The aquifer storage coefficient for confined aquifers, or storativity, is defined as the volume of water that can be drained from a unit area of aquifer materials per unit decline in head. The storage coefficient can be calculated by multiplying the aquifer thickness and specific storage. In unconfined aquifers a similar property is represented by the specific yield of the aquifer materials.[18] Specific yield is defined as the volume of water that can be drained from a unit area of an unconfined aquifer in response to a unit decline in the water table elevation. **Table F-2** presents a range of values for specific yield for a variety of potential aquifer materials. In a confined aquifer the specific storage of aquifer materials can be calculated as the storage coefficient multiplied by aquifer thickness, where the storage coefficient is the volume of water produced by a unit volume of aquifer material per unit decline in head. **Table F-3** presents a range of possible specific storage values for potential aquifer materials. Storage coefficients for confined aquifers typically range from $5x10^{-5}$ to $5x10^{-3}$ (Todd, 2005). Specific yield for unconfined aquifers typically range from 0.1 to 0.3 (Lohman, 1972).

Table F-2. Representative Specific Yield[1] Ranges for Selected Earth Materials (adapted from Walton, 1970)

Sediment	Specific Yield
Clay	0.01 – 0.10
Sand	0.10 – 0.30
Gravel	0.15 – 0.30
Sand and Gravel	0.15 – 0.25
Sandstone (e.g., Great Valley formation)	0.05 – 0.15
Shale (e.g., Great Valley formation)	0.005 – 0.05
[1]Specific yield can be considered equivalent to the storage coefficient for unconfined aquifers where aquifer compressibility is negligible.	

Table F-3. Representative Specific Storage Ranges for Selected Materials (adapted from Batu, 1998)

Material	Specific Storage (ft^{-1})
Loose Sand	$1.5x10^{-4}$ to $3.1x10^{-4}$
Dense Sand	$3.9x10^{-5}$ to $6.2x10^{-5}$
Dense Sandy Gravel	$1.5x10^{-5}$ to $3.1x10^{-5}$
Rock, fissured	$1x10^{-6}$ to $2.1x10^{-5}$

[18] An unconfined aquifer is defined by a water table that occurs where pore space pressures coincide with atmospheric pressure and where water released from aquifer storage occurs in large part due to the draining of saturated pore spaces in the aquifer material.

Transmissivity is another frequently used aquifer parameter. Transmissivity is defined as the capacity of the aquifer to transmit water across its entire thickness, calculated as the product of the aquifer hydraulic conductivity and the aquifer thickness. **Table F-4** presents representative hydraulic conductivity values found in the literature. Hydraulic conductivity ranges for the alluvial aquifer system have been mapped in Napa Valley by the US Geological Survey (USGS) (Faye, 1973), with more recent interpretations provided here based on a review of well driller's logs and other geologic data available through 2011 (LSCE and MBK, 2013). These ranges for hydraulic conductivity are depicted in **Figure F-3** and described in **Table F-5**, as interpreted by the County's groundwater consultants. Recent hydrogeologic investigations performed for the County have also produced maps and cross sections of subsurface geologic conditions which may be consulted for the determination of aquifer thickness in the vicinity of a proposed project (LSCE and MBK, 2013).

Table F-4. Representative Hydraulic Conductivity Ranges for Selected Materials (adapted from Leap, 1999 and Batu, 1998)

Material	**Hydraulic Conductivity (ft/day)**		
Gravel (Alluvium)	10^{1}	to	10^{5}
Sand (Alluvium)	10^{-1}	to	10^{3}
Silty Sand (Alluvium)	10^{-2}	to	10^{2}
Silt (Alluvium)	10^{-4}	to	1
Sandstone (e.g. Great Valley formation)	10^{-5}	to	10^{-1}
Shale (e.g., Great Valley formation)	10^{-8}	to	10^{-4}
Fractured Basalt (e.g., Sonoma Volcanics)	10^{-2}	to	10^{2}

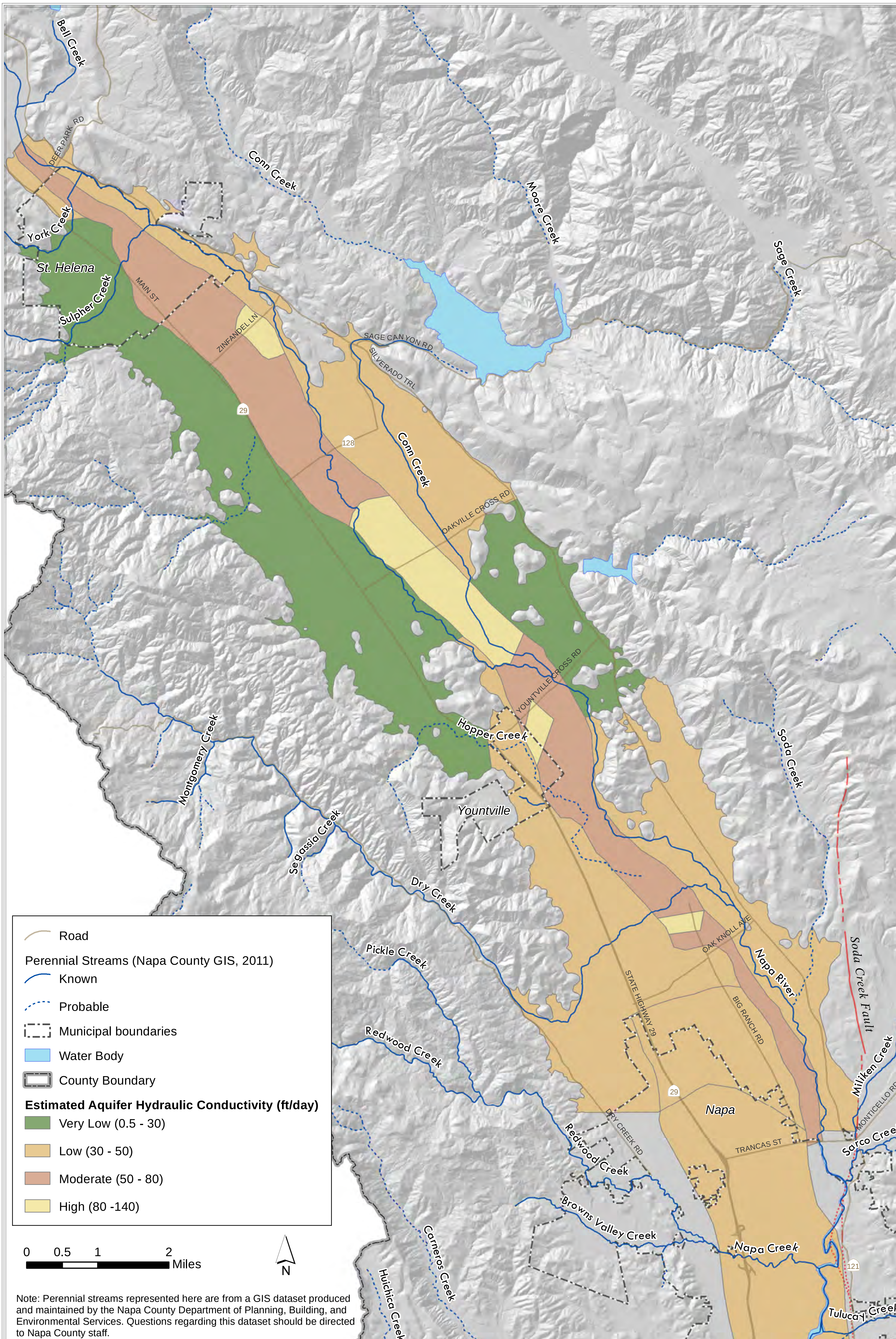


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Figure F-3
Estimated Alluvial Aquifer Hydraulic Conductivity Ranges, Napa Valley Floor

Table F-5. Representative Hydraulic Conductivity values for WAA analysis of Napa Valley Floor unconsolidated alluvial aquifer materials[3]

Hydraulic Conductivity, K, class	**Hydraulic Conductivity range[1], ft./day**	**Hydraulic Conductivity value, ft./day** (used for scenario results)
high	80 - 140	80
moderate	50 - 80	50
low	30 - 50	30
very low[2]	0.5 - 30	0.5, 10

[1] Hydraulic conductivity range have been developed from mapped values from Faye (1973) and interpretations based on a review of well driller's logs and other geologic data available through 2011 (LSCE and MBK, 2013).

[2] A hydraulic conductivity value of 0.5 ft./day was applied for calculations of groundwater and surface water interaction (Tables 3, 4 and 5). A hydraulic conductivity value of 10 ft./day was applied for calculations of well interference (Table 2B and F1).

[3]Representative hydraulic conductivity values shown here are applicable to the unconsolidated alluvial aquifer materials in the Napa Valley Floor and not aquifer zones beneath the Napa Valley Floor alluvium or outside of the Napa Valley Floor.

County staff will review well construction permits and records for wells within 500 feet of the proposed project. Information about existing wells within 500 feet of the proposed project site will include the following as available: the location of those wells relative to the project well(s), total depth, depth of screened intervals, annular seal depths, the geologic or lithologic record made as part of well construction, the elevation of the static water level in the well post-construction, the elevation of water levels while pumping, and the pump depth setting.

Tables F-6 to F-9 present, for comparison purposes, the results of scenarios intended to represent the groundwater drawdown experienced in the vicinity of a proposed project after a 24-hour continuous pumping period. The results in **Tables F-6 and F-7** indicate that drawdown in a confined aquifer would be greater than drawdown in an unconfined aquifer for a given pumping rate. These results also indicate that wells pumping at rates less than 30 gallons per minute (gpm) for periods of time less than 24-consecutive hours will likely have negligible drawdown effects at distances beyond 25 feet in a confined aquifer.

These scenarios are presented for comparison purposes. Actual drawdown due to well interference will have to be calculated using well construction information and site-specific hydrogeologic information and/or values from **Tables F-2, F-3, F-4 and F-5** that are applicable to site-specific conditions.

Table F-6: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in a confined aquifer

30 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**500**
0.0005	10	5.3	4.4	3.6	1.6
0.001	10	4.8	4.0	3.1	1.2

Table F-7: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in a confined aquifer

100 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**500**
0.0005	10	13.6	11.5	9.4	4.5
0.001	10	12.5	10.4	8.3	3.5

Table F-8: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in an unconfined aquifer

30 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**125**
0.1	80	0.4	0.3	0.2	n/a
0.1	50	0.6	0.4	n/a	n/a
0.1	30	0.9	0.6	n/a	n/a
0.1	10	2.0	n/a	n/a	n/a

"n/a" denotes cases where Theis equation results are not available due to mathematical constraints on valid parameter values.

Table F-9: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in an unconfined aquifer

100 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 100 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**125**
0.1	80	1.1	0.8	0.6	0.5
0.1	50	1.6	1.2	n/a	n/a
0.1	30	2.4	1.7	n/a	n/a
0.1	10	5.5	n/a	n/a	n/a

"n/a" denotes cases where Theis equation results are not available due to mathematical constraints on valid parameter values.

Example Applications of Additional Analysis Methods

Example 1: *Addition of a commercial tasting room facility with 10 acres of new vineyard and landscaping to an existing winery in a non-groundwater deficient area. The project involves construction of a new well proposed to be 30 feet from an existing six-inch diameter non-project well.*

Is well proposed to be completed in the same aquifer as an existing well ≤ 500 ft. away?

Yes, County well construction records indicate that the existing non-project well was constructed to a total depth of 160 feet in an unconfined aquifer, with a total screened interval of 80 feet throughout the older alluvium that is also mapped in the vicinity of the proposed well.

Calculate drawdown at all existing wells within 500 ft. of the proposed well. Is the calculated drawdown significant?

Yes, 10.9 feet of drawdown is calculated at the existing non-project well, based on available information about the existing well and the hydrogeology of the site (see **Table F-10**). This amount of drawdown exceeds the default well interference criterion of 10 feet and represents a potentially significant impact on groundwater resources.

Table F-10. Example 1: Drawdown calculated at an existing non-project well as a result of pumping a proposed well at 300 gallons per minute, where hydraulic conductivity = 30 ft./day, storage coefficient = 0.02, and aquifer thickness = 80 feet.		
	Distance between Proposed Well and Existing Well (ft.)	**Calculated Drawdown in Existing Well (ft.)[1]**
Initial Project Well Location	30	10.9
Alternate Project Well Location A	50	9.0
Alternate Project Well Location B	70	7.7
[1] Drawdown at an existing non-project well as a result of pumping the project well calculated using the Theis Equation.		

Conduct a site-specific analysis of drawdown induced by project well(s). Include, as necessary, site-specific project modifications (i.e., revise proposed well location, construction, and/or operational details).

Is simulated drawdown significant (see Table F-1)?

No, after reviewing the site's existing and proposed infrastructure the project applicant modified the proposed well location to a location 50 feet away from the existing non-project well. Calculated drawdown values at the existing wells using the same available information about the existing wells, site hydrogeology, and the new proposed well location show less than significant drawdown at the existing non-project well (i.e., 9.0 feet). The applicant's groundwater use permit was approved on the condition of adherence to the revised well location and County standards for well construction.

Example 2: *Modification of an existing 40-year old irrigation well on a 12-acre parcel. The parcel also includes a primary, single-family residence with an existing (or available) connection to a public water supply system. The applicant proposes installing a new 80 gallon per minute pump to supply irrigation water for 10 acres of replanted winegrapes on lands which had not been actively farmed for several years. The applicant proposes operating the pump for 3 days at a time during the irrigation season. One existing non-project well is located 50 feet from the applicant's project well on one adjacent parcel and another existing non-project well is located 120 feet from the applicant's project well on another adjacent parcel. Both non-project wells are six-inch diameter wells.*

Is well proposed to be completed in the same aquifer as an existing well ≤ 500 ft. away?

Yes, well construction records provided by the applicant (or available from the County) indicate that the applicant's existing well is constructed to a total depth of 140 feet, with a total screened interval of 60 feet, in the older, unconsolidated alluvium.

County well construction records indicate that the existing non-project 50 feet from the project well was constructed to a total depth of 115 feet, with a total screened interval of 50 feet throughout the older alluvium.

Calculate drawdown at all existing wells within 500 ft. of the proposed well. Is the calculated drawdown significant?

No, 5.8 feet of drawdown is calculated to occur at the existing non-project well, based on available information about the existing well and the hydrogeology of the site (see **Table F-11**). This amount of drawdown does not exceed the default well interference criterion of 10 feet and represents a less than significant impact on groundwater resources. The applicant's groundwater use permit was approved contingent upon the proposed pumping duration.

Table F-11. Example 2: Drawdown calculated at an existing non-project well as a result of pumping the applicant's existing project well, where hydraulic conductivity = 10 ft./day, storage coefficient = 0.1, and aquifer thickness = 60 feet.

	Applicant's well pumping rate (gpm)	**Applicant's well seasonal pumping duration (days)**	**Calculated Drawdown in Existing Well (ft.)[1]**
Initial Proposal	80	3	5.8

[1] Drawdown calculated using the Theis Equation at an existing non-project well as a result of pumping the applicant's existing project well located 50 feet away.

Definitions

Aquifer – A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Aquifer Unit - One part of a number of units that comprise a larger aquifer system.

Hydraulic Conductivity – The capacity of subsurface materials to permit flow through interconnected pores, fractures, or other void spaces, subject to intrinsic properties of the fluid. As applied in this WAA, hydraulic conductivity is equivalent to saturated hydraulic conductivity.

Specific Storage– an aquifer hydraulic property which is the volume of water that can be drained from a unit volume of aquifer materials per unit decline in head.

Specific Yield – an aquifer hydraulic property which is the volume of water that can be drained from a unit area of an unconfined aquifer in response to a unit decline in the water table elevation.

Storage Coefficient (also Storativity) – an aquifer hydraulic property which is the volume of water released or added to aquifer storage per unit surface area of a confined aquifer per unit change in head.

Substantial Evidence - Defined by case law as evidence that is of ponderable legal significance, reasonable in nature, credible and of solid value. The following constitute substantial evidence: facts, reasonable assumptions predicated on facts; and expert opinions supported by facts. Argument, speculation, unsubstantiated opinion or narrative, or clearly inaccurate or erroneous information do not constitute substantial evidence.

Surface Water - For the purposes of this procedure, surface waters are defined to include only those surface waters known or likely to support special status species or surface waters with an associated water right; <u>however, as with all of the procedures in this WAA, there may be unique circumstances that require additional site-specific analysis to adequately evaluate a project's potential impacts on surface water bodies</u>.

Transmissivity – an aquifer hydraulic property which reflects the capacity of the aquifer to transmit water across its entire thickness, calculated as the product of the aquifer hydraulic conductivity and the aquifer thickness.

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APPENDIX 3C

Technical Memorandum: Evaluating the Potential Effects of Groundwater Pumping on Surface Water Flows and Recommended Well Siting and Construction Criteria

FINAL TECHNICAL MEMORANDUM

APPROACH FOR EVALUATING THE POTENTIAL EFFECTS OF GROUNDWATER PUMPING ON SURFACE WATER FLOWS AND RECOMMENDED WELL SITING AND CONSTRUCTION CRITERIA

PREPARED FOR NAPA COUNTY

PREPARED BY

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OCTOBER 11, 2013

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1 Introduction

Groundwater and surface water are highly important natural resources in Napa County. Currently, municipal and private stakeholders are actively engaged in assessing the reliability of current and future demands and supplies. Important sources of water include both groundwater and surface water of good quality and quantity, to meet future urban, rural, and agricultural water demands. Similar to other areas in California, businesses and residents of Napa County face many water-related challenges.

As part of Napa County's General Plan (2008, amended June 23, 2009), and within the Conservation Element, six goals are set forth relating to the County's surface water and groundwater resources. Complementing these goals are twenty-eight policies and ten water resources action items (one of which is "reserved" for later description). Two of the County's water resources goals are included below as related to this Technical Memorandum and managing surface water and groundwater resources on a sustainable basis (the entire group of water resources goals, policies, and action items is included in LSCE, 2011a).

> **Goal CON-10:** Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations.

> **Goal CON-12:** Proactively collect information about the status of the County's surface and groundwater resources to provide for improved forecasting of future supplies and effective management of the resources in each of the County's watersheds.

Addressing the two water resources goals above, the County has produced specific General Plan Action Items related to the focus and objective of this Technical Memorandum. Those action items include:

> **Action Item CON WR-6:** Establish and disseminate standards for well pump testing and reporting and include as a condition of discretionary projects that well owners provide to the County upon request information regarding the locations, depths, yields, drilling and well construction logs, soil data, water levels and general mineral quality of any new wells. [Implements Policy 52 and 55]

> **Action Item CON WR-8:** The County shall monitor groundwater and interrelated surface water resources, using County-owned monitoring wells and stream and precipitation gauges, data obtained from private property owners on a voluntary basis, data obtained via conditions of approval associated with discretionary projects, data from the State Department of Water Resources, other agencies and organizations. Monitoring data shall be used to determine baseline water quality conditions, track groundwater levels, and identify where problems may exist. Where there is a demonstrated need for additional management actions to address groundwater problems, the County shall work collaboratively with property owners and other stakeholders to prepare a plan for managing groundwater supplies pursuant to State Water Code Sections 10750-10755.4 or other applicable legal authorities. [Implements Policy 57, 63 and 64]

This Technical Memorandum describes the approach developed to facilitate the County's evaluation of proposed groundwater extractions near to surface water courses and the potential effects of such pumping on streamflows. This Technical Memorandum focuses on criteria to evaluate discretionary projects being reviewed pursuant to the California Environmental Quality Act (CEQA). Recommendations are provided for the siting and construction of wells to minimize the potential effects of pumping on streamflows.

2 Background, Purpose, and Goals

2.1 Background

In 2009, Napa County embarked on a countywide project referred to as the "Comprehensive Groundwater Monitoring Program, Data Review, and Policy Recommendations for Napa County's Groundwater Resources" (Comprehensive Groundwater Monitoring Program), to meet identified action items in the 2008 General Plan update (Napa County, 2008). Napa County's Comprehensive Groundwater Monitoring Program involved many tasks that led to the preparation of five technical memoranda and a report on *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011b). This report and the other related documents can be found at: http://www.countyofnapa.org/bos/grac/.

The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information. The program covers the continuation and refinement of countywide groundwater level and quality monitoring efforts (including many basins, subbasins and/or subareas throughout the county) for the purpose of understanding groundwater conditions (i.e., seasonal and long-term groundwater level trends and also quality trends) and availability. This information is critical to enable integrated water resources planning and the dissemination of water resources information to the public and state and local decision-makers.

Napa County's combined efforts through the Comprehensive Groundwater Monitoring Program along with the related AB 303 Public Outreach Project on groundwater (CCP, 2010) and the efforts of the Watershed Information Center and Conservancy (WICC) of Napa County create a foundation for the County's continued efforts to increase public outreach and participation in water resources understanding, planning, and management.

Subsequent work has consisted of four tasks. Three of these tasks were related to the preparation of the report *Napa County Updated Hydrogeologic Conceptualization and Characterization of Conditions* (Report) conducted by Luhdorff and Scalmanini, Consulting Engineers (LSCE) together with MBK Engineers (MBK) on behalf of the County to implement a number of the recommendations pertaining to the County's Comprehensive Groundwater Monitoring Program, including:

- Preparation of an updated hydrogeologic conceptualization and characterization of conditions in various areas of Napa County;
- Analysis of the potential for surface water/groundwater interactions;
- Refining and further characterizing areas of the greatest recharge potential; and
- Linking well construction information to groundwater level monitoring data, and provide groundwater monitoring recommendations.

The fourth task is addressed in this Technical Memorandum.

2.2 Purpose

Task 4 involved the development of an approach to evaluate the potential effects of groundwater pumping on surface water that would result in a classification system or criteria for discretionary projects being reviewed pursuant to the CEQA. Specifically, Napa County has expressed interest in identifying an approach that could be used to determine whether groundwater pumping for a proposed project located near a surface water course would have impacts on flows in the stream. The approach would be guided by evaluation of hydrogeologic conditions (as can be identified with the Report and also existing site-specific data) along a defined corridor in the vicinity of the Napa River and the use of the methodology to quantify the potential effects of such projects. Task 4 has also involved recommendations for well siting and construction criteria to determine when proposed groundwater wells will have an insignificant or no measurable effect on surface water resources in the main Napa Valley Floor and other areas of the county.

3 Groundwater Levels

The nature of interactions between groundwater and surface water depends largely on the gradient for water flow between groundwater and surface water systems. Water flows from higher elevations to lower elevations. Groundwater elevation contours represent lines of equal groundwater elevation and are independent of surface topography. Contours of groundwater elevation provide a snapshot of the direction and relative magnitude of the groundwater flow gradient. If the groundwater system depicted on a contour map exists in an unconfined condition (i.e., at atmospheric pressure), as is expected in the widely distributed shallower alluvial deposits in Napa Valley, the groundwater elevation contours also represent the water table elevation. Characterizing the relationship between surface water elevations and groundwater elevations is important for understanding the nature of groundwater-surface water interaction. In an unconfined groundwater setting, groundwater and surface water will interact and exchange water according to the elevation gradient between these water bodies. To evaluate this relationship, elevations along surface waterways in the Napa Valley area were compared with groundwater elevations (LSCE and MBK, 2013).

3.1 Groundwater Elevation Contours

Groundwater elevation contours are derived from available water level measurements made in wells. As a result, the accuracy of interpretations in groundwater elevation contours depends on the spatial distribution and accuracy of water level control data points. Spring 2010 groundwater level measurements were available from 30 monitored wells in Napa Valley, excluding the Milliken-Sarco-Tulucay (MST) Subarea. **Figure 3.1** shows the locations of groundwater elevation data points used in generating the spring 2010 groundwater elevation contours.

Groundwater elevation contours are developed from the available depth to water records from the 30 available wells. Prior to interpolating groundwater elevations across the valley, depth to water values were converted to groundwater elevation values by subtracting the measured depth to water from the reference point elevation at each monitored well. In this way the depth to water measurements were related to mean sea level as a standard point of reference. The resulting groundwater elevation values at each well were used to interpolate groundwater elevation contours throughout the Napa Valley Floor. Measured groundwater levels used in contouring generally represent conditions in the Napa Valley alluvium; therefore, mapped bedrock outcrop areas were excluded from the contouring process.

Interpreted groundwater elevation contours for spring 2010 are shown in **Figure 3.1**. The direction of groundwater flow is perpendicular to the contour lines. Contours show a generally southeasterly to east-southeasterly groundwater gradient paralleling the valley axis from Calistoga to Yountville with similar groundwater elevation ranges. In the southwestern quadrants of the St. Helena and Yountville Subareas and eastern portions of the Napa Subarea, spring 2010 contours show a gradient for groundwater flow that is more perpendicular to the valley axis generally from the valley edges towards the Napa River.

3.2 Depth to Groundwater Relative to Stream Thalweg

The groundwater surface elevation and the estimated stream thalweg elevation data are important components for characterizing the groundwater-surface water relationship in the Napa Valley area. The spring 2010 contours of equal groundwater elevation are used to provide a snapshot representation of groundwater conditions with which to compare the vertical relationship between groundwater and surface water (LSCE and MBK, 2013). This spatial relationship assists in developing an understanding of the nature of water exchange between the groundwater and surface water systems. Further, this analysis focused specifically on the degree of connectivity between the Napa River thalweg and the elevation of the regional groundwater surface in the Napa Valley in spring 2010.

Groundwater/surface water interaction is characterized by comparing the elevation of surface water to the shallowest adjacent groundwater. Detailed remotely sensed elevation data of the mainstem Napa River and several major tributaries were obtained for this purpose. LiDAR data provided sub-meter precision elevation data and were sampled at 3 foot intervals along each watercourse. These data were then paired with groundwater level data to evaluate the interconnectedness of groundwater and surface water, particularly in the main Napa Valley Floor (LSCE and MBK, 2013).

Calculated depths to groundwater equal to or above the estimated thalweg alignment indicate that for spring 2010 the interpreted groundwater elevation was above the bottom of the Napa River thalweg. The data suggest areas where a direct connection between the water table and the river may have existed in spring 2010 and where groundwater has the potential to discharge into the stream channel. In other areas, the depth to groundwater is below the bottom of the Napa River thalweg such that surface flows in the river have the potential to percolate and recharge the groundwater system. The results provided an insight into reaches where a direct connection between the Napa River and the alluvial aquifer are not likely under the conditions documented in spring 2010. These areas include reaches along the northern boundary of the Napa and MST subareas at the Soda Creek Fault, adjacent to a previously documented area of lower groundwater elevations.

Despite the uncertainty in the data in parts of the valley, depths to groundwater (both measured and calculated) show generally shallow groundwater throughout much of the valley, particularly in the northern end of the valley. The calculated depths to groundwater appear to be reasonably represented in the Napa Subarea because this area has the greatest density of monitored sites, particularly along the lower elevation eastern edge. **Figure 3.2** presents the depths to groundwater for Napa Valley based on water level measurement for wells constructed in the alluvial aquifer system. This figure reflects the generally shallow groundwater levels measured particularly along the axis of the valley.

3.2.1 Blueline Stream Locations

Napa County's Planning, Building, and Environmental Services Department maintains a GIS dataset of perennial streams throughout the county, included as a part of the larger "bluelines" shapefile. The dataset includes both unnamed and 48 named streams, creeks, rivers, and other surface water courses classified as known perennial or probable perennial, see **Figure 3.3**. The known and probable classifications are a subset of all water courses originally digitized from U.S. Geological Survey (USGS) topographic maps of Napa County. Metadata for the dataset describe the known perennial water courses as those determined by "stream reports or other known data sources", while probable perennial water courses are defined as having been determined by "computer analysis of probable streams". As shown in **Figure 3.3**, known or probable perennial water courses are present in all Napa County subareas except for the Livermore Ranch, Knoxville, Berryessa, and Jameson/American Canyon Subareas.

3.3 Areas Potentially Susceptible to Pumping Effects

Any potential for direct impacts to surface water courses resulting from groundwater pumping relies on a physical connection between the pumped groundwater system and the surface water course. Analytical methods for calculating streamflow depletion due to pumping, such as the methods described in **Section 4**, are based in part on this principle of connectivity. It is only when a direct connection is maintained that the mathematical equations for flow in a saturated porous media remain valid. Given this practical constraint, it is important to consider the physical hydrogeologic conditions of an area when assessing the susceptibility of surface waters to groundwater pumping.

3.3.1 Main Napa Valley Floor

LSCE and MBK (2013) reviewed over 1,300 drillers' logs for wells drilled in the Napa Valley Floor, excluding the MST subarea, and mapped the extent and formational nature of the Quaternary alluvium from Deer Park Road, north of St. Helena, to Trancas Street, in the City of Napa (**Figure 3.4**). Three facies were defined according to patterns detected in the lithologic record and used to delineate the depositional environment which formed them: fluvial, alluvial fan, and sedimentary basin. **Figure 3.5** depicts the shallowest depth to groundwater as determined from spring 2010 measurements from wells constructed in the alluvial aquifer system to allow for a comparison between the alluvial facies and groundwater conditions.

The fluvial facies consists of a thin narrow band of stream channel sands and gravels deposited by the Napa River. The sand and gravel beds tend to be thicker and/or more numerous in the fluvial facies area. They are interbedded with finer-grained clay beds of probable floodplain origin. Wells constructed in the fluvial facies tend to be moderately high yielding (for the valley, roughly 50 to 200 gpm). Local areas where thicker sand and gravel beds are reported, the well yields are the highest in the valley, ranging from about 200 to 2,000 gpm.

These areas with thick sand and gravel beds occur in the Yountville Narrows area, which extends about five miles from Oakville south to Ragatz Lane. Local areas of relatively lower well yield values of 200 to 500 gpm occur to the north and south. Hydraulic properties of these deposits are recorded during airlift testing, and drawdown values are generally not reported. Only a few pump test results have been found, and these are in the high yielding area just north of the Yountville Narrows.

The fluvial facies generally occurs along the axis of the valley and corresponds to the shallowest depths to groundwater, as measured in spring 2010 (**Figures 3.4 and 3.5**). These areas of overlap between the fluvial facies and shallowest depths to groundwater represent the most likely areas of connection between surface water and groundwater in Napa Valley.

The alluvial plain facies of the Quaternary alluvium extends outward from the central fluvial facies and thins to zero thickness at the edge of the valley sides. These deposits appear to have been deposited as tributary streams and alluvial fans. These deposits appear to consist of interbedded sandy clays with thin beds (less than 10 feet thick) of sand and gravel. Wells constructed in the alluvial plain facies tend to be low yielding, ranging from a few gpm to a few tens of gpm. By at least 1970, most wells drilled on the alluvial plain facies were constructed to deeper depths into the underlying Sonoma Volcanics.

The alluvial facies shows some overlap with the shallowest depths to groundwater, as measured in spring 2010 (**Figures 3.4 and 3.5**). These areas of overlap occur generally to the west of the Napa River and adjacent to mapped perennial streams, including Hopper Creek, Sulpher Creek, York Creek, Bale Slough (west of Highway 29), and possibly Dry Creek. These areas represent somewhat likely areas of connection between surface waters (including the Napa River and perennial streams described above) and groundwater.

At the northern end of the lower valley, the sedimentary basin facies of the alluvium occurs. This facies is characterized by fine-grained silt, sand, and clays with thin to scattered thicker beds of sand and gravel. The sedimentary facies is believed to be floodplain deposits that extend to the southern marshland/estuary deposits. As noted, the extent of this facies is poorly known due to lack of well control farther south. Limited information indicates low to moderate well yields of a few gpm to possibly up to 100 gpm. Again, the lack of pump test information makes hydraulic properties of the deposits difficult to assess.

Napa Creek and the Napa River east of Highway 29 in the vicinity of downtown Napa show a connection with groundwater in this portion of the Napa Valley (**Figure 3.5**).

Portions of Napa Valley north of Deer Park Road were not characterized according to their Quaternary alluvium facies by LSCE and MBK (2013). However, depths to groundwater in the vicinity of monitored wells indicate the potential for connection between surface water and groundwater in the vicinity of Garnett Creek and Cyrus Creek in and near Calistoga (**Figure 3.2**).

3.3.2 Other Areas of County

Potential connections between surface water and groundwater in other areas of the county are less well known. Perennial water courses have been mapped by Napa County in other portions of the county with state-designated groundwater basins. In the Pope Valley Groundwater Basin, these include Pope Creek, Burton Creek, and Maxwell Creek. In the small portion of the Suisun-Fairfield Valley Groundwater Basin that extends into Napa County, in the Southern Interior Valley Subarea, Wooden Valley Creek is mapped as a probable perennial stream.

3.4 Summary of Groundwater Conditions

Based on the available groundwater level data, groundwater levels in the county are generally stable, with the exception of the MST Subarea (LSCE, 2011b; LSCE and MBK, 2013). Groundwater in the Napa Valley Floor generally flows toward the axis of the valley and south along the axis when not influenced by local pumping depressions. The MST Subarea, however, has shown significant declines in groundwater levels, especially in the central portion of the subarea. Contemporaneous changes in water level trends are possible to discern throughout the MST. The variation and timing of groundwater level declines and trends in the north, central, and southern areas of the MST that have historically occurred may be attributable to increased pumping and are also indicated to be related to variations in geologic conditions. Wells in the immediate vicinity of the MST Subarea also may be vulnerable to these variations, as seen from limited data in the eastern portion of the Napa Valley Floor-Napa (NVF-Napa) Subarea (LSCE and MBK, 2013). Most wells elsewhere in the valley with sufficient records indicate that groundwater levels are more affected by climatic conditions, are within historic levels, and seem to recover from dry periods during subsequent wet or normal periods.

Groundwater level conditions outside of the Napa Valley Floor are much less known (LSCE, 2011b). Subareas south of the valley have very limited water level data, making it difficult to impossible to assess any potential for historic or current saltwater intrusion from San Pablo Bay. Subareas east and west of the valley floor all have limited data or are lacking groundwater level data entirely (as seen in Livermore Ranch, Southern Interior Valleys, and Western Mountains Subareas). Where data are available, most records are short, spanning a few years at most, and it appears that groundwater level conditions are stable.

4 Methodology and Assumptions

4.1 Overview of Methods

The tools applied to assess the effects of groundwater pumping on streamflow often include analytical and numerical groundwater modeling methods. The two approaches use different mathematical techniques to solve the partial differential equation of groundwater flow (or change in groundwater flow) (Barlow and Leake, 2012). Analytical models are limited to the analysis of idealized conditions that involve many simplifying assumptions. While numerical models are better able to address heterogeneity of the aquifer system and other parameters involved in the analysis, analytical models can provide insights into the potential effects and are often used to make initial estimates of effects of a particular well on a nearby stream (Barlow and Leake, 2012).

One of the simplest and most widely applied analytical methods for determining the effect pumping a well may have on a nearby stream is the Glover-Balmer (1954) approach, which was later modified by other researchers (Hantush, 1965) to better represent natural streambed conditions. For Napa County, this approach may be helpful for conceptualizing areas of proposed well locations that have the potential (depending on the local hydrogeology) to create the circumstance where pumping near a surface water course may have an effect on the stream (e.g., this is referred to as the potential for "stream depletion" due to pumping).

The Hantush (1965) method uses the Glover-Balmer (1954) approach to estimate a stream depletion flow rate, which can in turn be used to estimate a cumulative volume of stream depletion over a period of pumping. The method makes many assumptions about the subsurface and stream, most notably that the surface water course is modeled as an infinitely long straight line with zero drawdown, the stream completely penetrates a homogeneous infinitely extensive aquifer, and over time water pumped from the well changes from coming completely out of aquifer storage to coming completely from the river. In other words, there is no recharge supplied to the system besides that originating from the infinite supply of the stream. Because of these assumptions, this approach may overestimate the actual amount of stream depletion because there are other streams/canals/ditches, precipitation, applied water return flows, etc. that play important roles in recharging the pumped aquifer.

4.2 Analytical Methods to Assess Potential Effect of Pumping on Streamflow

Under certain conditions, a relationship exists between a pumped well and the resulting depletion of a nearby stream due to pumping. Glover and Balmer (1954) published an equation based on Theis's mathematical analysis of transient stream depletion from pumping. The Theis analysis was modeled according to the schematic in **Figure 4.1** where there is a stream (left portion of the schematic) which fully penetrates the aquifer in which the well is located.

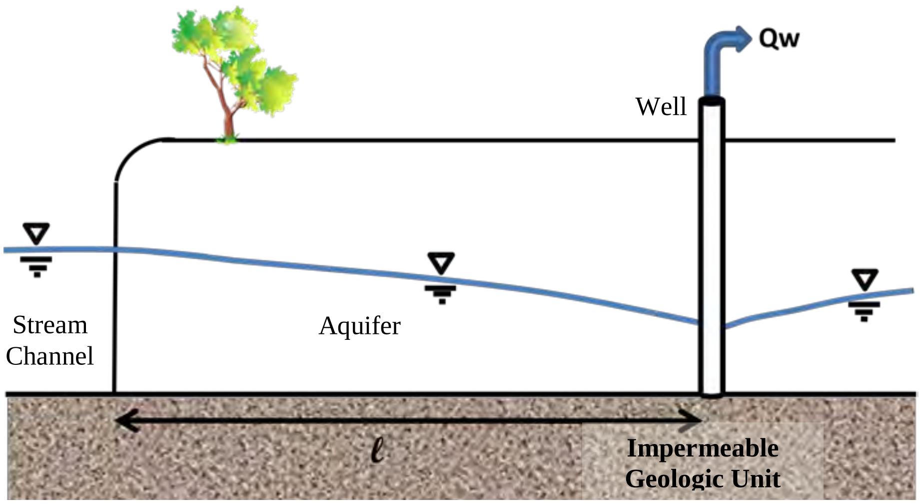

Figure 4.1 Theis/Glover-Balmer (1954) Stream Depletion Conceptual Model

Theis's method involved an integral equation to be evaluated with an infinite-series approximation, while Glover and Balmer (1954) utilized the complementary error function, *erfc*[1], to solve the equation, now commonly referred to as the "Glover equation":

$$\frac{\Delta Q}{Q_w} = erfc\left(\sqrt{\frac{l^2 S}{4tT}}\right) \qquad (1)$$

The Glover equation relates the stream depletion rate, ΔQ, to the aquifer pumping rate in a well, Q_w, located a perpendicular distance l to the nearby stream, as a function of aquifer properties (S - storativity and T - transmissivity) and time, t. Integrating Equation (1) in closed form yields the following equation:

$$\frac{v}{Q_w t} = \left(\frac{l^2}{2tT/S}+1\right) erfc\left(\frac{l}{\sqrt{4tT/S}}\right) - \left(\frac{l}{\sqrt{4tT/S}}\right)\left(\frac{2}{\sqrt{\pi}}\right)\exp\left(\frac{-l^2}{4tT/S}\right) \qquad (2)$$

Equation (2) relates the cumulative stream depletion volume, v, to the cumulative pumped volume, $Q_w t$ (Jenkins, 1968; Miller et al., 2007). The assumptions made for this analysis are listed here (Jenkins, 1968, Miller et al., 2007, Langstaff, 2006):

1. Transmissivity, T, does not change with time, therefore groundwater level drawdown is considered to be negligible when compared to the saturated thickness in an unconfined aquifer and groundwater flow is horizontal.

[1] The complementary error function, *erfc(x)*, is the approximation, widely accepted and applied throughout applications of physics, used to solve some forms of the integral of the natural exponent, e.g., $\frac{2}{\sqrt{\pi}}\int_x^{\infty} e^{-t^2}\,dt$, which includes the integral form of the equation for groundwater flow as a function of drawdown and time applied by Glover and Balmer (1954).

2. The temperature of the stream is constant and equal to the temperature of the groundwater so there are no viscosity differences.
3. The aquifer is isotropic, semi-infinite in areal extent, and homogeneous.
4. The aquifer is bounded on one side by a stream which is assumed to be infinitely long and straight and fully penetrates the entire thickness of the aquifer. The streambed coincides with the confining bed at the bottom of the aquifer and water flows between the stream and the aquifer through the stream bank (no clogging).
5. The potentiometric surface is initially horizontal.
6. The stream stage maintains a constant height.
7. The pumping well fully penetrates the entire aquifer thickness.
8. The pumping rate is steady during any period of pumping.
9. Water is released instantaneously from storage.
10. Water pumped from the well initially comes from storage in the aquifer and then from the stream; as the pumping time increases and approaches infinity, all of the well discharge comes from the stream (no other source of recharge).

Several of these assumptions may not be valid for conditions in Napa County, due to the following reasons:

- The hydrogeology is very complex and the aquifer system is heterogeneous;
- Most existing wells likely do not fully penetrate the entire aquifer thickness;
- The Napa River and its tributaries do not fully penetrate the entire aquifer thickness;
- The streambed and banks of the Napa River do not have the same water transmitting capability (transmissivity) as the surrounding aquifer materials, which may be further clogged with finer-grained material over time, decreasing the hydraulic conductivity of the streambed;
- The geometry of the Napa River along the main Napa Valley Floor is not infinitely long or straight;
- The river is not the aquifer’s sole source for recharge because there are other sources, including irrigation, precipitation, applied water return flows, and subsurface groundwater inflow that play important roles in the recharge of the aquifer underlying the main Napa Valley Floor. Thus, groundwater pumped from wells near the river does not entirely originate from the Napa River, as the Glover-Balmer approach assumes;
- There are interactions between wells.

It should also be noted that if large-capacity wells are located close to a stream, and streambed permeability is lower than aquifer permeability, the water table may be drawn down below the bottom of the streambed. This will result in a disconnection between the stream and the well, and the stream depletion would be a function of streambed permeability, the area of the streambed, the temperature of the water, and the stage of the stream, making the Glover-Balmer approach not applicable for those wells.

The limitations to using the Glover-Balmer approach are numerous; and, because of these limitations when this approach is applied to the Napa Valley Floor, the results of stream depletion will be overestimated and will over-simplify the groundwater/surface water relationship at potential well sites analyzed by this method. Another documented approach to solving the stream depletion problem was put forth by Hantush (1965). This approach utilizes an impedance between the stream and pumped well, which can be used to simulate the effect the streambed has on stream depletion (**Figure 4.2**):

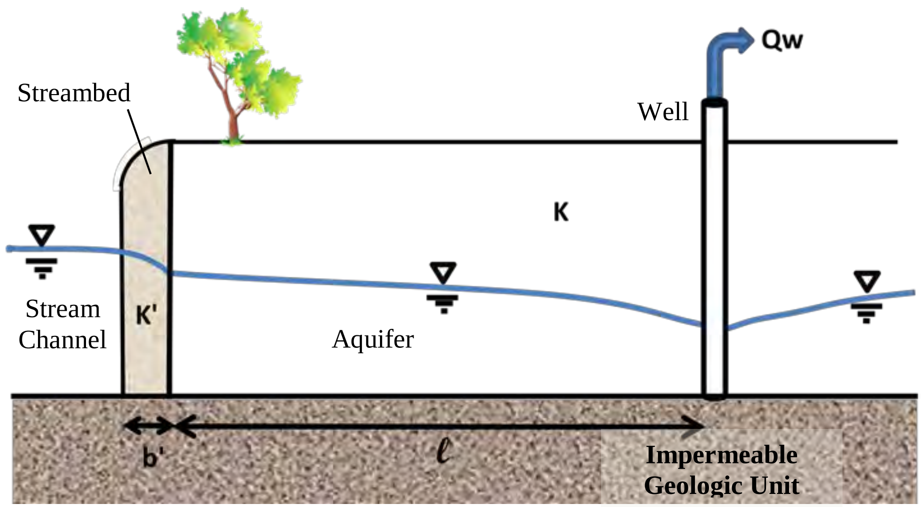

Figure 4.2. Hantush (1965) Stream Depletion model

Hantush (1965) was the first to develop a solution that accounted for resistance to flow at the stream/aquifer boundary due to streambed materials having a lower hydraulic conductivity than the aquifer (Barlow and Leake, 2012). The Hantush (1965) method has most of the same assumptions described above for the Glover-Balmer approach, except that instead of assuming that the bed of the stream has the same properties as the aquifer, Hantush allows for the assignment of a distinct conductivity value for the streambed. One of the assumptions of the Hantush method is that the hydraulic conductivity of the streambed (K') must be considerably smaller than that of the aquifer, so that flow through the bank is mainly in the horizontal direction and the storage capacity of the bank is insignificant (Hantush, 1965). The Hantush (1965) solution is given by the following equation (Hunt, 1999):

$$\frac{\Delta Q}{Q_w} = erfc\left(\sqrt{\frac{Sl^2}{4Tt}}\right) - \exp\left(\frac{Tt}{SL^2} + \frac{l}{L}\right) erfc\left(\sqrt{\frac{Tt}{SL^2}} + \sqrt{\frac{Sl^2}{4Tt}}\right) \qquad (3)$$

Where ΔQ represents the stream depletion rate; Q_w represents the pumping rate in the well a distance l away from the river; T and S are the transmissivity and storage terms of the aquifer; t is time; and L is a streambed leakance term that has dimensions of length and is defined as a combination of the aquifer hydraulic conductivity (K), the hydraulic conductivity of the streambed (K'), and the thickness of the semi-pervious layer (streambed) (b'):

$$L = \frac{K}{K'} b' \qquad (4)$$

The first term in Equation (3) is equivalent to Equation (1), and the second piece of Equation (3) reduces the resulting overall proportion of stream depletion to well pumpage. Also, as the streambed leakance term (L) goes to zero (by reducing the streambed thickness to zero while maintaining a fixed value of K/K', for example), Equation (3) reduces to Equation (1). Although the Hantush method incorporates the assumptions described above for the Glover-Balmer method, it better represents actual conditions near the Napa River because of the addition of the term for the naturally occurring impedance between the river and a proposed well. The Hantush method is therefore considered more appropriate for purposes of the initial screening analysis on proposed wells in Napa County near surface water courses.

5 Scenarios to Assess Potential Pumping Effects on Surface Water

Stream depletion due to groundwater pumping was evaluated using the methods described above for a range of scenarios representative of conditions in Napa County. The scenarios were created specifically to evaluate the effects of groundwater pumping on streamflow rates over the six month period from April through September, which is characterized by normally low streamflows, reduced average annual precipitation, and reduced recharge to the shallow aquifer systems considered here (LSCE and MBK, 2013).

Table 5.1 presents the scenarios based on the arrangement of four variables: pumping rate, pumping duration, distance between the well and surface water course, and aquifer hydraulic conductivity. Irrigation wells and domestic wells were simulated separately in the scenarios, according to differences in pumping duration and pumping rates associated with each well type. The domestic well pumping rate of 89.5 ft^3/day is the average daily pumping rate equivalent to a per residence annual demand of 0.75 acre-feet/year, which is the upper bound of residential water use estimated in the Napa County Draft Water Availability Analysis Policy Report (2013). Irrigation well pumping rates are based on a demand of 5 gallons per vine per week for a vineyard planted to 1,555 vines per acre, as described by Cooper et al. (2012). A pumping rate of 6,160 ft^3/day is sufficient to supply 40 acres of vines at that planting density with a pump producing 32.3 gpm in continuous operation. A pumping rate of 48,125 ft^3/day sufficient to supply approximately 320 acres of vineyard at the 1,550 vines per acre planting density with a pump producing 250 gpm in continuous operation. These pumping rates represent reasonable bounds for possible well permit applicants based on a review of over 1,300 driller's logs for wells drilled in Napa County, as described by LSCE and MBK (2013). A steady pumping rate is one of the assumptions of the Hantush method. Accordingly, the pumping rate is calculated based on the total water demand over the period of the scenario and assumes continuous operation. The Hantush method does not account for cyclical pumping during which groundwater levels would recover; nor does it account for stream depletion after pumping stops or the overlapping effects of multiple pumping events (i.e., the superposition of multiple stress periods).

The durations of pumping for each well type, domestic and irrigation, are representative of two conditions with respect to the simulated surface water course: a water course continuously connected throughout the annual dry season and a water course in connection with the alluvial aquifer for only a portion of the annual dry season. For the first condition, an irrigation well was simulated over a 140-day pumping period spanning from the third week of May to the end of September, according to the irrigation schedule applied by the University of California Cooperative Extension for a study of winegrape production costs in Napa County (Cooper et al., 2012). A domestic well was simulated over a 183-day pumping period lasting from April 1 through September 30. For the second condition, an irrigation well was simulated over a 70-day pumping period, and a domestic well was simulated over a 122-day pumping period. These shorter pumping durations produce lower estimates of streamflow depletion rates but represent limitations that should be applied to the Hantush method in cases where the surface water course of interest does not maintain surface flow throughout the dry season.

These scenarios are presented as example applications of the Hantush method for representative conditions in Napa County. The variables, input parameters, and results presented here are valid only for the scenarios tested and should not be construed to represent all possible proposed projects in the future. Accurate characterization of aquifer parameters, surface water course parameters, proposed well location, pumping rate, and pumping duration will be required in order to appropriately apply the Hantush method on a case-by-case basis.

5.1 Input Parameters

In order to implement the scenarios described in **Table 5.1** a set of input parameters were compiled to represent the physical properties of the alluvial aquifer system and surface water course. **Table 5.2** summarizes these input parameters used for the domestic well and irrigation well scenarios. Aquifer and streambed parameters applied for these simulations were derived from published sources, where available, and estimated values. Streambed conductivity (K') and streambed thickness (b') values used were based on estimates for those parameters based on knowledge of thalweg slopes and local alluvium lithology (LSCE and MBK, 2013) and published hydraulic conductivity values for similar sediments (Domenico and Schwartz, 1990). Specific yield, the aquifer storage coefficient (S), is the volumetric ratio of water that can be drained from a unit volume of aquifer materials and was determined by Kunkel and Upson (1960) based on a review of lithology reported on driller's logs in Napa Valley. Aquifer thickness (b) was set at 200 feet in accordance with the review of driller's logs by LSCE and MBK (2013), Faye (1973), and Kunkel and Upson (1960). Aquifer transmissivity (T) varied according to the range of hydraulic conductivity values applied, where transmissivity is defined as the capacity of the aquifer to transmit water across its entire thickness, calculated as the product of the aquifer hydraulic conductivity and the aquifer thickness (e.g., T=Kb, for an isotropic aquifer).

Table 5.1: Napa County Stream Depletion Scenarios

Well Type	Pumping Rate[1,2] (ft^3/day)	Pumping Duration[3] (days)	Distance from surface water channel		
			500 ft	**1000 ft**	**1500 ft**
Domestic	89.5	183/122	*high K*[4]	*high K*	*high K*
Domestic	89.5	183/122	*moderate K*	*moderate K*	*moderate K*
Domestic	89.5	183/122	*low K*	*low K*	*low K*
Domestic	89.5	183/122	*very low K*	*very low K*	*very low K*
Irrigation	6,160	140/70	*high K*	*high K*	*high K*
Irrigation	6,160	140/70	*moderate K*	*moderate K*	*moderate K*
Irrigation	6,160	140/70	*low K*	*low K*	*low K*
Irrigation	6,160	140/70	*very low K*	*very low K*	*very low K*
Irrigation	48,152	140/70	*high K*	*high K*	*high K*
Irrigation	48,152	140/70	*moderate K*	*moderate K*	*moderate K*
Irrigation	48,152	140/70	*low K*	*low K*	*low K*
Irrigation	48,152	140/70	*very low K*	*very low K*	*very low K*

[1] Domestic well pumping rate of 89.5 ft^3/day is the average daily pumping rate equivalent to a per residence annual demand of 0.75 acre-feet/year, which is the upper bound of residential water use estimated in the Napa County Draft Water Availability Analysis Policy Report (2013).

[2] Irrigation well pumping rates are based on a demand of 5 gal/vine/week for a vineyard planted at 1,555 vines/acre, as described by Cooper et al. (2012). A rate of 6,160 ft^3/day is sufficient to supply 40 acres of vines at that planting density with a pump producing 32.3 gpm in continuous operation. A pumping rate of 48,125 ft^3/day sufficient to supply approximately 320 acres of vineyard at the 1,550 vines per acre planting density with a pump producing 250 gpm in continuous operation. These pumping rates represent reasonable bounds for possible well permit applicants based a review of over 1,300 driller's logs from well drilled in Napa County, as described by LSCE and MBK (2013).

[3] Pumping durations represent the temporal extent of pumping in relation to a perennial water course over a six-month dry season (183 days of domestic well pumping) or a 20 week irrigation season (140 days of irrigation pumping) and the temporal extent of pumping in relation to a seasonal water course with a direct connection to the aquifer maintained through the end of July (122 days of domestic well pumping) or half of the 20-week irrigation season (70 days of irrigation pumping), as discussed in **Section 5.0**.

[4] Aquifer hydraulic conductivity (K) class (see **Table 5.3** below)

Table 5.2: Input Parameters for Stream Depletion Scenarios

Parameter	Units	Value	Description	Source
S	%	6	aquifer storage coefficient, e.g., specific yield for unconfined aquifers	Kunkel and Upson (1960)
b	ft	200	aquifer thickness	Kunkel and Upson (1960), Faye (1973), LSCE and MBK (2013)
K'	ft/day	0.02	streambed hydraulic conductivity	LSCE estimate based on knowledge of thalweg slopes and local alluvium lithology, described in LSCE and MBK (2013)
b'	ft	4	streambed thickness	LSCE estimate based on knowledge of thalweg slopes and local alluvium lithology, described in LSCE and MBK (2013)

Table 5.3 presents the aquifer hydraulic conductivity (K) values applied for each scenario. Hydraulic conductivity is a spatially-variable measure of an aquifer's ability to transmit water under saturated conditions. Faye (1973) described and mapped hydraulic conductivity values for the saturated alluvial sediments of Napa Valley based on a review of driller's logs for wells completed prior to the early 1970s. Subsequently, a description of alluvium lithology and well yields for wells drilled through 2011 were included in the report *Updated Hydrogeologic Conceptualization and Characterization of Conditions* (LSCE and MBK, 2013). **Figure 5.1** presents a range of aquifer hydraulic conductivity values developed by LSCE for the portion of Napa Valley addressed by those two investigations. The lowest values from each range were selected for application in the scenarios to provide a cautious estimate of the potential contribution to flow from the simulated well by the aquifer relative to the surface water course. Each hydraulic conductivity value was converted to a corresponding aquifer transmissivity value for use in the Hantush (1965) analytical model, calculated as the product of the aquifer thickness and its hydraulic conductivity.

The hydraulic conductivity values presented in **Table 5.3** are for unconsolidated alluvial sediments. Consolidated sediments have significantly lower hydraulic conductivities (e.g., approximately 10^{-4} ft/day for igneous and metamorphic rocks and approximately 10^{-2} to 10^{-3} ft/day for laminated sandstone, shale and mudstone). Scenarios representative of an unconsolidated alluvial aquifer were developed for this analysis in order to more accurately reflect groundwater conditions in the Napa Valley where groundwater and surface water interaction is likely to occur.

Table 5.3: Shallow Aquifer Hydraulic Conductivity Variables

Aquifer Hydraulic Conductivity Class	Example Lithologic Materials Related to Conductivity Classes	Aquifer Hydraulic Conductivity Range (ft/day)	Aquifer Hydraulic Conductivity Scenario Value (ft/day)	Aquifer Transmissivity (ft^2/day, calculated)
High	Sand and gravel	80 - 140	80	16,000
Moderate	Fine sand to sand	50 - 80	50	10,000
Low	Fine sand	30 - 50	30	6,000
Very Low	Silt, clay and mixtures of silt, clay and sand	0.5 - 30	0.5	100

Input parameters may be refined as more aquifer-specific and streambed-specific information becomes available from testing of new wells (i.e., those subject to testing requirements) or geotechnical analysis of streambed conditions.

6 Results

Scenario results are considered measurable for streamflow depletion rates greater than or equal to 0.01 ft^3/s, which is the practical extent of precision available from streamflow monitoring equipment.[2] Although some scenario results indicate streamflow depletion at amounts that are measurable, a significance threshold has not been developed. Specific project settings and conditions may result in different significance thresholds. **Tables 6.1a and 6.2a** present the results for scenarios addressing surface water courses with perennial streamflows, while **Tables 6.1b and 6.2b** present the results for scenarios addressing surface water courses with seasonal streamflows. **Tables 6.1a and 6.1b** present the calculated rate at which flow is removed from the simulated surface water channel, the streamflow depletion rate, at the end of each scenario as a result of groundwater pumping. **Table 6.2a and 6.2b** present the streamflow depletion rate as a proportion of the simulated well pumping rate.

It is important to note that the streamflow depletion rates considered by the Hantush method are not equivalent to the rate at which the simulated well produces water that originates in the simulated surface water channel. Instead, depleted streamflow is that which is removed from the surface water channel into the aquifer in response to the pumping stress of the well on the aquifer. Thus, a well can produce streamflow depletion before it actually produces water that originated in a surface water channel.

Both sets of results indicate that, for a given aquifer hydraulic conductivity, the degree of streamflow depletion induced by a well increases as the distance between the well and the surface water channel decreases. This result is consistent with the conceptual design of the Hantush method, whereby the simulated well can produce only water supplied by the aquifer or the surface water course. None of the results for the domestic well scenarios produce a streamflow depletion rate greater than or equal to 0.01 ft^3/s, indicating that the effect of a domestic well would be difficult to measure at distances greater than 500 feet from the surface water channel for the pumping rate and durations simulated here. However, the irrigation well scenarios show measurable streamflow depletions for all but the smallest hydraulic conductivity values simulated here, see **Table 6.1a**. The high, moderate, and low hydraulic conductivity values are generally representative of conditions near the axis of Napa Valley. At these hydraulic conductivities, measurable streamflow depletion rates could occur for wells pumping at average rates of 6,160 ft^3/day up to 1500 feet away from the surface water channel. An irrigation well average pumping rate of 48,125 ft^3/day is shown, in these scenarios, to produce measurable streamflow depletion rates at distances up to 1,500 feet for high, moderate, and low hydraulic conductivities, respectively, see **Table 6.1a**. However, these results may over estimate actual effects due to the increased likelihood that aquifer heterogeneity or sources of aquifer recharge other than the simulated surface water channel would significantly reduce streamflow depletion rates for such scenarios in ways that the Hantush method does not reflect.

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[2] Nationally, USGS surface-water data include more than 850,000 station years of time-series data that describe stream levels, streamflow (discharge), reservoir and lake levels, surface-water quality, and rainfall. The data are collected by automatic recorders and manual measurements at field installations across the Nation (http://waterdata.usgs.gov/nwis/measurements and http://waterdata.usgs.gov/usa/nwis/sw). At low streamflows, these data may be reported to 0.01 ft^3/s.

Table 6.1a: Streamflow Depletion Rate (ft^3/s) in a Perennial Water Course at End of Pumping

Well Type	Pumping Rate (ft^3/day)	Pumping Days	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel		
				500 feet	1000 feet	1500 feet
Domestic	89.5	183	high	0.0003	0.0003	0.0003
Domestic	89.5	183	moderate	0.0004	0.0004	0.0003
Domestic	89.5	183	low	0.0005	0.0004	0.0004
Domestic	89.5	183	very low	0.0005	0.0002	0.0000
Irrigation	6,160	140	high	**0.0201**	**0.0186**	**0.0172**
Irrigation	6,160	140	moderate	**0.0233**	**0.0212**	**0.0192**
Irrigation	6,160	140	low	**0.0269**	**0.0238**	**0.0209**
Irrigation	6,160	140	very low	**0.0251**	0.0063	0.0009
Irrigation	48,125	140	high	**0.1567**	**0.1453**	**0.1344**
Irrigation	48,125	140	moderate	**0.1821**	**0.1656**	**0.1499**
Irrigation	48,125	140	low	**0.2103**	**0.1860**	**0.1634**
Irrigation	48,125	140	very low	**0.1964**	**0.0490**	0.0072

Bold values indicate streamflow depletion rates that are measurable by standard streamflow monitoring equipment.

Table 6.1b: Simulated Streamflow Depletion Rate (ft^3/s) in a Seasonal Water Course at End of Pumping

Well Type	**Pumping Rate** (ft^3/day)	**Pumping Days**	**Aquifer Hydraulic Conductivity**	**Distance from Surface Water Channel**		
				500 feet	**1000 feet**	**1500 feet**
Domestic	89.5	122	high	0.0003	0.0003	0.0002
Domestic	89.5	122	moderate	0.0003	0.0003	0.0003
Domestic	89.5	122	low	0.0004	0.0003	0.0003
Domestic	89.5	122	very low	0.0004	0.0001	0.0000
Irrigation	6,160	70	high	**0.0158**	**0.0142**	**0.0128**
Irrigation	6,160	70	moderate	**0.0185**	**0.0162**	**0.0141**
Irrigation	6,160	70	low	**0.0215**	**0.0181**	**0.0151**
Irrigation	6,160	70	very low	**0.0159**	0.0018	0.0001
Irrigation	48,125	70	high	**0.1233**	**0.1112**	**0.1000**
Irrigation	48,125	70	moderate	**0.1442**	**0.1266**	**0.1103**
Irrigation	48,125	70	low	**0.1677**	**0.1415**	**0.1180**
Irrigation	48,125	70	very low	**0.1243**	**0.0140**	0.0006

Bold values indicate streamflow depletion rates measurable by standard streamflow monitoring equipment.

Table 6.2a: Proportion of Perennial Water Course Streamflow Depletion Rate to Well Pumping Rate at End of Pumping

Well Type	Pumping Rate (ft^3/day)	Pumping Days	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel		
				500 feet	1000 feet	1500 feet
Domestic	89.5	183	high	*0.33*	0.31	0.29
Domestic	89.5	183	moderate	*0.38*	*0.35*	*0.33*
Domestic	89.5	183	low	*0.44*	*0.40*	*0.36*
Domestic	89.5	183	very low	*0.45*	*0.16*	*0.04*
Irrigation	6160	140	high	*0.28*	*0.26*	*0.24*
Irrigation	6160	140	moderate	*0.33*	*0.30*	*0.27*
Irrigation	6160	140	low	*0.38*	*0.33*	*0.29*
Irrigation	6160	140	very low	*0.35*	*0.09*	*0.01*
Irrigation	48125	140	high	*0.28*	*0.26*	*0.24*
Irrigation	48125	140	moderate	*0.33*	*0.30*	*0.27*
Irrigation	48125	140	low	*0.38*	*0.33*	*0.29*
Irrigation	48125	140	very low	*0.35*	*0.09*	*0.01*

Table 6.2b: Proportion of Seasonal Water Course Streamflow Depletion Rate to Well Pumping Rate at End of Pumping

Well Type	Pumping Rate (ft^3/day)	Pumping Days	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel		
				500 feet	**1000 feet**	**1500 feet**
Domestic	89.5	122	high	*0.28*	0.26	0.24
Domestic	89.5	122	moderate	*0.33*	*0.30*	*0.27*
Domestic	89.5	122	low	*0.38*	*0.33*	*0.29*
Domestic	89.5	122	very low	*0.35*	*0.09*	*0.01*
Irrigation	6160	70	high	*0.22*	*0.20*	*0.18*
Irrigation	6160	70	moderate	*0.26*	*0.23*	*0.20*
Irrigation	6160	70	low	*0.30*	*0.25*	*0.21*
Irrigation	6160	70	very low	*0.22*	*0.03*	*0.00*
Irrigation	48125	70	high	*0.22*	*0.20*	*0.18*
Irrigation	48125	70	moderate	*0.26*	*0.23*	*0.20*
Irrigation	48125	70	low	*0.30*	*0.25*	*0.21*
Irrigation	48125	70	very low	*0.22*	*0.03*	*0.00*

7 Recommended Criteria

This Technical Memorandum has been prepared to facilitate Napa County's evaluations of proposed groundwater extractions near to surface water courses and the potential effects of such pumping on streamflows. The analytical method and the results of example scenarios can be applied to proposed wells planned to be located on the Napa Valley Floor or elsewhere in small valleys where unconsolidated alluvial deposits are present near surface water courses. Such zones of susceptibility in the Napa Valley Floor excluding the MST subarea, are shown, based on the latest available data, in **Figure 7.1**.

The recommended criteria offered here account for the combined interpretation of the surface water and groundwater hydrology setting, see **Section 3**, and the analytical method scenario results, see **Section 5**. The criteria seek to account for the extent of surface water courses potentially susceptible to pumping effects along with the streamflow depletion results indicated by the Hantush method scenarios. In some cases, criteria allow for siting wells within the minimum distance to a surface water course at which measureable streamflow depletion is predicted by the Hantush method.

Based on the results for the example scenarios with consideration for the hydrogeologic setting, the following well siting and recommended construction criteria are shown in **Tables 7.1**, **7.2**, and **7.3**. **Table 7.1** recommends siting domestic wells 500 feet or farther away from surface water channels, and only when the specified construction criteria are met. The scenario results, see **Tables 6.1 and 6.1b**, show that a domestic well completed in unconsolidated deposits could be sited closer to the surface water channel, if needed for exceptional circumstances and if an exception is granted according to one or more of the circumstances listed below or for other reasons. Although a very small amount of streamflow depletion is shown for all four domestic well scenarios, the results are so low as to be immeasurable with common streamflow measuring devices.

Scenario results for the relatively lower and relatively higher irrigation well pumping rates indicate that a greater distance between the proposed well and surface water channel is warranted in most cases, see **Tables 6.1a and 6.1b**. The criteria presented in **Table 7.2** for an irrigation well with a pumping capacity of up to 30 gpm recommend siting only wells encountering very low hydraulic conductivity aquifer materials between 1000 feet and 1,500 feet of a surface water channel, and only when the specified construction criteria are met. Irrigation wells of equivalent pumping capacity but encountering low, moderate, or high hydraulic conductivity aquifer materials are recommended to be sited at distances greater than 1,500 feet from a surface water channel, and only when the specified construction criteria are met.

The scenario results presented in Section 6 indicate estimated measureable streamflow depletions for distances up to 1,500 feet from the surface water channel. Conditions in Napa Valley suggest that accurate simulations of streamflow depletion at distances greater than 1,500 feet are difficult to obtain. At distances beyond 1,500 feet several aspects of the conceptual foundation, or assumptions, underpinning the Hantush method are less likely to remain valid. These include the assumption of no other source of recharge to the aquifer except the surface water channel, which is likely not valid at greater distances due to the potential for subsurface groundwater flow to contribute to recharge in response to groundwater pumping. Another factor related to applications of the Hantush method at distances greater than 1,500 feet in Napa Valley is that the heterogeneity of the alluvial aquifer is likely to interrupt the hydraulic connection between the surface water channel and the well.

The criteria presented in **Table 7.3** recommend siting irrigation wells with a pumping capacity of between 30 gpm and 250 gpm at distances greater than 1,500 feet from a surface water channel, and only when the specified construction criteria are met.

Future applications of the Hantush method (as described in **Section 4)** to quantify the potential effects of proposed projects involving groundwater pumping in the vicinity of a surface water channel should include a site-specific consideration of the aquifer hydraulic conductivity. Aquifer hydraulic conductivity is a spatially-variable aquifer property. Given the heterogeneity in the Napa Valley alluvial aquifer system documented by LSCE and MBK (2013), accurate determination of this parameter is important to the success of any analysis. The recommended method for determining the aquifer hydraulic conductivity is by analyzing aquifer test data. Aquifer test data are typically recorded by a well driller at the time of well construction and included as part of the Well Completion Report submitted to the California Department of Water Resources. However, a review of over 1,300 Well Completion Reports for wells drilled in Napa Valley, excluding the MST subarea, through 2011 found that aquifer tests of sufficient quality to calculate aquifer hydraulic conductivity are rarely performed (LSCE and MBK, 2013). If aquifer test data are not available, an alternative source for aquifer hydraulic conductivity values would include lithologic data reported for wells drilled in the vicinity of a proposed well interpreted based on knowledge of the local hydrogeologic setting and published hydraulic conductivity values for similar aquifer materials.

Tables 7.1, **7.2**, and **7.3** also include recommendations for surface seal depths of 50 feet and the depth to uppermost perforations in the well ranging from 100 to 150 feet. For domestic wells, the depth of the uppermost perforation is recommended to be at least 100 feet deep. While the analytical method does not take either of these well construction criteria into account, the recommended criteria increase the likelihood of a less direct communication with the surface water channel by influencing the primary flow path to the pumped well. With increased pumping time, a stable mainly radial flow pattern is established (Todd and Mays, 2005). Accordingly, as the depth of the perforated interval increases, a given well is less likely to fully penetrate the aquifer and, as a result, will derive more flow from below the depth of the surface water channel and from deeper portions of the aquifer not directly connected with the surface water channel.

Table 7.1: Recommended Well Siting and Construction Criteria; Domestic Wells (i.e., less than 10 gpm) Planned to be Constructed in Unconsolidated Deposits in the Upper Part of the Aquifer System (Unconfined Aquifer Conditions)

Well Type	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel			Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
		500 feet	1000 feet	1500 feet		
Domestic	High	✓	✓	✓	50	100
Domestic	Moderate	✓	✓	✓	50	100
Domestic	Low	✓	✓	✓	50	100
Domestic	Very Low	✓	✓	✓	50	100

Table 7.2: Recommended Well Siting and Construction Criteria; Irrigation Wells (Relatively Lower Pumping Rates, i.e., between 10 gpm and 30 gpm) Planned to be Constructed in Unconsolidated Deposits in the Upper Part of the Aquifer System (Unconfined Aquifer Conditions)

Well Type	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel			Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
		500 feet	1000 feet	1500 feet		
Irrigation	High			✓	50	150
Irrigation	Moderate			✓	50	150
Irrigation	Low			✓	50	100
Irrigation	Very Low		✓	✓	50	100

See section on circumstances for exceptions.

Table 7.3: Recommended Well Siting and Construction Criteria; Irrigation Wells (Relatively Higher Pumping Rates, e.g., from 30 gpm to 250 gpm) Planned to be Constructed in Unconsolidated Deposits in the Upper Part of the Aquifer System (Unconfined Aquifer Conditions)

Well Type	Aquifer Hydraulic Conductivity	Distance from Surface Water Channel			Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
		500 ft	1000 feet	1500 feet		
Irrigation	High			✓	50	150
Irrigation	Moderate			✓	50	150
Irrigation	Low			✓	50	100
Irrigation	Very Low			✓	50	100

See section on circumstances for exceptions.

7.1 Circumstances for Exceptions to Recommended Criteria

Exceptions to the recommended criteria may be considered where it can be shown that a proposed well will have a sufficient geologic or hydrologic separation from the surface water channel that would prevent the well from causing as much streamflow depletion as would be expected at the minimum distance specified by the criteria. The California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (USBR) allow for similar exceptions when considering the potential effect on surface water flows of groundwater pumping proposed for water transfers involving groundwater substitution pumping in the Sacramento Valley. Some example circumstances for exceptions to the stated criteria (based on DWR and USBR, 2013) include:

- Sufficient information, including site-specific geologic or hydrologic data, is provided to demonstrate that the well does not have significant hydraulic connection to the surface water system;
- The well's uppermost perforations are planned to be deeper than recommended and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 20 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, depending on the well type and planned well operations;
- If the well's uppermost perforations are planned to be shallower than recommended and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 40 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, depending on the well type and planned well operations;
- If the proposed well is an irrigation well and the criteria call for the uppermost perforations to be located no shallower than 150 feet deep, the perforations may be

shallower (e.g., 100 feet deep), if there is a total of at least 50 percent fine-grained materials in the interval above 100 feet below ground surface (bgs), and at least one fine-grained layer that exceeds 40 feet in thickness in the interval above 100 feet bgs.

Other circumstances for exceptions also may be present.

Wells proposed to be sited or constructed in a way that does not conform to the recommended criteria should be evaluated in a site-specific manner in order to consider the potential acceptability of one or more of these possible exceptions or other possible exceptions[3]. This review would include an evaluation of site-specific hydrogeologic data to address whether conditions at the site would provide the geologic or hydrologic separation necessary to prevent the streamflow depletion shown in the scenario results presented here. Sources of site-specific data would include Well Completion Reports (i.e., drillers' logs) for any existing wells in the vicinity of the proposed well, water level data collected at wells in the vicinity of the proposed well (if the details of those wells' construction are known), and any geologic data collected in the area, including data pertaining to the surface water channel. If these data are available and sufficient to indicate that the proposed well could achieve hydraulic separation from the surface water channel then one or more of the exceptions described above, or some other exceptions, may be applicable.

If available data regarding the hydrogeologic conditions in the vicinity of the proposed well are not sufficient to demonstrate the suitability of any of the exceptions described above, or some other exception, then a more detailed evaluation of the proposed well, hydrogeologic conditions, and surface water channel would be warranted. A more detailed evaluation would also be appropriate if the proposed well would be designed and constructed to operate beyond the pumping rates simulated in the scenarios presented in this Technical Memorandum. A process to address these more detailed evaluations is available in the Napa County Draft Water Availability Analysis Policy Report.

[3] Additionally, wells proposed to be constructed and outfitted to produce water at a rate in excess of the rates considered by the scenarios developed in **Section 5** of this document should not be considered to be represented by the scenarios presented in this document and should be reviewed further.

8 Summary and Recommendations

The analytical method used in this Technical Memorandum involves assumptions and results that probably over estimate the actual effects of well pumping on streamflows. For this reason, the approaches described in this Technical Memorandum are considered an appropriate level of initial screening for discretionary projects for which one of the scenarios examined herein is applicable. Potential circumstances may apply under which exceptions to the recommended well siting and construction criteria are also presented. For more regional analysis, i.e., basinwide analysis of multiple wells pumping simultaneously, numerical modeling methods are recommended (LSCE and MBK, 2013).

9 References

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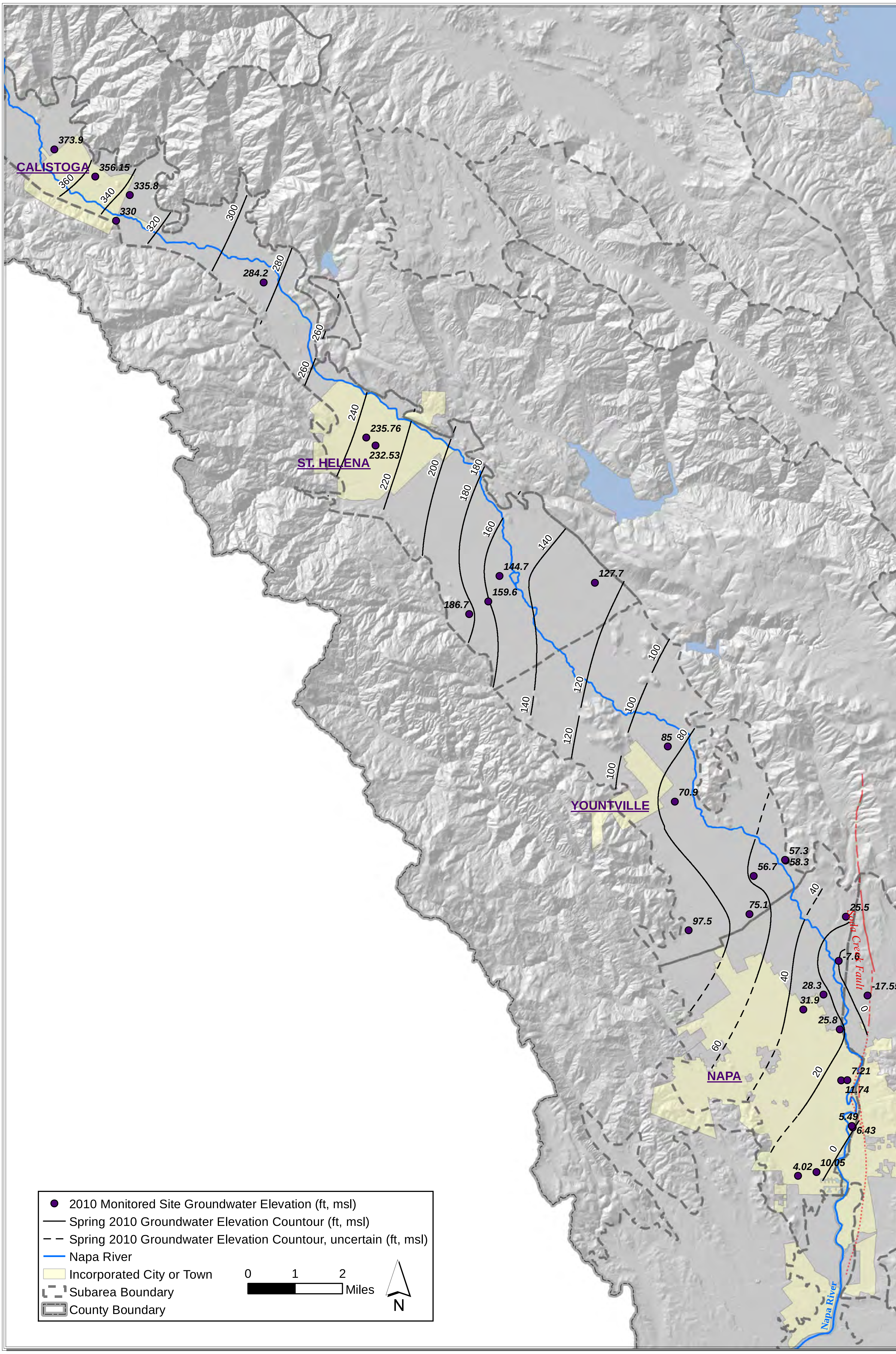

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Figure 3.1
Contours of Equal Groundwater Elevation
Napa Valley, Spring 2010

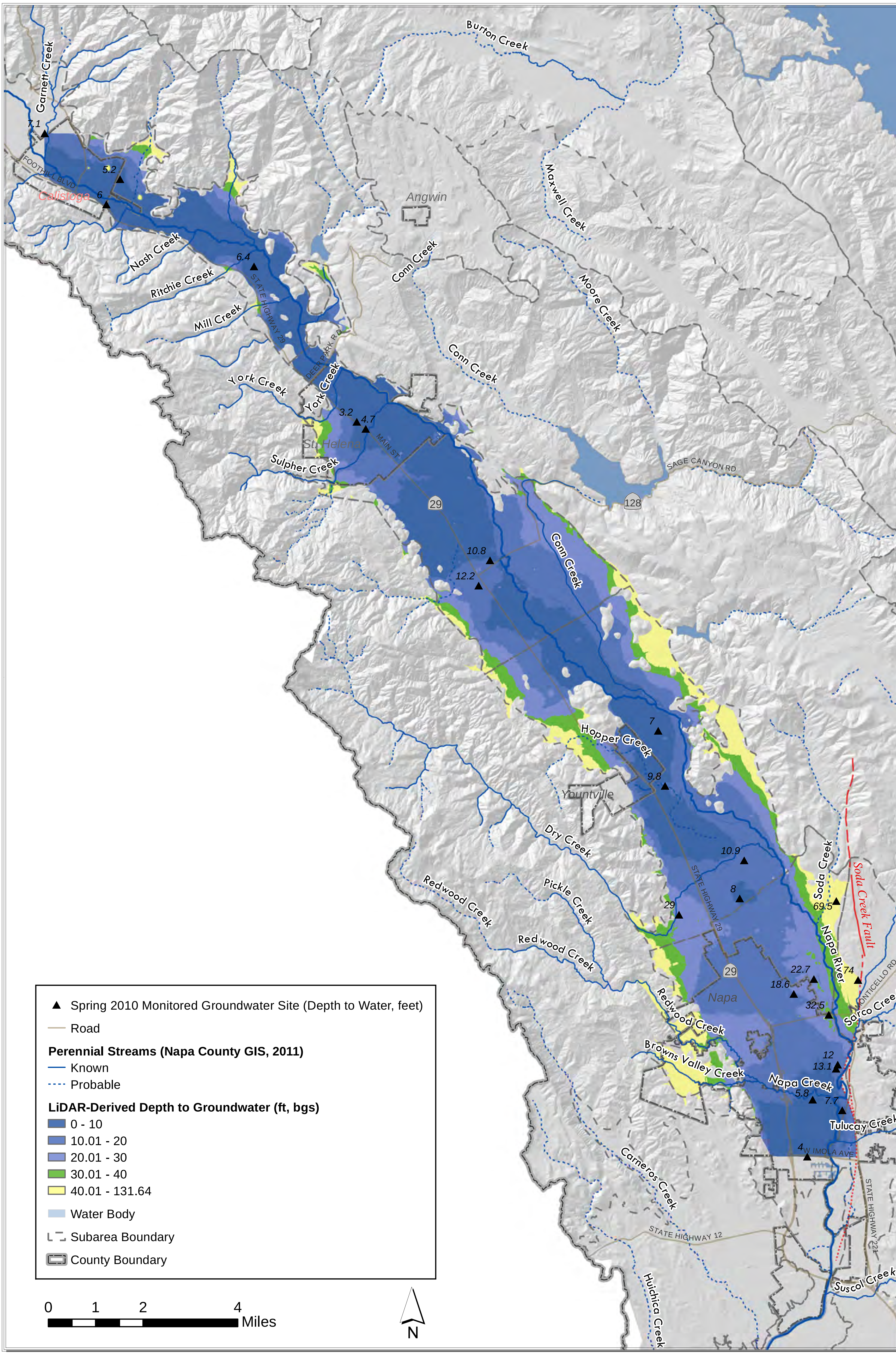

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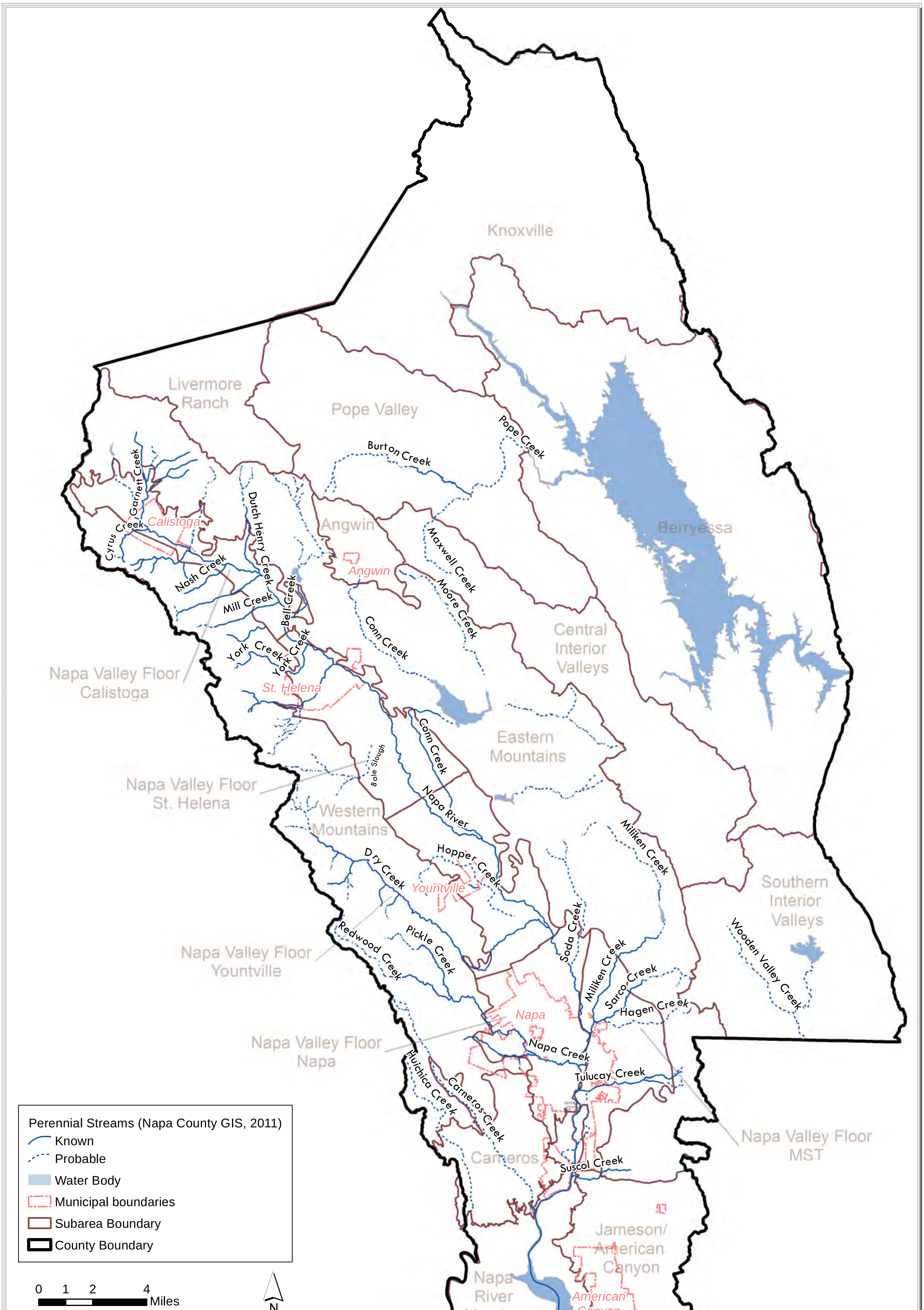
Figure 3.2
Spring 2010 Calculated Depth to Groundwater
Napa Valley Floor



Note: Perennial streams represented here are from a GIS dataset produced and maintained by the Napa County Department of Planning, Building, and Environmental Services. Questions regarding this dataset should be directed to Napa County staff.

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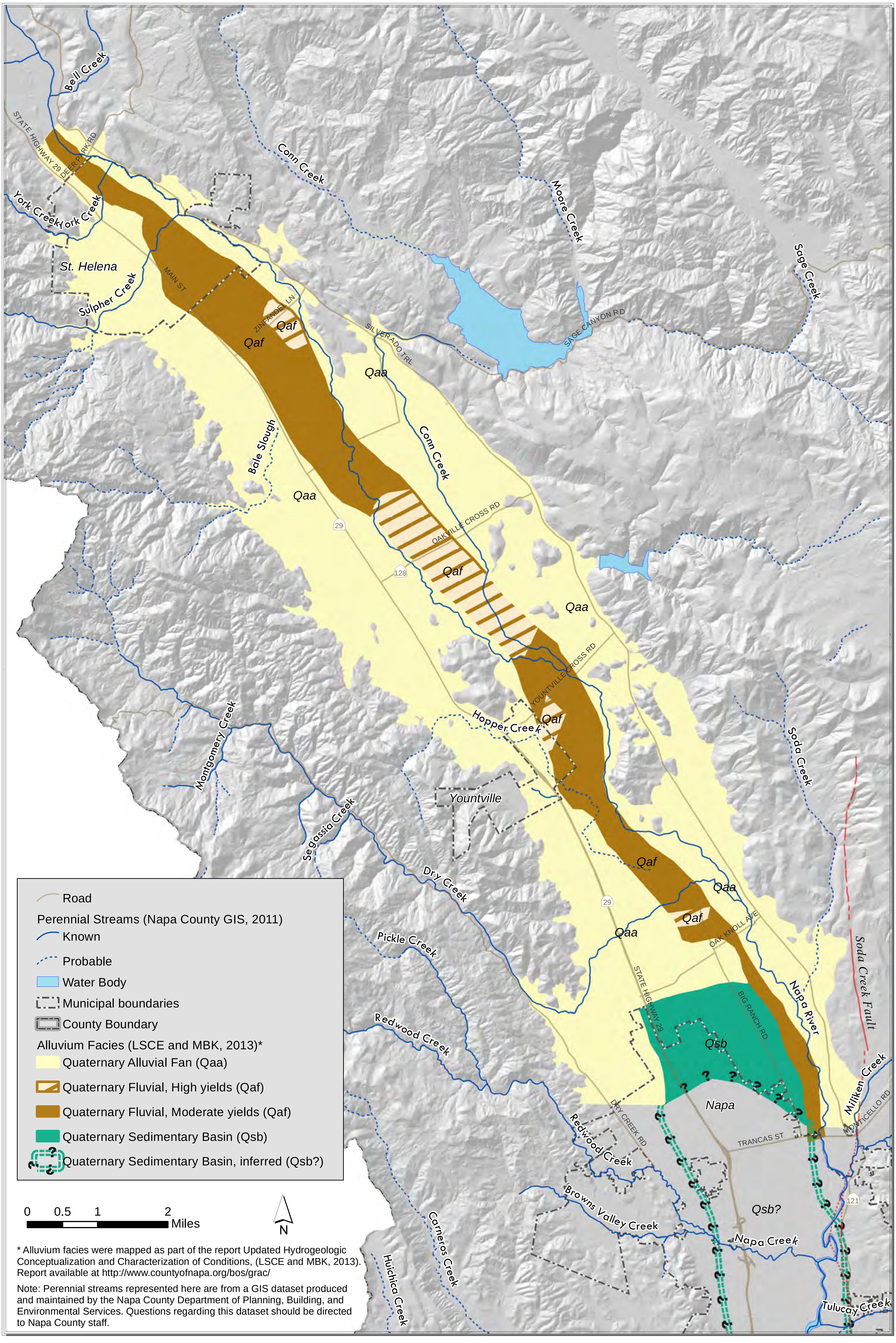
Figure 3.3
Known and Probable Perennial Surface Water Courses in Napa County



* Alluvium facies were mapped as part of the report Updated Hydrogeologic Conceptualization and Characterization of Conditions, (LSCE and MBK, 2013). Report available at http://www.countyofnapa.org/bos/grac/

Note: Perennial streams represented here are from a GIS dataset produced and maintained by the Napa County Department of Planning, Building, and Environmental Services. Questions regarding this dataset should be directed to Napa County staff.

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Figure 3.4
Perennial Surface Water Courses and Alluvium Facies in Napa Valley Floor

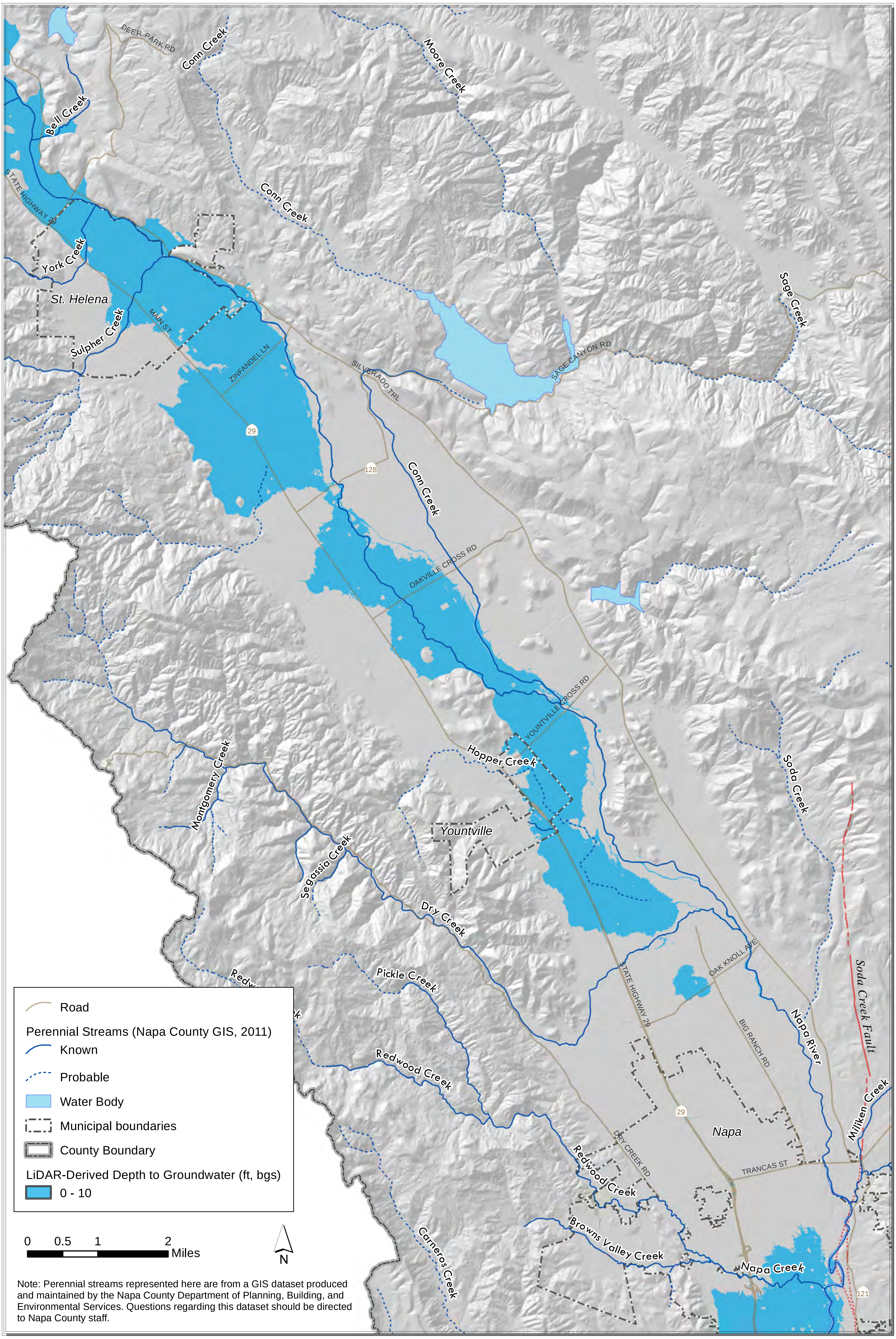

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Figure 3.5
Shallow Depths to Groundwater in the Alluvial Aquifer, Napa Valley Floor

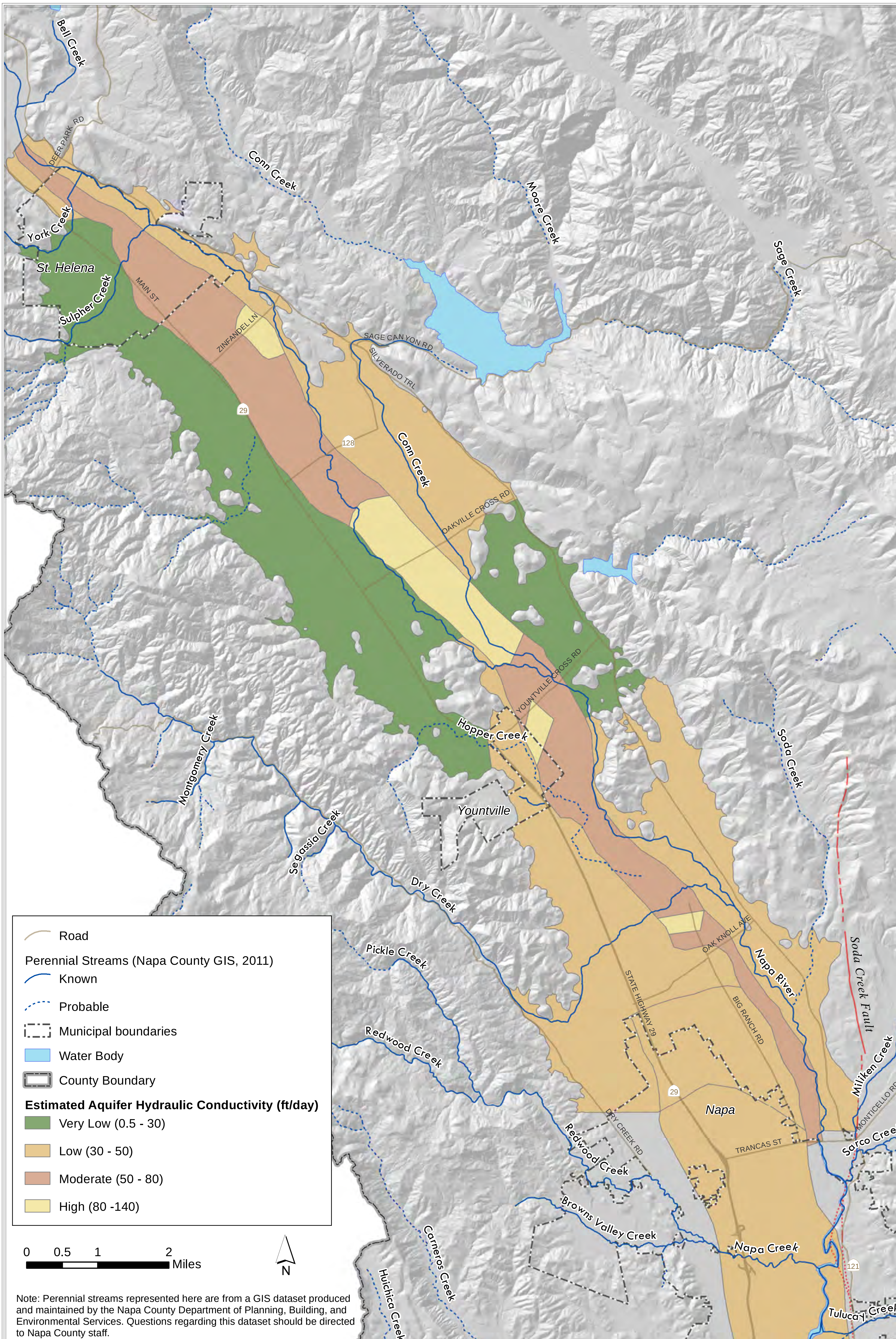

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Figure 5.1
Estimated Alluvial Aquifer Hydraulic Conductivity Ranges, Napa Valley Floor

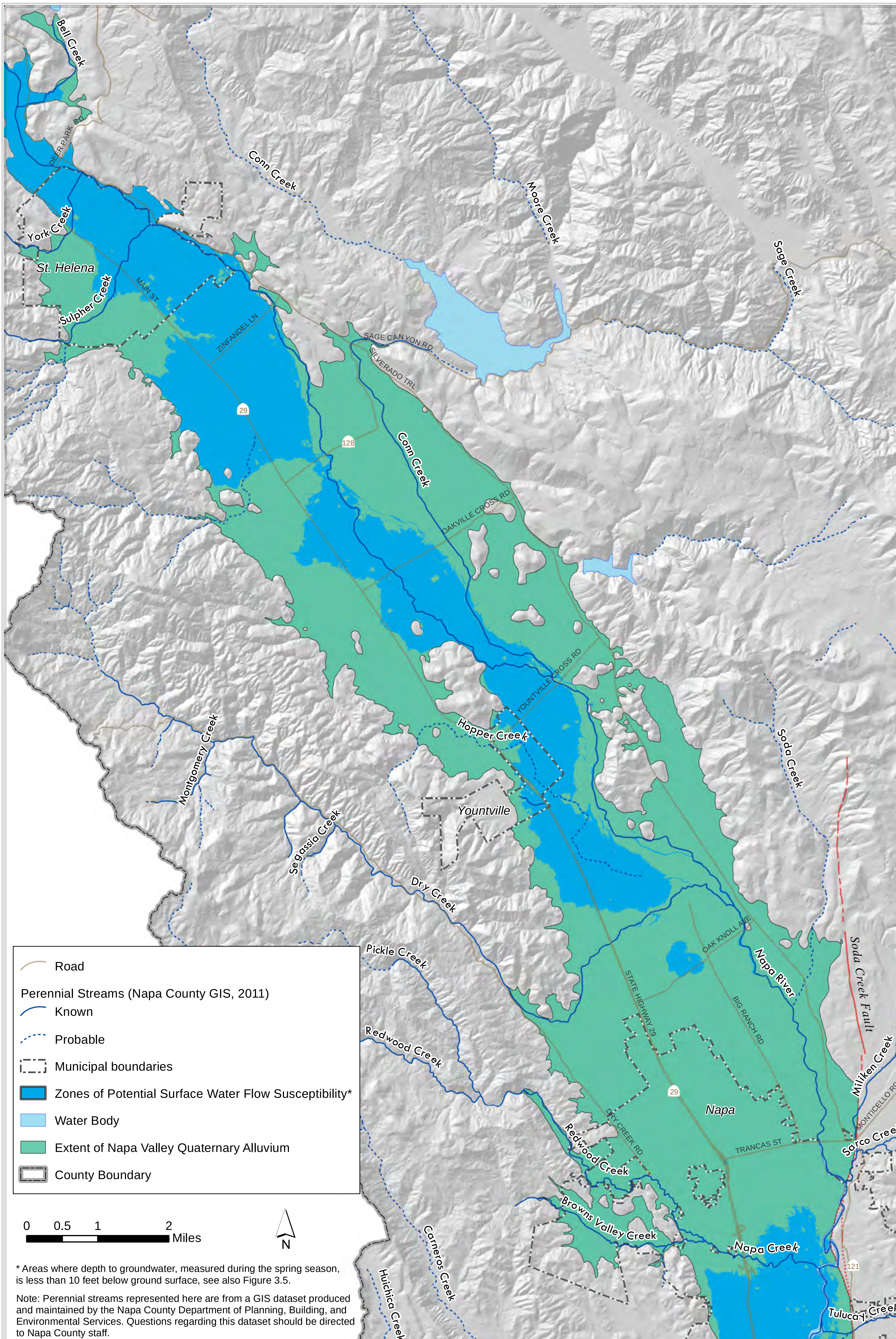

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Figure 7.1
Zones of Potential Surface Water Flow Susceptibility to Groundwater Pumping, Napa Valley Floor

APPENDIX 3D

Napa County Well Construction/Destruction Forms and Guidelines

A Tradition of Stewardship
A Commitment to Service

Planning, Building & Environmental Services

1195 Third Street, Suite 210
Napa, CA 94559
www.countyofnapa.org

David Morrison
Director

INSTRUCTIONS FOR COMPLETING APPLICATION FOR GROUNDWATER PERMIT

1. Fill out the application form entitled, "Groundwater Permit Application" (attach additional sheets as needed).

2. Submit a "Water Availability Analysis" application in accordance with the attached guidance document.

3. Be sure to include the 8 ½" x 11" reproduction of the USGS quad sheet with your parcel outlined on the map.

4. Include a list of all owners (including site and mailing addresses) of real property, including businesses, corporations or other public entities as shown on the latest equalized assessment roll within 300 feet of the outer perimeter of the properties that will utilize the extracted groundwater. In lieu of utilizing the assessment roll, the records of the Napa County Assessor or Tax Collector may be used if they contain information more recent than the assessment roll. **This list must be prepared by a title company, which then certifies the list as being accurate**.

5. Return the above information to Planning, Building and Environmental Services with the required fee of $2,247.57.

6. REMEMBER, YOU MUST SHOW <u>NO NET INCREASE</u> IN YOUR WATER USE. IF YOU HAVE QUESTIONS CONTACT THIS DEPARTMENT BEFORE PAYING YOUR FEES AND SUBMITTING THIS APPLICATION.

Application No:

GROUNDWATER PERMIT APPLICATION

Property Owner: ______________________________ Phone Number: __________

Site Address: ______________________________ APN: __________

Mailing Address: ______________________________

1. Describe the project that triggered this Groundwater Permit Application:

2. Identify the present and future uses of the water system, including to what extent groundwater is, or will be, used as a water source:

3. Identify any water sources other than groundwater used or intended to be used:

4. State the number of parcels and service connections the water system is intended to serve:

5. Discuss the structures and improvements to be served by the water system and identify future uses and users. Attach a site plan to show the location of these improvements.

6. Does the water system or requested improvement have the potential to adversely impact the affected groundwater table? Provide supporting documentation.

7. Will the water system or proposed improvement adversely affect reasonable and beneficial uses of groundwater, interfere with surface flows, or cause other adverse changes to the physical environment? Explain.

8. If your project is related to an erosion control plan, briefly summarize the project and indicate the water source to be used on the parcel.

Owner's Signature

Date

WATER AVAILABILITY ANALYSIS (WAA)

Adopted May 12, 2015

Contents

Introduction and Purpose

The County is required by the California Environmental Quality Act (CEQA) (Public Resources Code 21000–21177) and the CEQA Guidelines (California Code of Regulations, Title 14, Division 6, Chapter 3, Sections 15000–15387) to conduct an environmental analysis of all discretionary permits submitted for approval. CEQA requires analysis of literally dozens of environmental aspects, including the following:

"Would the project substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?"

The purpose of this document, the Water Availability Analysis (WAA), is to provide guidance and a procedure to assist county staff, decision makers, applicants, neighbors, and other interested parties to gather the information necessary to adequately answer that question. The WAA is not an ordinance, is not prescriptive, and project specific conditions may require more, less, or different analysis in order to meet the requirements of CEQA. However, the WAA is used procedurally as the baseline to commence analysis of any given discretionary project.

A Water Availability Analysis is required for any discretionary project that may utilize groundwater or will increase the intensity of groundwater use of any parcel through an existing, improved, or new water supply system[1]. As such, it will most commonly be used for discretionary development applications using groundwater such as wineries and commercial uses. Since CEQA does not apply to non-discretionary ("ministerial") projects, it does not apply to projects such as building permits, single family homes, track II replants, etc. While discretionary vineyard projects are welcome to borrow from the WAA, such vineyard projects, due to their size and scope, generally receive a much more exhaustive analysis under longstanding processes managed by the Conservation Division of the Planning Building & Environmental Services (PBES) Department.

The WAA may also apply when a discretionary Groundwater Permit is required by the Groundwater Conservation Ordinance, Section 13.15.010 of the Napa County Code. The ordinance's provisions are summarized below. (Should there be any conflict between the summary below and the Ordinance, the Ordinance shall prevail).

Outside of Designated Groundwater Deficient Areas

Most non-discretionary development in any area of the county, except for designated groundwater deficient areas, is exempt from the need to secure any type of groundwater permit. This includes projects to develop an on-site or off-site water source serving agriculture, projects to construct or develop rainwater harvesting or graywater recycling systems and minor and convenience water supply system improvements (see definitions in 13.15.010). Other

[1] The Groundwater Conservation Ordinance (Section 13.15.010) defines a water supply system as "any system including the water source the purpose of which is to extract and distribute groundwater".

exemptions outside groundwater deficient areas include projects such as building permits, well and septic permits, lot line adjustments, track II replants, etc. The following, however, are not exempt:

- Projects to develop or improve a water supply to serve *more* than a single contiguous parcel (agricultural development for multiple contiguous parcels is eligible for an exemption under certain conditions) or
- Projects that can be served by a public water supply.

Within Designated Groundwater Deficient Areas

Most any type of development in groundwater deficient areas (as defined in Napa County Code, Section 13.15.010.C) will trigger the need for a discretionary groundwater permit unless specifically exempted or unless eligible for a ministerial groundwater permit (see 13.15.030C). Ministerial groundwater permits are specifically for (1) a single family residence with associated well and landscaping when no other uses exist on the property, or (2) for agricultural re-plants. Specific exemptions include applications to construct or develop rainwater harvesting or graywater recycling systems and minor and convenience improvements (see definitions in 13.15.010) which include:

- Changes to existing water supply systems for the purposes of repair or rendering a system more efficient or to add to or improve existing legal uses on a property such as swimming pools (if provided with a cover and initially filled with trucked in water),
- Replacement dwellings (when an existing legal dwelling unit had previously existed on the property),
- Additional potential bedrooms whether or not attached to the single-family dwelling, and replacement of a site's existing well (provided the old well is destroyed and the new well is drilled to the same or smaller diameter as the existing well) are all exempt.

WAA Procedure

The Water Availability Analysis (WAA) uses a screening process for discretionary permit applications (both for new projects and for project modifications that change groundwater use) and determines if a proposal may have an adverse impact on the groundwater basin as a whole or on the water levels of neighboring non-project wells or on surface waters.[2] The WAA also provides procedures for further analysis when screening criteria are exceeded. An important sidelight to the process is public education and awareness. The WAA is based on an application which requires the applicant to gather information about existing non-project groundwater wells and water uses at the applicant's site, to describe planned project well operations, to document existing uses of groundwater on the property, and to estimate future water

[2] For the purposes of this procedure, surface waters are defined to include only those surface waters known or likely to support special status species or surface waters with an associated water right; however, as with all of the procedures in this WAA, there may be unique circumstances that require additional site-specific analysis to adequately evaluate a project's potential impacts on surface water bodies.

demands associated with the proposed project. In addition, other information relating to the geology, proximity to surface water bodies (e.g., river, creeks, etc.), and the location and construction of existing non-project wells located near the applicant's property or project well(s) will also be important to evaluate, as warranted, for the potential for well interference and effects on surface water. County staff can provide assistance to the applicant in obtaining and reviewing the latter information as part of the application data collection process.

WAA Application Procedure

A WAA groundwater permit application may be prepared by the applicant or their agent. (NOTE TO PUBLIC: PBES WILL CREATE/UPDATE AN APPLICATION FORM BASED ON THIS DOCUMENT ONCE APPROVED). **It must be signed by the applicant. If prepared by the applicant's agent, it must contain the letterhead of the agent, the name of the agent, and the agent's signature.** The WAA application contains the following information:

1. The name and contact information of the property owner and the person preparing the application.

2. Site map of the project parcel and adjoining parcels. The map should include: Assessor's Parcel Number (APN), parcel size in acres, location of existing or proposed project well(s) and other water sources, general layout of structures on the subject parcel, location of agricultural development and general location within the county. Approximate locations of existing non-project wells on other parcels within 500 feet of the existing or proposed project well(s) should also be identified based on the applicant's knowledge and available public information. All surface waters within 1500 feet of the existing or proposed project well(s) should also be identified, based on the applicant's knowledge and available public information. County staff can provide assistance to the applicant in obtaining adjacent well location, APNs and parcel size information.

3. A narrative on the nature of the proposed project, including all land uses on the subject parcel, projected future water uses in normal and dry years, details of current and proposed operations related to water use, description of interconnecting plumbing between the various water sources and any other pertinent information.

4. Tabulation of existing water use compared to projected water use for all land uses current and proposed on the parcel. Should the water use extend to other parcels, they should be included in the analysis (see Appendix E for additional information on determining water use screening criteria when multiple parcels are involved). **These estimates should reflect the specific requirements of the applicant's operations.** Guidelines attached in **Appendix B** are an example of one way to calculate projected water demand. The applicant shall use these, other publicly available guidelines, other guidelines that may be provided by the Department of Planning, Building, and Environmental Services (PBES), or project specific estimates, whichever best approximate the proposed water use for the specific project and account for all other existing water uses at the subject parcel(s).

PBES and Public Works (PW) staff will review the application for completeness and reasonableness, review the County's groundwater data management system for additional information about the characteristics of the areas/basin and nearby wells, compare the analysis to the screening criteria, and determine if additional analysis is required. In reviewing available information, County staff will consider:

1. The characteristics of the groundwater area or basin (such as confined or unconfined aquifer system; alluvial or hard rock geological setting) and related aquifer properties; and,

2. The location and present use of all existing non-project wells that are within 500 feet of the project well(s), identifying well depths and construction information for existing wells, if known; and,

3. The distance to surface waters within 500 feet of any Very Low pumping capacity project well(s) or 1500 feet of project well(s) with a capacity greater than 10 gallons per minute (gpm). [3]

Screening Criteria

Applications will be evaluated based on project information, to be provided by the applicant, and available geologic and hydrologic information, to be provided by County staff. As shown in **Table 1,** projects on the Napa Valley Floor and the Milliken-Sarco-Tulucay (MST) that meet the Tier 1 criteria (water use) will generally not be subject to second tier criteria evaluation, unless substantial evidence[4] in the record indicates the need to do so. Parcels in all other areas will generally be required to conduct a Tier 2 evaluation. Projects will be subject to Tier 3 criteria and analysis only when substantial evidence in the record determines the need for such analysis. All criteria are based on information outlined in this procedure, as well as a detailed conceptualization of hydrogeologic conditions in the Napa Valley and substantial evidence in the form of monitoring and hydrologic data, past studies, and well drillers' logs. Procedures for three tiers of screening criteria will be used on each project as designated herein and as needed for projects with unique issues:

[3] For the purposes of this WAA, "very low pumping capacity wells" are defined as wells with a casing diameter of six inches or less and an installed pump capable of producing less than 10 gallons per minute (gpm). Pumping capacities referenced throughout this WAA were developed as part of a separate analysis of potential streamflow depletion in unconsolidated alluvial settings. Details of this analysis are provided in a separate Technical Memorandum (LSCE, 2013).

[4] Substantial evidence is defined by case law as evidence that is of ponderable legal significance, reasonable in nature, credible and of solid value. The following constitute substantial evidence: facts, reasonable assumptions predicated on facts; and expert opinions supported by facts. Argument, speculation, unsubstantiated opinion or narrative, or clearly inaccurate or erroneous information do not constitute substantial evidence.

Table 1: Project Screening Criteria Applicability

Tier	Criteria Type	Napa Valley Floor	MST	All Other Areas
1	Water Use	Yes	Yes	Yes
2	Well and Spring Interference	No[1]	No[1]	Yes
3	Groundwater/Surface Water Interaction	No[1]	No[1]	No[1]

1. Further analysis may be required under CEQA if substantial evidence, in the record, indicates a potentially significant impact may occur from the project.

The three tiers of screening criteria are discussed below. **Appendices B-F** provide additional detail.

Tier 1--Water Use Criteria

For projects on the Napa Valley Floor and in the MST, water use criteria will be compared to the water use estimate provided by the applicant in the WAA application. Water use criteria vary according to the location of the project parcel(s). As such, projects must meet the applicable water use criterion, through project revisions or water use estimate refinements, if necessary and reasonable, in order to be considered in compliance with this criterion.

Table 2A presents the water use criteria. Napa Valley Floor areas include all locations that are within the Napa Valley except for areas specified as groundwater deficient areas. Groundwater deficient areas are areas that have been so designated by the Board of Supervisors. PBES staff can assist the applicant with determining which area a project is located in.

Currently the only designated groundwater deficient area in Napa County is the MST Subarea. Areas of the county not within the Napa Valley Floor or the MST Groundwater Deficient Area are classified as All Other Areas. Public Works can assist applicants in determining the correct classification for project parcel(s). **Appendix B** contains a discussion of the origins of these water use criteria.

Table 2A: Water Use Criteria

Project parcel location	Water Use Criteria (acre-feet per acre per year)
Napa Valley Floor	1.0
MST Groundwater Deficient Area	0.3 or no net increase, whichever is less [1]
All Other Areas	Parcel Specific [2]

1. Does not apply to the Ministerial Exemption as outlined in the Groundwater Conservation Ordinance
2. Water use criteria for project shall be considered in relation to the average annual recharge available to project property, as calculated by the applicant or their consultant.

In general, the acceptable water use screening criterion for parcels located on the Napa Valley Floor is 1 acre-foot per acre of land per year (an acre-foot of water is the amount of water it takes to cover one acre of land to a depth of one foot, or 325,851 gallons). Therefore, a 40-acre parcel will meet this criterion if the projected groundwater use would not exceed 40 acre-feet per year.

Areas designated as groundwater deficient areas as defined in the Groundwater Conservation Ordinance will have criteria established for that specific area. For example, the MST Subarea screening criterion is 0.3 acre-feet per acre per year or "no net increase" over existing conditions, whichever is less (see **Appendices B and C**).

Water Use Criterion including Estimated Recharge

The water use criterion for parcels termed All Other Areas (i.e. not located in the Napa Valley Floor or a groundwater deficient area), will be determined on a parcel specific basis. No single criterion can be established for "All Other Areas" due to the uncertainty of the geology, and the increasingly fractured rock aquifer systems in the mountainous and non-Napa Valley areas, including Carneros, Pope Valley, Wooden Valley, and Capell Valley. The project applicant will need to estimate the average annual recharge occurring on the project parcel(s) and consider the amount of recharge relative to the estimation of project water use (e.g., all current and projected water demands for the property on which the planned project is located). The estimate of average annual recharge can be made by various methods including water balance methods. The selected method should be based on data from the parcel or watershed where the proposed project is located. The estimated project water use, including existing and proposed uses of water on the project parcel(s), shall include estimates for normal and dry water years. If an alternative water source will be used for dry years (e.g. trucked in water for non-potable uses), that information shall be provided by the applicant along with the alternate source location and estimated water volume.

Projects on the Napa Valley Floor and in the MST that meet the Tier 1 screening criteria are considered to be in compliance with the standards of the WAA, unless other substantial evidence in the record indicates the need for further evaluation. Projects in "All Other Areas" shall complete Tier 1, and then proceed to Tier 2.

Tier 2--Well and Spring Interference Criterion

When applicable (see **Table 1**), the Tier 2 well interference criterion is presumptively met if there are no non-project wells located within 500 feet[5] of the existing or proposed project well(s). For those projects with neighboring wells located within 500 feet of the project well(s), additional evaluation will be required to assess the potential drawdown in those existing wells resulting from project well operation relative to the Tier 2 criterion described below. Though highly recommended, if the neighboring well is located on a parcel that is also owned by the applicant, the Tier 2 evaluation for that well may be waived, however certain safeguards must be in place to ensure that the water allotment and transfer between parcels is clearly documented and

[5] Distance is measured horizontally from the well.

recorded, especially in cases where the water from more than one parcel will ultimately serve a use on a single parcel (see **Appendix E**).

The potential interference will be determined based on data including the distance between the project well(s) and the neighboring non-project well(s), the hydrogeologic setting, and well construction information and operational configurations for the project well(s). Well construction information and operational configurations provided by the applicant will include:

- the planned pumping rate of well(s)[6],
- well depth(s),
- well screen intervals and
- well seal locations.

Table 2B presents default well interference criteria that the County may apply in the determination of significant adverse effects. The minimum significant drawdown values presented in **Table 2B** are intended for use in cases where information about existing non-project wells is limited or non-existent. However, when the status and configuration of an existing non-project well are known, for example the depths of screen intervals, locations of any annular seals, and/or water levels in the well and the pump depth setting, then site-specific measures of significance should be used. Site-specific measures of significance should also account for known seasonal variations[7] in groundwater elevations in the vicinity of the proposed project and mutual well interference (i.e., interference between the planned project well usage (new and/or existing) and one or more neighboring wells. County staff shall inform the applicant of the site-specific Tier 2 well interference criteria that will be applied in the evaluation of a project before the applicant conducts a site-specific analysis.

Table 2B. Default Well Interference Criteria

Type of wells within 500 ft. screened within the same aquifer as project well	Estimated Drawdown at Neighboring Non-Project Wells
Wells with a casing diameter of six inches or less	10 feet
Wells with a casing diameter greater than six inches	15 feet

[6] Estimates of well yield shown on driller's logs are not sufficient for this purpose. The planned pumping rate should be determined based on the pump and related equipment installed, or planned to be installed, in the well and, if available, constant rate aquifer test data for tests conducted for a minimum of 8 hours.

[7] As used here, seasonal variations refer to typical changes over the course of a year.

Low pumping capacity project wells in unconfined aquifers will typically require a minimum amount of information due to the limited drawdown that they induce. [8]

Springs

Napa County enjoys the occurrence of many natural springs, and the potential for planned projects to affect spring flow has been considered. A spring is defined as: "A place where groundwater flows naturally from a rock or the soil onto the land surface or into a body of surface water. Its occurrence depends on the nature and relationship of rocks, esp. permeable and impermeable strata, on the position of the water table, and on the topography" (Jackson, J. 1997. *Glossary of Geology*. American Geological Institute). Springs can be formed by multiple causes, including the interception of groundwater by the land surface; permeability differences that can cause groundwater to emerge; flow from faults or fractures; and drainage from landslides. Springs are ephemeral geologic features which may cease to flow due to natural causes such as changes to flow paths, water level declines, porosity lost by mineral precipitation, or sediment plugging.

Because springs originate as groundwater, springs are eligible for WAA Tier 2 analysis. It is required that any proposed project wells within 1,500 feet[9] of natural springs that are being used for domestic or agricultural purposes be evaluated to assess potential connectivity between the part of the aquifer system from which groundwater is planned to be produced and the spring(s). Springs exist in complex hydrogeologic environments. Other substantial evidence in the record may result in the need for such an analysis even though the spring(s) is located a greater distance from the planned well site. Where evaluation of potential connectivity between the project well(s) and springs is required, site-specific spring interference criteria will be established as appropriate for the springs(s) under consideration.

Although the Tier 2 analyses described above relate to mutual well interference and the avoidance of significant interference, potential pumping effects on springs may result in spring flow depletion. Springs are also commonly observed in locations where little to no quantitative records have been kept relating to the spatial occurrence or temporal variability of spring flow. Therefore, projects located in the vicinity of springs, where potential impacts of pumping are possible but unknown, may require monitoring and further analysis.

Tier 3--Groundwater/Surface Water Interaction Criteria

Tier 3 analysis is only conducted when substantial evidence in the record determines the need for such an analysis.

The groundwater/surface water criteria are presumptively met if the distance standards and project well construction assumptions are met (see **Tables 3, 4, and 5).** The distance standards vary according to groundwater pumping capacity, well construction information and operational

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[8] For the purposes of this WAA, low pumping capacity wells are defined as wells with a casing diameter of six inches or less and an installed pump capable of producing between 10 gpm up to 30 gpm. As shown in Appendix F, Table F-6, a well pumping 30 gpm continuously for one day in an unconfined aquifer, even in an aquifer with a low hydraulic conductivity, is expected to induce a drawdown of two feet or less at radial distances as small as 25 feet.

[9] Distance is measured horizontally from the well.

configurations for the project well(s), and aquifer properties as described in **Appendix F**. The criteria are also based on a 140-day period to account for the effect of groundwater withdrawal on surface waters throughout the dry season (typically late May through early October).

The distance standards and construction assumptions in **Tables 3, 4, and 5** are provided as examples of conditions that, if applicable, would be expected to preclude any significant adverse effects on surface waters. The distance standards and construction assumptions in **Tables 3, 4, and 5** were developed as part of a separate analysis of streamflow depletion for surface waters and wells in unconsolidated alluvial geologic settings (LSCE, 2013). Project wells located in other geologic settings, particularly consolidated formations more common in locations deemed All Other Areas, will be subject to other distance standards based on site-specific aquifer conditions. Distance standards for project wells completed in consolidated formations will generally be no more restrictive than those shown in **Tables 3, 4, and 5** for hydraulic conductivity values of 0.5 ft/day.

The distance standards and construction assumptions in **Tables 3, 4, and 5** are not intended to serve as absolute setback criteria. Instead, if the proposed project is located in an equivalent geologic setting but does not meet the distance standards and conform to the associated well construction assumptions (See **Tables 3, 4, and 5)**, then additional analysis will be required to determine project impacts relative to site-specific criteria. The site-specific groundwater/surface water interaction criteria will be established as appropriate for the surface water(s) under consideration[10] (see **Appendix F**).

Additional evaluation will be required to identify the potential for impacts of very low pumping capacity wells within 500 feet[11] of surface waters, low pumping capacity wells within 1000 feet of surface waters, and moderate to high pumping capacity wells within 1500 feet of surface waters, as described in **Appendix F**.[12] The potential impacts will be determined based on data including distance(s) between the project well(s) and the surface water features of concern, the hydrogeologic setting, the streambed (or equivalent feature) hydraulic properties, and well construction information and operational configurations for the proposed project wells. Well construction information and operational configurations provided by the applicant will include:

- the planned pumping rate of well(s) [13],
- well depth(s),
- well screen intervals and
- well seal locations.

[10] Site-specific criteria will be developed to address project impacts on beneficial uses of affected surface waters.

[11] Distance is measured horizontally from the well.

[12] For the purposes of this WAA, moderate to high pumping capacity wells are defined as wells with a casing diameter greater than six inches and an installed pump capable of producing more than 30 gpm

[13] Estimates of well yield shown on driller's logs are not sufficient for this purpose. The planned pumping rate should be determined based on the pump and related equipment installed, or planned to be installed, in the well and, if available, constant rate aquifer test data for tests conducted for a minimum of 8 hours.

Very low pumping capacity wells in unconfined aquifers will typically require a minimum amount of information due to the limited potential for surface water flow depletion. Other well types located at distances of 1500 feet or greater from surface waters will also likely require a minimum amount of information, particularly when it can be shown that the project well targets aquifer units not hydraulically connected to surface water.

Table 3. Well Distance Standards and Construction Assumptions; Very low capacity pumping rates (i.e., less than 10 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	Acceptable Distance from Surface Water Channel			Minimum Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
	500 feet	1000 feet	1500 feet		
80	✓			50	100
50	✓			50	100
30	✓			50	100
0.5	✓			50	100

Table 4. Well Distance Standards and Construction Assumptions; Low capacity pumping rates (i.e., between 10 gpm and 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	Acceptable Distance from Surface Water Channel			Minimum Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5		✓		50	100

Table 5. Well Distance Standards and Construction Assumptions; Moderate to high capacity pumping rates (i.e., greater than 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	**Acceptable Distance from Surface Water Channel**			**Minimum Surface Seal Depth (feet)**	**Depth of Uppermost Perforations (feet)**
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5			✓	50	100

If distance standards and construction criteria in **Tables 3, 4, and 5** above are not met, project approval may still be possible pending additional analysis (see below).

If the minimum surface seal depth is not met, and if available information does not indicate a hydraulic separation provided by geologic conditions at the site, then these cases would require additional analysis by the applicant. Shorter seals can allow for significant flow into the well from shallow portions of an aquifer, even if the screens are at greater depths.

Additional Analysis Required

If the proposed project exceeds one or more of the screening criteria and the applicant is unable to modify the project (i.e., different location, well construction, water usage, or operations) to meet the screening criteria, then further analysis will be required (see **Appendix F**). Additional analysis will also be required if insufficient information exists in the project application to evaluate conformance with the criteria.

The applicant or the applicant's agent should consult with County staff regarding the required scope of the analysis, which is likely to include consultation with a professional hydrologist, geologist, or engineer, and may include field testing. Projects requiring additional analysis regarding Tier 2 or Tier 3 criteria may be subject to state requirements for preparation by a California registered professional geologist or professional engineer. **Appendix F** describes the additional analyses that will be required if the project screening criteria are applicable and are not met or if substantial evidence in the record indicates that a potentially significant impact may result from the project.

The geology of many areas of Napa County is very complex (LSCE and MBK, 2013). Accurate determination of hydrologic parameters (See **Appendix F**) is important to the additional analyses that may be necessary to evaluate potential well interference or impacts on surface water. Several approaches may be considered. One approach, applicable in areas with unconsolidated aquifer materials, is to estimate aquifer hydraulic conductivity values, based on evaluation and interpretation of lithologic data reported for wells drilled in the vicinity of project or well(s) and published hydraulic conductivity values for similar aquifer materials. This method may be applicable in areas of the Napa Valley Floor where the unconsolidated aquifer system has been previously characterized (LSCE and MBK, 2013). This method is not applicable in areas with consolidated or hard rock aquifer materials, including the MST subarea and All Other Areas, due to the increased likelihood of significant variations in aquifer characteristics over relatively small distances.

The County's preferred method for determining the aquifer hydraulic conductivity or other parameters is by conducting an aquifer test and analyzing aquifer test data. In some cases, pump test data may be recorded by a well driller at the time of well construction and included as part of the Well Completion Report submitted to the California Department of Water Resources. However, these tests are not always conducted to standards that result in meaningful aquifer parameters (i.e., the pumping rate may not be constant, the pumping rate may not be large enough to analyze aquifer parameters, the test may be of too short a duration, and groundwater level measurements may not have been made during the test in the pumped well and one or more observation wells, etc.). If adequate aquifer test data are not available, and there is substantial evidence in the record that the project (including the proposed location, construction and operation of any project wells) regarding potential impacts on neighboring non-project wells or nearby surface waters, then an aquifer test may be required of the applicant's project well(s). A constant rate aquifer test is generally required for projects in All Other Areas, if acceptable test data are not already available. Interpretation of pump test data provided in driller's logs is not intended for consolidated aquifers. Pending the proposed project details, the County may also require installation of a monitoring well or monitoring of a nearby existing non-project well.

As described in the Groundwater Conservation Ordinance, the County may require applicants in groundwater deficient areas to install a water meter to verify actual groundwater usage. In addition to the above screening criteria, if the actual usage exceeds the projected use, or the screening criteria, the applicant may be required to reduce groundwater consumption and/or find alternate water sources (See **Appendix D**).

WAA Application Submittals

WAA applications for all use permits and parcel divisions, as well as for all Groundwater Conservation Ordinance permits must be submitted to the Department of Planning, Building and Environmental Services (PBES), which will consult with the Department of Public Works, and be the conduit for communication between the County and the applicant. All subsequent communication should likewise pass through PBES. Any mitigation measures identified via the additional analysis will become either project modifications to, or conditions of approval for, the proposed project. Details of the use permit, land division, or groundwater ordinance can be obtained from PBES, along with mapping of groundwater deficient areas.

Conclusions

The Napa County Board of Supervisors has long been committed to the preservation of groundwater for agriculture and rural residential uses within the County. It is their belief that through proper management, the excellent groundwater resources found within the County can be sustained for future generations. Several conclusions can be drawn from application of the Water Availability Analysis process to date:

- In the process of conducting the analysis, applicants develop a greater awareness of water use by their project, providing a higher level of awareness and potentially leading to more efficient use of the resource.

- Information submitted by applicants has led to a broader database for future study and management.

- Groundwater use can vary widely depending upon its availability, local hydrogeologic constraints, and periodic hydrologic constraints which may affect the recharge and replenishment of the aquifer system.

- On the Napa Valley Floor and in the MST, the practice of evaluating an applicant's WAA by using screening criteria is an accepted method for making groundwater determinations. Based on the significant information available on Napa County groundwater basins, the screening criteria present a reasonable approach to the process. Because of the variability in parcel conditions in "All Other Areas", these parcels warrant a site-specific analysis, as discussed elsewhere in this document.

- The Water Availability Analysis is based upon the basic premise that each landowner has equal right to the groundwater resource below his or her property, so long as it doesn't significantly impact others. Furthermore, the WAA provides sufficient information and supporting documentation to enable the County to determine whether a proposed project may significantly affect groundwater resources and the reasonable and beneficial uses in the proposed area. By implementing policies to prevent wasteful or harmful use of groundwater, it is intended that sufficient groundwater will be available for both current and future property owners. Ensuring wells are located and constructed so as to avoid impacts on neighboring wells and surface water bodies will minimize neighbor disputes and avoid significant environmental impacts. In summary, this WAA implements a process that recognizes:

    - The current understanding of the occurrence and availability of the County's groundwater resources,

    - The hydrogeologic constraints that can locally affect the utilization of those resources, and

    - The periodic hydrologic constraints that may also affect the utilization of the resource and replenishment of the aquifer system.

Appendix A: Water Availability Analysis Background

At the height of the 1990 drought in Napa County, the Napa County Board of Supervisors and the Napa County Planning Commission became very concerned with the approval of use permits and parcel divisions that would cause an increased demand on groundwater supplies within Napa County. During several Commission hearings, conflicting testimony was entered as to the impact of such groundwater extraction on water levels in neighboring wells. The Commission asked the Department of Public Works to evaluate what potential impact an approval might have on neighboring wells and on the groundwater system as a whole. In order to simplify a very complex analysis, the Department developed a three phase Water Availability Analysis to provide a cost-effective answer to the question.

On March 6, 1991 an interim policy report, prepared by County staff, was presented to and approved by the Commission requiring use permit and parcel division applicants to submit a Water Availability Analysis with their application. The staff policy report provided a procedure by which applicants could achieve compliance with the Commission policy. Oversight of groundwater development within the County's jurisdiction was later refined by the Board of Supervisors approval of Napa County Ordinance No.1162 (Groundwater Conservation Ordinance) on August 3, 1999. A revised staff policy report was subsequently adopted by the Board of Supervisors in August 2007. The 2007 Policy Report updated the Water Availability Analysis procedure and restated the purpose and functionality of the analysis relative to the Groundwater Conservation Ordinance.

In January 2011, as part of the County's Comprehensive Groundwater Monitoring Program initiated in 2009, the County's technical consultant, Luhdorff & Scalmanini, Consulting Engineers, completed a review of the County's Groundwater Conservation Ordinance and procedures, and recommended updating the staff policy report and Water Availability Analysis procedure. The consultant's review found that the initial "phase one" analysis was valuable as a screening process, but that the pump test envisioned in "phase two" was not the best way to assess whether projects exceeding the screening criteria would have detrimental groundwater impacts.

On September 11, 2011, the Board of Supervisors appointed a Groundwater Resources Advisory Committee (GRAC) to assist with development of a groundwater monitoring program, and to recommend updates to the Groundwater Conservation Ordinance, as needed. As part of their work, the GRAC also reviewed changes to this Water Availability Analysis policy report in late 2013.

Appendix B: Estimated Water Use for Specified Land Use

Each project applicant is responsible for determining estimated water usage for their proposed project. While some guidelines are provided below, other industry standards exist, PBES may be able to provide data based on previous applications, and each project has its own unique characteristics. The most appropriate data should be used by the applicant to estimate water use for their specific project.

Guidelines for Estimating Residential Water Use:

The typical water use associated with residential buildings is as follows:

Primary Residence	0.5 to 0.75 acre-feet per year (includes minor to moderate landscaping)
Secondary Residence or Farm Labor Dwelling	0.20 to 0.50 acre-feet per year

Additional Usage to Be Added

1. Add an additional 0.1 acre-feet of water for each additional 1000 square feet of drought tolerant lawn or 2000 square feet of non-xeriscape landscaping above the first 1000 square feet.
2. Add an additional 0.05 acre-feet of water for a pool with a pool cover.
3. Add an additional 0.1 acre-feet of water for a pool without a cover.

Residential water use can be estimated using the typical water uses above. All typical uses are dependent on the type of fixtures and appliances, the amount and type of landscaping, and the number of people living onsite. If a residence uses low-flow fixtures and has appliances installed, is using xeriscape landscaping, and is occupied by two people, the water use estimates will be on the low side of the ranges listed above.

Examples of Residential Water Usage:

Residential water use can vary dramatically from house to house depending on the number of occupants, the number and type of appliances and water fixtures, the amount and types of lawn and landscaping. Two homes sitting side by side on the same block can consume dramatically different quantities of water.

Example 1:

Home #1 is 2500 square feet. Outside the house there is an extensive bluegrass lawn, a lot of water loving landscaping, and a swimming pool with no pool cover. Inside the house all the appliances and fixtures, including toilets and shower-heads, are old and have not been upgraded or replaced by water saving types. The owners wash their cars weekly but they don't have nozzles or sprayers on the hose. They do not shut off the water while they are soaping up the vehicles, allowing the water to run across the ground instead. Water is commonly used as a broom to wash off the driveways, walkways, patio, and other areas. The estimated water usage for Home #1 is 1.2 acre-feet of water per year

Example 2:

Home #2 is also 2500 square feet. Outside of the house there is a small lawn of drought tolerant turf, extensive usage of xeriscape landscaping, and no swimming pool. Inside the house all of the appliances and fixtures, including toilets and showerheads, are of the low flow water saving types. The owners wash their cars weekly, but have nozzles or sprayers on the hose to shut off the water while they are soaping up the vehicles. Driveways, walkways, patios, and other areas are swept with brooms instead of washed down with water. Estimated water usage for Home #2 is 0.5 acre-feet of water per year.

The above are only examples of unique situations. The estimated water use for each project will vary depending on existing parcel conditions.

Guidelines For Estimating Non-Residential Water Usage:

Agricultural:

Vineyards	
Irrigation Only	0.2 to 0.5 acre-feet per acre per year
Heat Protection	0.25 acre-feet per acre per year
Frost Protection	0.25 acre-feet per acre per year
Irrigated Pastures	4.0 acre-feet per acre per year
Orchards	4.0 acre-feet per acre per year
Livestock (sheep or cows)	0.01 acre-feet per acre per year

Winery:

Process Water	2.15 acre-feet per 100,000 gal. of wine
Domestic and Landscaping	0.50 acre-feet per 100,000 gal. of wine
Employees	15 gallons per shift
Tasting Room Visitation	3 gallons per visitor
Events and Marketing, with on-site catering	15 gallons per visitor

Industrial:

Food Processing	31.0 acre-feet per employee per year
Printing/Publishing	0.60 acre-feet per employee per year

Commercial:

Office Space	0.01 acre-feet per employee per year
Warehouse	0.05 acre-feet per employee per year

Estimates of water use for other categories are available in the technical literature from sources such as the American Water Works Association's Water Distribution Systems Handbook (Mays, 2000).

Parcel Location Factors:

The water use screening criterion for each parcel is based on the location of the parcel. There are three different location classifications: Napa Valley Floor, MST Groundwater Deficient Area, and All Other Areas. Napa Valley Floor areas include all locations that are within the Napa Valley excluding areas designated as groundwater deficient areas. Groundwater deficient areas are areas determined by the Department of Public Works as having a history of insufficient or declining groundwater availability or quality. At present the only designated groundwater deficient area in Napa County is the MST Subarea. Areas of the County not within the Napa Valley Floor and MST Groundwater Deficient Area are classified as All Other Areas. Public Works can assist applicants in determining the appropriate classification for project parcel(s).

Project Parcel Location	Water Use Criteria
Napa Valley Floor	1.0 acre feet per acre per year
MST Groundwater Deficient Area	0.3 acre feet per acre per year or no net increase, whichever is less*
All Other Areas	Parcel Specific
* Does not apply to the Ministerial Exemption as outlined in the Groundwater Conservation Ordinance	

The criterion for the Napa Valley Floor Area was agreed to 1991 by the Board of Supervisors. The criterion of 0.3 acre feet per acre per year for the MST Groundwater Deficient Area was determined using data from the 1977 USGS report on the Hydrology of the MST Subarea (Johnson, 1977). The value is calculated by dividing the "safe annual yield," as determined by the USGS (Johnson, 1977), by the total acreage of the affected area (10,000 acres). The addition of the "no net increase" standard reflects the County's obligation to assess potential cumulative impacts under CEQA. In a groundwater deficient area, any discretionary project that increases groundwater use may contribute to the declining groundwater levels in the aquifer.

No single criterion can be established for "All Other Areas" due to the uncertainty of the geology, and the increased complexity of the fractured rock aquifer systems in the mountainous and non-Napa Valley areas, including Carneros, Pope Valley, Wooden Valley, and Capell Valley. The project applicant will need to estimate the average annual recharge occurring in the project area and consider the amount of recharge relative to the estimation of project water use (e.g., all current and projected water demands for the property on which the planned project is located). The estimated project water use shall include estimates for normal and dry water years for both current and proposed water uses. If an alternative water source will be used for dry years (e.g.

trucked-in water for non-potable uses), that information shall be provided by the applicant including the source and estimated water volume.

The criteria above were reviewed by the County's groundwater consultants in 2011-2013 and are considered to be reasonable indicators on a watershed scale of the levels below which significant environmental impacts would be unlikely to occur. The review was based on existing monitoring data and an updated hydrogeologic conceptualization of the Napa Valley aquifer system (LSCE and MBK, 2013) and is consistent with the County's experience since establishment of the water use criteria in 1991. In addition, these criteria have been successfully applied as part of the WAA procedure since their establishment.

Appendix C: Guidance for MST Subarea Permit Applications

Historical data collected from the monitoring of wells within the MST Subarea over many decades indicate that it may be in overdraft, leading to the conclusion that the existing water users within the basin historically pumped more water from the ground than is being naturally replaced each winter season. To offset the overdraft trend, a recycled water pipeline is being installed, and once operating, its beneficial effects will be measured. However, as no other reasonable water resources currently exist in the MST, to avoid a ban on all new construction, the County has permitted each property owner to develop their property with the uses involving ministerial approvals under Section 13.15.030(C) of the groundwater ordinance, which are limited to a "reasonable" level of water use that may reduce the rate at which the groundwater levels are being lowered.

Single Family Dwellings on Small Parcels In the MST Subarea: The average, single family dwelling will likely use between 0.5 and 0.75 acre-feet of groundwater per year. Using a criterion of 0.3 acre-ft/year/acre, the minimum parcel size able to support the above range is between 1.5 to 2.5 acres. However, in order to ensure that all property owners have viable use of their land, applications for the construction of a single family home in these instances can be approved ministerially if the owner agrees to the conditions outlined in the Groundwater Ordinance. If the conditions are not agreed upon, or if the project involves a secondary dwelling or other groundwater uses not consistent with a single family dwelling, then the project would be subject to the analysis outlined in the WAA report. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share"[14] water use screening criterion is met.

Agricultural Development In the MST Subarea: Agriculture in the MST Subarea is not exempt from the groundwater permit process. In these cases, such development will require an application for a groundwater permit and a WAA detailing the existing and proposed water use(s) on the project parcel(s). All new agricultural development in the MST will be required to meter all wells supplying water to the property with periodic reports to the County. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share" water use screening criterion is met.

Existing Vineyard, New Primary or Secondary Residence In the MST Subarea: On an application related to a new residence on a parcel with an existing vineyard or residence, the WAA shall include all water use on the property, both existing and proposed. Projects on parcels with an established vineyard will be required to meter all wells supplying water to the property with periodic reports to the County. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share" water use screening criterion is met.

Wineries and Other Use Permits In the MST Subarea: On a use permit application, the applicant is required to provide a WAA. Should the application be approved, a specific condition

[14] The "fair share" allotment for water use is based on the parcel(s) location in the Napa Valley Floor, MST Groundwater Deficient Area or All Other Areas (see additional information in Appendix B).

of approval will be required to meter all wells supplying groundwater to the property with periodic reports to the County. It is also possible that water conservation measures will be a condition of approval. All new use permits must meet the criterion for water use for the project parcel. The County cannot approve the groundwater permit unless the proposed use is off-set by reductions elsewhere, such that the "no net increase" and "fair share" water use screening criterion is met.

Appendix D: Water Meters (in Groundwater Deficient Areas Only)

If required, water meters shall measure all groundwater used on the parcel. Additional meters may also be required for monitoring the water use of individual facilities or operations, such as a winery, residence, or vineyard located on the same parcel. If a meter(s) is installed, the applicant shall read the meter(s) and provide the readings to the County Engineer at a frequency determined by the County Engineer. The applicant shall also convey to the County Engineer, or his designated representative, the right to access and verify the operation and reading of the meter(s) at any time.

If the meters indicate that the water consumption of a parcel in the MST Subarea exceeds the fair share amount, the applicant will be required to submit a plan which will be approved by the Director of Public Works to reduce water usage. The applicant may be required to find additional sources of water to reduce their groundwater usage. Additional sources may include using water provided by the City of Napa, the installation of water tanks which are filled by water trucks, or other means which will ensure that the groundwater usage will not exceed the fair share amounts.

The readings from water meters may also be used to assist the County in determining trends in groundwater usage, adjusting baseline water use estimates, and estimating overall groundwater usage in the MST Subarea.

Appendix E: Determining water use numbers with multiple parcels

The Water Availability Analysis is based on the premise that each landowner has equal right to the groundwater resource below his or her property. There will be cases where one person or entity owns multiple contiguous parcels and requests that the total water allotment below all of his or her parcels be considered in the Water Availability Analysis. Determining the total water demand based on multiple contiguous parcels is acceptable; however, to protect future property owners, certain safeguards must be in place to ensure that the water allotment and transfer between parcels is clearly documented and recorded, especially in cases where the water from more than one parcel will ultimately serve a use on a single parcel.

When multiple parcels are involved, the parcels for which the total water usage is being based on must be contiguous and clearly identified on a site plan with the Assessor's parcel numbers noted. The transfer of water from these parcels to the parcel on which the requested use is located must be documented using the form provided by the Department of Public Works. The form must be approved by the County and subsequently recorded by the applicant prior to commencement of any activity authorized by the groundwater permit or other county permit or approval. A condition requiring such will be placed on the use permit, groundwater permit or other permit for approval.

Alternatively, if the method above is not feasible, the applicant may provide an additional analysis for each project parcel, with the understanding that the water use on each individual parcel must not exceed the water use screening criterion for that parcel (see additional information in Appendix B).

Appendix F: Water Availability Analysis Tiers 2 & 3 Screening Criteria & Additional Analysis

County staff will conduct, or require the applicant to conduct, additional analysis of the proposed project according to any screening criteria that are not met. Additional analysis is required for projects that are not located on the Napa Valley Floor or in the MST (i.e. "All Other Areas"). Additional analysis will also be required if insufficient information exists in the project application to judge conformance with one or more of the criteria.

Water Use Evaluation (Tier 1)

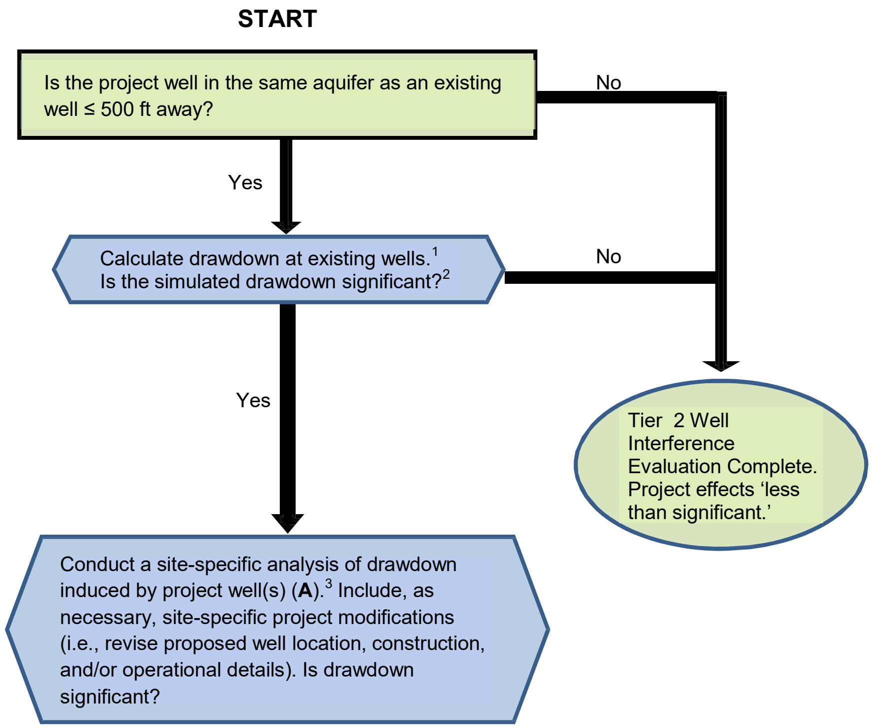
When the proposed project's estimated water demand does not meet the applicable water use criterion, the applicant will be encouraged to first revise the project and/or refine the water use estimate based on project details not adequately reflected in the water use screening criterion. County staff will then review the revised estimate and determine if the acceptable water use criterion has been met.

Well and Spring Interference Evaluation (Tier 2)

The Tier 2 well interference criterion is presumptively met if there are no non- project wells located within 500 feet of the existing or proposed project well(s). When a project well is within 500 feet of a neighboring non-project well(s) additional analysis of well interference will be required (see **Figure F-1**) for projects located in "All Other Areas". It may also be required for the Napa Valley Floor and the MST when substantial evidence in the record indicates the need to do so under CEQA. The analysis will first determine whether the existing or proposed project and non-project wells are, or are proposed to be, screened in the same aquifer unit and, if so, whether any drawdown induced in the non-project well(s) may constitute a significant adverse effect. **Table F-1** provides standard well interference criteria for induced drawdown in a non-project well that will be used in the absence of site-specific information regarding the susceptibility of existing non-project wells to drawdown induced by project well(s). Site-specific susceptibility information would include the pump depth setting and construction of project and non-project wells.

The Tier 2 spring interference criterion is presumptively met if no natural springs in use for domestic or agricultural purposes are located within 1,500 feet of any proposed project wells. When a project well is within 1,500 feet of a natural spring additional analysis of connectivity between the part of the aquifer system from which groundwater is planned to be produced and spring(s). When additional analysis is required, site-specific spring interference criteria will be established as appropriate for the springs(s) under consideration.

FIGURE F-1. WAA Additional Analysis Decision Tree (as shown, for well interference evaluation), where designated A = applicant responsibility, C = County staff responsibility



[1] Drawdown to be calculated using industry standard method(s) appropriate to the aquifer under consideration, such methods include the Theis Equation applicable for confined or unconfined aquifers (**A** or **C**).

[2] See Table F-1 or similar, superseding criteria provided by County staff (C).

[3] This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations and must include details of the project well(s) construction and operation relative to the site hydrogeology and any known information concerning the construction of any existing non-project wells under consideration (**A**).

The additional analysis will consider site-specific information including:

- the distance between the project well(s) and any existing non-project wells within 500 feet or natural springs within 1,500 feet;
- depth, screen intervals, and pump design flow rate for project well(s);
- depth, screen intervals, and pumping capacity/well type for the existing non- project well(s) or elevation and historical records of spring production;
- site hydrogeology (including aquifer units accessed by the project well and by existing non-project well(s) or natural springs and aquifer hydraulic properties (see **Tables F-2 and F-3**).

Data collected for the analysis will initially come from the WAA application, including information about existing non-project wells and site hydrogeology provided by County staff. These data will be used to calculate drawdown at any existing non-project wells, completed in the same aquifer unit, resulting from planned operation of the project well(s). Drawdown will be calculated using industry standard methods appropriate to the aquifer unit under consideration; such methods include the Theis Equation applicable for confined or unconfined aquifers (Theis, 1935).

If the initial calculated drawdown exceeds the Tier 2 well interference criteria, the applicant shall be required to submit a site-specific analysis prepared by a qualified professional demonstrating that the proposed project will not have an adverse effect (direct, indirect, or cumulative), on groundwater resources or neighboring non-project wells. This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations. The site-specific analysis may also demonstrate less than significant impacts by proposing modifications to the location, construction, or operation of project well(s).

If available data indicate a possible hydraulic connection between the project well(s) and any identified springs, an analysis of the hydraulic connection induced by the project well(s) will be conducted. Potential spring flow depletion induced by the project well(s) will be compared to site-specific spring interference criteria to determine if they constitute a significant adverse effect. The site-specific spring interference criteria will be established as appropriate for the spring(s) under consideration. Depending on site-specific concerns, more or less restrictive criteria may be required.

Table F-1 presents well interference criteria that the County may apply in the determination of significant adverse effects. The minimum significant drawdown values presented in **Table F-1** are intended for use in cases where information about existing non-project wells is limited or nonexistent. However, when the status and configuration of an existing non-project well are known, for example the depths of screen intervals, locations of any annular seals, and/or water levels in the well and the pump depth setting, then site-specific measures of significance should be used. Site-specific measures of significance should also account for known seasonal variations[15] in groundwater elevations in the vicinity of the proposed project and mutual well interference (i.e., interference between the planned project well usage (new and/or existing) and one or more neighboring wells). County staff shall inform the applicant of the site-specific Tier 2 well interference criteria that will be applied in the evaluation of a project before the applicant conducts a site-specific analysis.

[15] As used here, seasonal variations refer to typical changes over the course of a year.

Table F-1. Default Well Interference Criteria	
Type of wells within 500 ft. screened within the same aquifer as project well	**Estimated Drawdown at Neighboring Non-Project Wells**
Wells with a casing diameter of six inches or less	10 feet
Wells with a casing diameter greater than six inches	15 feet

Groundwater/Surface Water Interaction Evaluation (Tier 3)

When Tier 3 analysis is required[16], it shall be conducted as described below. The analysis will first determine whether the project well(s) are, or are proposed to be, screened in an aquifer unit hydraulically connected to the surface water(s) within the applicable distance specified by **Tables 3, 4, and 5** for unconsolidated aquifers (see also Figure F-2). If a hydraulic connection does exist, even one of limited temporal extent, then an analysis of the streamflow or surface water depletion induced by the project well(s) will be conducted. The streamflow depletion induced by the project well(s) will be compared to site-specific groundwater/surface water interaction criteria to determine if they constitute a significant adverse effect. The site-specific groundwater/surface water interaction criteria will be established as appropriate for the surface water(s) under consideration. Depending on the temporal extent of hydraulic connection and the special status species and/or surface water rights under consideration, more or less restrictive criteria may be required, up to and including no measurable streamflow depletion.

The additional analysis will consider site-specific information including:

- the distance between the proposed well and naturally-present surface water bodies within 1500 feet;
- depth, screened intervals, seal depths, and pumping capacity of applicant's well(s);
- site hydrogeology (including aquifer zones accessed by proposed well and existing wells and aquifer hydraulic properties (see **Tables F-2, F-3 and F-4**); and
- streambed (or equivalent feature) hydraulic properties.

Data collected for the analysis will initially come from the WAA application, including information about existing non-project wells and site hydrogeology provided by County staff. The evaluation will include calculation of streamflow depletion due to planned operation of the project well(s). Streamflow depletion will be calculated using industry standard methods appropriate to the

[16] Tier 3 analysis may be required under CEQA if substantial evidence, in the record, indicates a potentially significant impact may occur from the project.

aquifer under consideration; such methods include the Hantush Equation applicable for aquifers hydraulically connected with surface waters (Hantush, 1965).[17] If the initial calculated streamflow depletion exceeds the groundwater/surface water interaction criteria, the applicant shall be required to submit a site-specific analysis prepared by a qualified professional demonstrating that the proposed project will not have an adverse effect (direct, indirect, or cumulative), on surface water resources. This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in streamflow depletion calculations. The site-specific analysis may also demonstrate less than significant impacts by proposing modifications to the location, construction, or operation of project well(s).

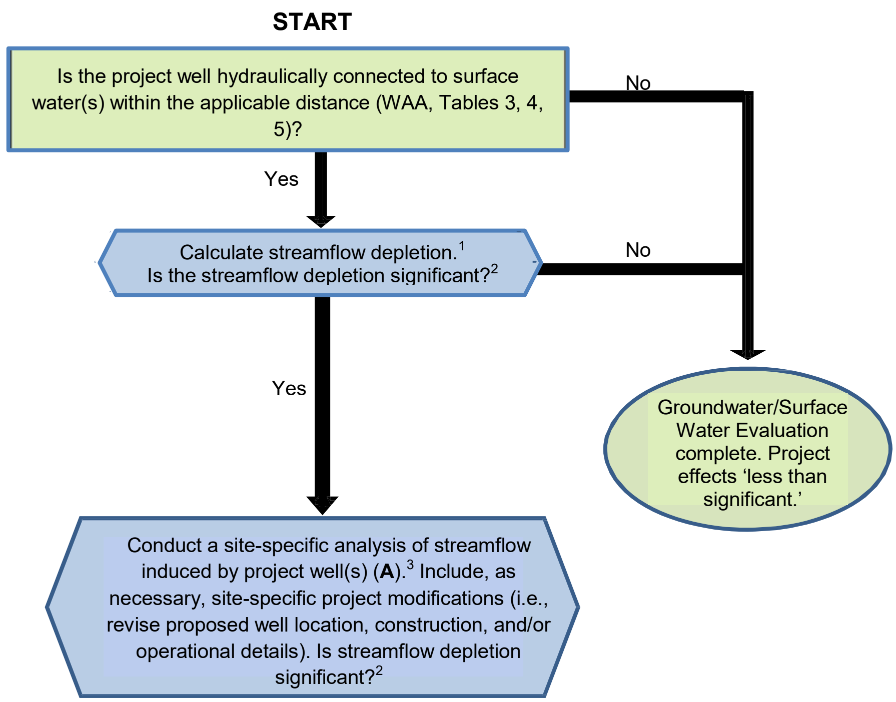
Modifications to the proposed project will be considered acceptable in satisfying the criteria where project well(s) can be shown to have a sufficient geologic or hydraulic separation from the surface water(s) that would prevent the well from causing streamflow depletion at least as much as would be expected at the minimum distance specified by the WAA Tables 3, 4, and 5. The California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (USBR) allow for similar exemptions when considering the potential effect on surface water flows of groundwater pumping proposed for water transfers involving groundwater substitution pumping in the Sacramento Valley. Some example circumstances for exception to the stated criteria (based on DWR and USBR, 2013) include:

- Sufficient information, including site-specific geologic or hydrologic data, is provided to demonstrate that the well does not have significant hydraulic connection to the surface water system;
- The well's uppermost perforations are planned to be deeper than recommended (see **Tables 3, 4, 5**) and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 20 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, pending the well type and planned well operations;
- The well's uppermost perforations are planned to be shallower than recommended (see **Tables 3, 4, 5**) and there is demonstration of low permeability deposits overlying the zone from which extraction is proposed to occur (i.e., a confining unit at least 40 feet thick exists above the depth of the uppermost perforation). In this case a somewhat lesser distance from the surface channel may be considered, pending the well type and planned well operations;
- The project well is a moderate to high pumping capacity well and the uppermost perforations are located no shallower than 150 feet deep, the perforations may be shallower (e.g., 100 feet deep), if there is a total of at least 50 percent fine-grained

[17] Streamflow depletion is to be calculated using industry standard method(s) appropriate to the aquifer and surface water source under consideration, such methods include the Hantush Equation applicable for unconfined aquifers with a direct hydraulic connection to a surface water body (Hantush, 1965).

materials in the interval above 100 feet below ground surface (bgs), and at least one fine-grained layer that exceeds 40 feet in thickness in the interval above 100 feet bgs.

FIGURE F-2. WAA Additional Analysis Decision Tree (as shown, for groundwater/surface water evaluation), where designated A = applicant responsibility, C = County staff responsibility



[1] Streamflow depletion to be calculated using industry standard method(s) appropriate to the aquifer under consideration, such methods include the Hantush Equation applicable for aquifers hydraulically connected with surface waters (**A** or **C**).

[2] Streamflow depletion criteria will be determined according to site-specific conditions (C).

[3] This site-specific analysis may include an aquifer test or an alternative study at the proposed well site to refine aquifer properties used in drawdown calculations and must include details of the project well(s) construction and operation relative to the site hydrogeology and any known information concerning the surface water(s) under consideration (**A**).

Data Needs for Additional Analysis

Hydrogeologic information at or in the vicinity of the subject parcel may be available from previous activities, or may be reasonably estimated from prior work conducted by the County. Previous activities may include (but are not limited to) aquifer tests, well completion reports with lithologic logs, water level, and well yield data collected on the parcel, and water level data collected as part of other groundwater monitoring activities. County staff will determine whether and how to best include such data in the WAA evaluation process. If no geologic information exists in the vicinity of the subject parcel, additional analysis may be required of the applicant.

The hydrogeologic information needed for WAA evaluation may include the aquifer storage coefficient, specific yield, hydraulic conductivity, transmissivity, and aquifer thickness. The aquifer storage coefficient for confined aquifers, or storativity, is defined as the volume of water that can be drained from a unit area of aquifer materials per unit decline in head. The storage coefficient can be calculated by multiplying the aquifer thickness and specific storage. In unconfined aquifers a similar property is represented by the specific yield of the aquifer materials.[18] Specific yield is defined as the volume of water that can be drained from a unit area of an unconfined aquifer in response to a unit decline in the water table elevation. **Table F-2** presents a range of values for specific yield for a variety of potential aquifer materials. In a confined aquifer the specific storage of aquifer materials can be calculated as the storage coefficient multiplied by aquifer thickness, where the storage coefficient is the volume of water produced by a unit volume of aquifer material per unit decline in head. **Table F-3** presents a range of possible specific storage values for potential aquifer materials. Storage coefficients for confined aquifers typically range from $5x10^{-5}$ to $5x10^{-3}$ (Todd, 2005). Specific yield for unconfined aquifers typically range from 0.1 to 0.3 (Lohman, 1972).

Table F-2. Representative Specific Yield[1] Ranges for Selected Earth Materials (adapted from Walton, 1970)

Sediment	**Specific Yield**
Clay	0.01 – 0.10
Sand	0.10 – 0.30
Gravel	0.15 – 0.30
Sand and Gravel	0.15 – 0.25
Sandstone (e.g., Great Valley formation)	0.05 – 0.15
Shale (e.g., Great Valley formation)	0.005 – 0.05

[1]Specific yield can be considered equivalent to the storage coefficient for unconfined aquifers where aquifer compressibility is negligible.

Table F-3. Representative Specific Storage Ranges for Selected Materials (adapted from Batu, 1998)

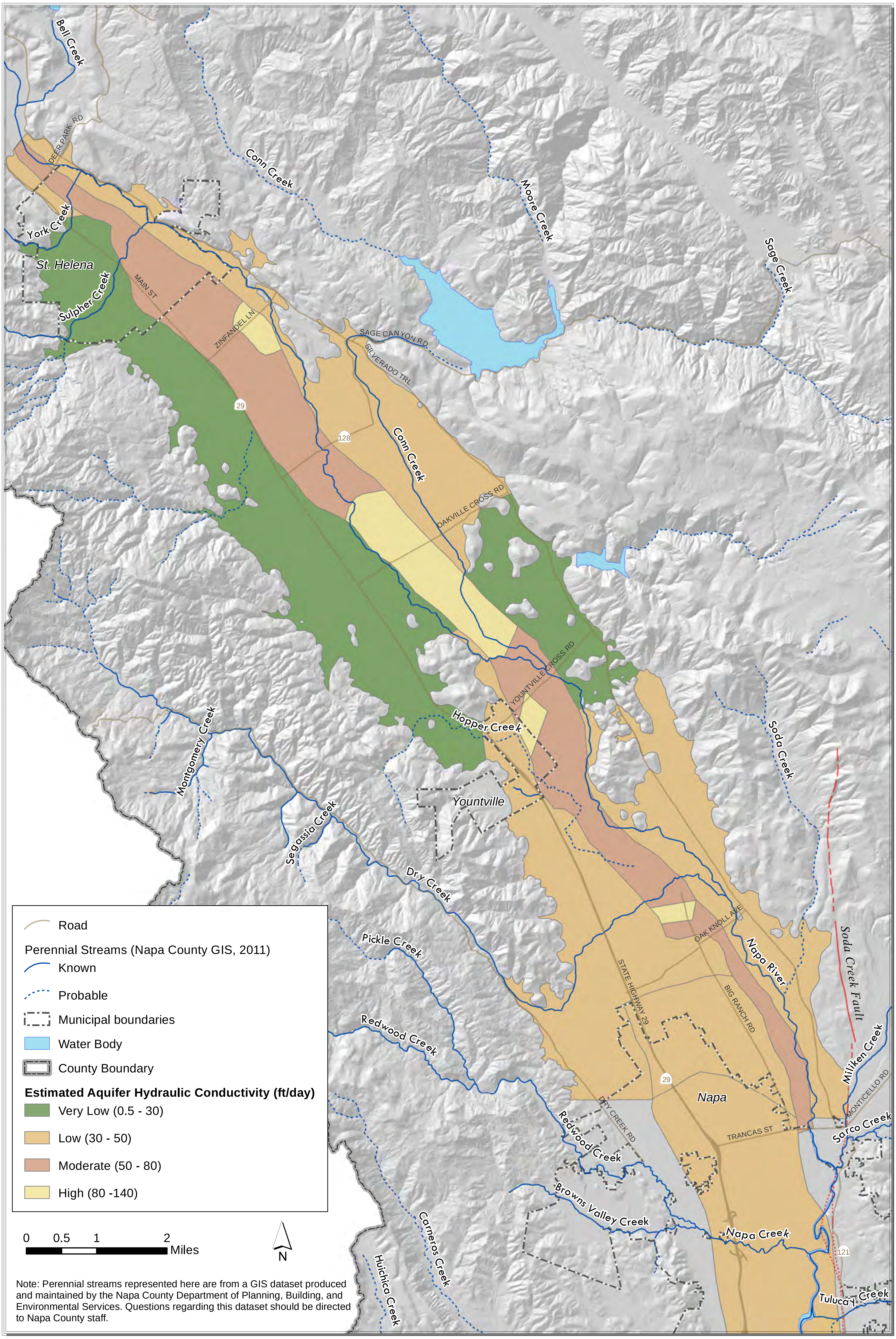
Material	**Specific Storage (ft^{-1})**
Loose Sand	$1.5x10^{-4}$ to $3.1x10^{-4}$
Dense Sand	$3.9x10^{-5}$ to $6.2x10^{-5}$
Dense Sandy Gravel	$1.5x10^{-5}$ to $3.1x10^{-5}$
Rock, fissured	$1x10^{-6}$ to $2.1x10^{-5}$

[18] An unconfined aquifer is defined by a water table that occurs where pore space pressures coincide with atmospheric pressure and where water released from aquifer storage occurs in large part due to the draining of saturated pore spaces in the aquifer material.

Transmissivity is another frequently used aquifer parameter. Transmissivity is defined as the capacity of the aquifer to transmit water across its entire thickness, calculated as the product of the aquifer hydraulic conductivity and the aquifer thickness. **Table F-4** presents representative hydraulic conductivity values found in the literature. Hydraulic conductivity ranges for the alluvial aquifer system have been mapped in Napa Valley by the US Geological Survey (USGS) (Faye, 1973), with more recent interpretations provided here based on a review of well driller's logs and other geologic data available through 2011 (LSCE and MBK, 2013). These ranges for hydraulic conductivity are depicted in **Figure F-3** and described in **Table F-5**, as interpreted by the County's groundwater consultants. Recent hydrogeologic investigations performed for the County have also produced maps and cross sections of subsurface geologic conditions which may be consulted for the determination of aquifer thickness in the vicinity of a proposed project (LSCE and MBK, 2013).

Table F-4. Representative Hydraulic Conductivity Ranges for Selected Materials
(adapted from Leap, 1999 and Batu, 1998)

Material	Hydraulic Conductivity (ft/day)		
Gravel (Alluvium)	10^{1}	to	10^{5}
Sand (Alluvium)	10^{-1}	to	10^{3}
Silty Sand (Alluvium)	10^{-2}	to	10^{2}
Silt (Alluvium)	10^{-4}	to	1
Sandstone (e.g. Great Valley formation)	10^{-5}	to	10^{-1}
Shale (e.g., Great Valley formation)	10^{-8}	to	10^{-4}
Fractured Basalt (e.g., Sonoma Volcanics)	10^{-2}	to	10^{2}



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LUHDORFF & SCALMANINI CONSULTING ENGINEERS

Figure F-3
Estimated Alluvial Aquifer Hydraulic Conductivity Ranges, Napa Valley Floor

Table F-5. Representative Hydraulic Conductivity values for WAA analysis of Napa Valley Floor unconsolidated alluvial aquifer materials[3]

Hydraulic Conductivity, K, class	Hydraulic Conductivity range[1], ft./day	Hydraulic Conductivity value, ft./day (used for scenario results)
high	80 - 140	80
moderate	50 - 80	50
low	30 - 50	30
very low[2]	0.5 - 30	0.5, 10

[1] Hydraulic conductivity range have been developed from mapped values from Faye (1973) and interpretations based on a review of well driller's logs and other geologic data available through 2011 (LSCE and MBK, 2013).

[2] A hydraulic conductivity value of 0.5 ft./day was applied for calculations of groundwater and surface water interaction (Tables 3, 4 and 5). A hydraulic conductivity value of 10 ft./day was applied for calculations of well interference (Table 2B and F1).

[3]Representative hydraulic conductivity values shown here are applicable to the unconsolidated alluvial aquifer materials in the Napa Valley Floor and not aquifer zones beneath the Napa Valley Floor alluvium or outside of the Napa Valley Floor.

County staff will review well construction permits and records for wells within 500 feet of the proposed project. Information about existing wells within 500 feet of the proposed project site will include the following as available: the location of those wells relative to the project well(s), total depth, depth of screened intervals, annular seal depths, the geologic or lithologic record made as part of well construction, the elevation of the static water level in the well post-construction, the elevation of water levels while pumping, and the pump depth setting.

Tables F-6 to F-9 present, for comparison purposes, the results of scenarios intended to represent the groundwater drawdown experienced in the vicinity of a proposed project after a 24-hour continuous pumping period. The results in **Tables F-6 and F-7** indicate that drawdown in a confined aquifer would be greater than drawdown in an unconfined aquifer for a given pumping rate. These results also indicate that wells pumping at rates less than 30 gallons per minute (gpm) for periods of time less than 24-consecutive hours will likely have negligible drawdown effects at distances beyond 25 feet in a confined aquifer.

These scenarios are presented for comparison purposes. Actual drawdown due to well interference will have to be calculated using well construction information and site-specific hydrogeologic information and/or values from **Tables F-2, F-3, F-4 and F-5** that are applicable to site-specific conditions.

Table F-6: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in a confined aquifer

30 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**500**
0.0005	10	5.3	4.4	3.6	1.6
0.001	10	4.8	4.0	3.1	1.2

Table F-7: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in a confined aquifer

100 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**500**
0.0005	10	13.6	11.5	9.4	4.5
0.001	10	12.5	10.4	8.3	3.5

Table F-8: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in an unconfined aquifer

30 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 75 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**125**
0.1	80	0.4	0.3	0.2	n/a
0.1	50	0.6	0.4	n/a	n/a
0.1	30	0.9	0.6	n/a	n/a
0.1	10	2.0	n/a	n/a	n/a

"n/a" denotes cases where Theis equation results are not available due to mathematical constraints on valid parameter values.

Table F-9: Simulated effect of a project well on water levels at an existing non-project well after one day of pumping at the stated flow rate in an unconfined aquifer

100 gpm Scenarios, calculated drawdown (ft)					
aquifer thickness = 100 ft. time = 1 day		distance between project well and existing non-project well (ft)			
Specific Storage	Hydraulic Conductivity (ft./day)	**25**	**50**	**100**	**125**
0.1	80	1.1	0.8	0.6	0.5
0.1	50	1.6	1.2	n/a	n/a
0.1	30	2.4	1.7	n/a	n/a
0.1	10	5.5	n/a	n/a	n/a

"n/a" denotes cases where Theis equation results are not available due to mathematical constraints on valid parameter values.

Example Applications of Additional Analysis Methods

Example 1*: Addition of a commercial tasting room facility with 10 acres of new vineyard and landscaping to an existing winery in a non-groundwater deficient area. The project involves construction of a new well proposed to be 30 feet from an existing six-inch diameter non-project well.*

Is well proposed to be completed in the same aquifer as an existing well ≤ 500 ft. away?

Yes, County well construction records indicate that the existing non-project well was constructed to a total depth of 160 feet in an unconfined aquifer, with a total screened interval of 80 feet throughout the older alluvium that is also mapped in the vicinity of the proposed well.

Calculate drawdown at all existing wells within 500 ft. of the proposed well. Is the calculated drawdown significant?

Yes, 10.9 feet of drawdown is calculated at the existing non-project well, based on available information about the existing well and the hydrogeology of the site (see **Table F-10**). This amount of drawdown exceeds the default well interference criterion of 10 feet and represents a potentially significant impact on groundwater resources.

Table F-10. Example 1: Drawdown calculated at an existing non-project well as a result of pumping a proposed well at 300 gallons per minute, where hydraulic conductivity = 30 ft./day, storage coefficient = 0.02, and aquifer thickness = 80 feet.

	Distance between Proposed Well and Existing Well (ft.)	**Calculated Drawdown in Existing Well (ft.)[1]**
Initial Project Well Location	30	10.9
Alternate Project Well Location A	50	9.0
Alternate Project Well Location B	70	7.7

1 Drawdown at an existing non-project well as a result of pumping the project well calculated using the Theis Equation.

Conduct a site-specific analysis of drawdown induced by project well(s). Include, as necessary, site-specific project modifications (i.e., revise proposed well location, construction, and/or operational details).

Is simulated drawdown significant (see Table F-1)?

No, after reviewing the site's existing and proposed infrastructure the project applicant modified the proposed well location to a location 50 feet away from the existing non-project well. Calculated drawdown values at the existing wells using the same available information about the existing wells, site hydrogeology, and the new proposed well location show less than significant drawdown at the existing non-project well (i.e., 9.0 feet). The applicant's groundwater use permit was approved on the condition of adherence to the revised well location and County standards for well construction.

Example 2: *Modification of an existing 40-year old irrigation well on a 12-acre parcel. The parcel also includes a primary, single-family residence with an existing (or available) connection to a public water supply system. The applicant proposes installing a new 80 gallon per minute pump to supply irrigation water for 10 acres of replanted winegrapes on lands which had not been actively farmed for several years. The applicant proposes operating the pump for 3 days at a time during the irrigation season. One existing non-project well is located 50 feet from the applicant's project well on one adjacent parcel and another existing non-project well is located 120 feet from the applicant's project well on another adjacent parcel. Both non-project wells are six-inch diameter wells.*

Is well proposed to be completed in the same aquifer as an existing well ≤ 500 ft. away?

Yes, well construction records provided by the applicant (or available from the County) indicate that the applicant's existing well is constructed to a total depth of 140 feet, with a total screened interval of 60 feet, in the older, unconsolidated alluvium.

County well construction records indicate that the existing non-project 50 feet from the project well was constructed to a total depth of 115 feet, with a total screened interval of 50 feet throughout the older alluvium.

Calculate drawdown at all existing wells within 500 ft. of the proposed well. Is the calculated drawdown significant?

No, 5.8 feet of drawdown is calculated to occur at the existing non-project well, based on available information about the existing well and the hydrogeology of the site (see **Table F-11**). This amount of drawdown does not exceed the default well interference criterion of 10 feet and represents a less than significant impact on groundwater resources. The applicant's groundwater use permit was approved contingent upon the proposed pumping duration.

Table F-11. Example 2: Drawdown calculated at an existing non-project well as a result of pumping the applicant's existing project well, where hydraulic conductivity = 10 ft./day, storage coefficient = 0.1, and aquifer thickness = 60 feet.

	Applicant's well pumping rate (gpm)	**Applicant's well seasonal pumping duration (days)**	**Calculated Drawdown in Existing Well (ft.)[1]**
Initial Proposal	80	3	5.8

[1] Drawdown calculated using the Theis Equation at an existing non-project well as a result of pumping the applicant's existing project well located 50 feet away.

Definitions

Aquifer – A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Aquifer Unit - One part of a number of units that comprise a larger aquifer system.

Hydraulic Conductivity – The capacity of subsurface materials to permit flow through interconnected pores, fractures, or other void spaces, subject to intrinsic properties of the fluid. As applied in this WAA, hydraulic conductivity is equivalent to saturated hydraulic conductivity.

Specific Storage– an aquifer hydraulic property which is the volume of water that can be drained from a unit volume of aquifer materials per unit decline in head.

Specific Yield – an aquifer hydraulic property which is the volume of water that can be drained from a unit area of an unconfined aquifer in response to a unit decline in the water table elevation.

Storage Coefficient (also Storativity) – an aquifer hydraulic property which is the volume of water released or added to aquifer storage per unit surface area of a confined aquifer per unit change in head.

Substantial Evidence - Defined by case law as evidence that is of ponderable legal significance, reasonable in nature, credible and of solid value. The following constitute substantial evidence: facts, reasonable assumptions predicated on facts; and expert opinions supported by facts. Argument, speculation, unsubstantiated opinion or narrative, or clearly inaccurate or erroneous information do not constitute substantial evidence.

Surface Water - For the purposes of this procedure, surface waters are defined to include only those surface waters known or likely to support special status species or surface waters with an associated water right; <u>however, as with all of the procedures in this WAA, there may be unique circumstances that require additional site-specific analysis to adequately evaluate a project's potential impacts on surface water bodies</u>.

Transmissivity – an aquifer hydraulic property which reflects the capacity of the aquifer to transmit water across its entire thickness, calculated as the product of the aquifer hydraulic conductivity and the aquifer thickness.

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Planning, Building & Environmental Services

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David Morrison
Director

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A Commitment to Service

WELL DESTRUCTION APPLICATION

Date: ______________ Well Permit Number:_________________

PROPERTY OWNER INFORMATION

Name: ___________________________________

Address: ________________________________

APN: ___________________________________

Phone # _________________________________

WELL DRILLER INFORMATION LICENSE #________________

Company Name: ___________________________________

Contact person: __________________________________

Address: ____

Phone # ____

TYPE OF WELL TO BE DESTROYED: ☐ CASED WELL ☐ HAND DUG WELL ☐ OTHER: _________________

FOR CASED WELLS:

Casing material ☐ Steel ☐ PVC ☐ Other: ________________________________

Total Depth of Well: ________Feet Well Screen interval(s): ____

Total Depth: _______________ Feet (For no seal – write "NONE", if unknown write "Unknown")

Casing Diameter: _____ Inches Annulus Diameter: _________ inches (For no annulus, write "None". If unknown, write "Unknown")

Well Pack Material: _________________________ Static water level: _________________feet.

FOR HAND DUG WELLS:

Total Depth of Well: _____________ feet Diameter of Well: _____________ inches

Well construction material (brick, stone, etc.)____

DESTRUCTION PROCEDURES:

Filling well with (choose one): ☐ Pea Gravel ☐ Concrete

Well filled to ______________ feet below ground surface.

Describe method of perforating casing (i.e. Mills Knife, Dynamite, etc.):_______________________________________

____

Sealing Material: ☐ Concrete ☐ Neat Cement ☐ Cement Grout ☐ Bentonite Grout (high solids) ☐ Other: ___________________

Driller's Comments: ____

____

____

APPLICATION
THIS IS NOT A PERMIT

Worker's Compensation Coverage (please check one):

☐ A Certificate of current Worker's Compensation Insurance Coverage is on file with the State of California, Department of Consumer Affairs, Contractors State License Board.

OR

☐ I certify that in the performance of the work for which this permit is issued, I shall not employ any person in any manner so as to become subject to the Worker's Compensation laws of California.

By executing this application, the undersigned agrees to comply with all conditions, inspections and comments of the issued permit and all federal, state and county code requirements applicable to this permit. Furthermore, I understand that the Department of Environmental Health in no way guarantees trouble-free operation of the well and that future repair or the drilling of a new well may be necessary.

Please sign below:

Signature: ____ Date: ____________

Please print your name: ____

Napa County Well Destruction Guidelines

With increasing concerns over contaminants affecting the quality of groundwater, the potential for inactive or abandoned wells to act as pathways for contaminants into groundwater becomes more critical. Local ordinance as well as California Bulletins 74-81 and 74-90 contains general guidelines as to the materials to be used and procedures to be followed in the destruction of wells. There have been, however, advances in technology and sealing materials since these documents were written. The purpose of these guidelines is to incorporate such new technologies and provide guidance based on current industry practice, on the type and application of sealing materials and techniques for well destructions.

This document covers what exists in County Code as well as what is being incorporated as best practices (*indicated by text in italics*). These guidelines will govern well destruction techniques (as allowed by County Code section 13.12.240 and 13.12.480) and requirements contained herein shall be included in any work plan submitted for a well destruction.

13.12.240 Well destruction.

"Well destruction" means certain work done to an existing well, the intent of which is to effectively seal the entire well up to the ground surface, in such a manner that each intersected water stratum is sealed and isolated from every other stratum and from surface water. Destruction of wells shall be completed in accordance with the procedures outlined in Article IV of this division or as otherwise specified by the director.

Article IV. Destruction of Abandoned Wells

13.12.460 Abandoned wells.

A. The owner of any property shall be responsible for destroying any abandoned well located thereon. A well is considered to be abandoned when it has not been connected for service to any structure and/or not used for a period of one year. An abandoned well also includes a well, which is in such a state of disrepair that no water can be produced.

B. The well will not be considered abandoned if all of the following occur: (1) the owner declares his or her intention to the director, in writing, to use such well again for supplying water or for other approved purposes, (2) the well has no defects in construction which would cause pollution or contamination to the ground water by surface water, (3) the well is covered with a safe well cover, (4) the well is marked so as to be clearly seen, and (5) the ground area surrounding the well is sloped away from the casing and kept clear of brush and debris.

13.12.480 Destruction of wells.

A. Prior to destroying a well, a detailed evaluation and report on the well shall be submitted to the director by a licensed well driller (as defined in section 13.12.250). Such report shall indicate the type of well to be sealed *(including total depth of well, well screened interval(s), sealed depth, well casing diameter, well annulus diameter [if known], well pack materials, and static water levels),* all known information of the geological conditions of the soil, and the methods and material to be used in the destroying and sealing process. The methods and materials used in destroying wells shall be such that the ground water is protected from pollution or contamination. *The County shall be notified as soon as possible if pollutants and contaminants* *are known or suspected to be in a well to be destroyed, or the immediate vicinity. Well destruction operations may then proceed only after approval by the County.*

B. When a water well or an abandoned water well is to be destroyed, it shall be destroyed as follows:

1. Any obstructions in said well, including pipes, pump, etc. shall be removed when possible. *Once pumps, piping and electrical wiring are removed from the well, the presence of any obstructions (including collapsed casing) to the total original depth of the well should be determined. Any obstruction in the casing, such as debris, pumps, or junk should be removed, to the original total depth of the well. All "reasonable" efforts should be made to clear the well casing to the original depth.*

2. As much casing shall be removed as possible, but not less than three (3) feet below grade or as determined by the director. *Well destruction operations performed prior to or simultaneously with the sealing of cased wells may involve pulling any existing casing out of the ground as applicable and/or feasible, or perforating or otherwise causing openings to be made in the casing. Openings in casing may be made with a gun-perforator per oilfield practice, an air-percussion perforator, or ripped with a "Mills Knife" or similar device if casing condition allows. PVC casing cannot be successfully perforated in most cases. In some situations, detonator cord or shaped charges may be placed in the well at selected intervals, and after placement of neat cement sealing material, exploded, thus simultaneously opening the casing and driving the sealing material into the annulus and borehole wall. The purpose of any of these operations is to facilitate entry of sealing material into the annulus and achieve penetration into the native formation of any existing gravel pack to the maximum extent possible. Mechanical perforators generally do not work in PVC casing, and drilling out the PVC casing and accompanying seal is probably the most effective method of destruction. The drilling (using a reaming and long-pilot bit) needs to be done slowly to avoid deflection and plugging of the bit with PVC Chips. Remnants of PVC casing left in place are not considered to be a hazard to water quality.*

3. The well *(with properly removed and/or perforated casing)* shall be filled with concrete, or "p" gravel to thirty (30) feet or below the first impervious layer (if known), <u>whichever is deeper</u>. If the well is less than thirty (30) feet deep, proceed to step 4. *If the well is in an area with known contamination or in the immediate vicinity of an existing or planned septic system*, t*he well (with properly removed and/or perforated casing) shall be filled with concrete, or "p" gravel to fifty (50) feet or below the first impervious layer (if known), <u>whichever is deeper</u>. Evidence of at least a 5-foot thick impervious layer must be presented to allow for a seal depth of less than fifty (50) feet. Any such evidence shall be presented to the County for such determination.*

4. Fill well *(with properly removed and/or perforated casing)* with concrete, neat cement or sand-cement grout to surface. *The appropriate sealing materials are to be placed from the bottom of the well up, using a tremie pipe which is kept submerged in the mixture and is periodically raised as the well bore is filled in one continuous operation (continuous pour). Special situations however may dictate two or more stages. Some applications may call for pressure grouting. In some deep wells where lost circulation of cement into the formation behind the casing might result (or actually occurs) from the fracture gradient of the formation being exceeded, use of additives to lighten the mixture, and emplacement in a minimum of two "stages" may be necessary. With any sealing method, the volume of the hole to be filled should be calculated, and compared with the actual volume of sealing materials used, to be sure that the volume of materials emplaced is at least equal to the hole volume.*

5. The placement of the material shall be done in such a way as to assure a dense seal, free of voids, in order to exclude surface water. Gravity installation of sealant without the aid of a tremie or grout pipe shall not be used unless the interval to be sealed is dry.

ADDITIONAL REQUIREMENTS

General.

1. *Well penetrating creviced or fractured rock. If creviced or fractured rock formations are encountered just below the surface, the portions of the well opposite this formation shall be sealed with neat cement, sand-cement grout, or concrete. If these formations extend to considerable depth, alternate layers of coarse stone and cement grout or concrete may be used to fill the well. Fine-grained material shall not be used as fill material for creviced or fractured rock formations.*

2. *Well penetrating specific aquifers, local conditions. Under certain localized conditions, Napa County may require that specific aquifers or formations be sealed off during destruction of the well.*

Additional Requirements for Wells in Urban Areas.

1. *In incorporated areas or unincorporated areas developed for multiple habitation, to make further use of the well site, the following additional requirements must be met for well destruction:*

2. *A hole shall be excavated around the well casing to a depth of 5 feet below the ground surface and the well casing removed to the bottom of the excavation.*

3. *The sealing material used for the upper portion of the well shall be allowed to spill over into the excavation to form a cap.*

4. *After the well has been properly filled, including sufficient time for sealing material in the excavation to set, the excavation shall be filled with native soil.*

Large Diameter Hand-Dug Wells

1. *Open, large diameter hand-dug wells not only present a pathway for groundwater contamination, but also provide a physical hazard to persons or animals that may fall in. These wells may involve large volumes of fill and sealing materials, and may present other unusual problems in their destruction. Sometimes there are small-diameter "laterals" at the bottom of such wells as used in the "wagon wheel" type construction, that must be dealt with for effective destruction. Occasionally, there is a drilled well extending from the bottom of the hand dug well, constructed when water levels dropped below the lift of a shallow centrifugal pump, and this bored well at the bottom must be destroyed first.*

2. *As much of the lining should be removed as possible, consistent with safety concerns, with particular attention paid to the upper 5 feet of "curbing', so as to assure to the extent possible good contact of the upper sealing material with native materials of the well. If the well is dry, or can be pumped dry, clean backfill materials as previously described, can be used to fill the well up to 30 feet below the surface (or a shallower depth as applicable) at which point, sealing material should be placed to the surface or just below the "plowing" depth, with an accompanying concrete cap. If the well contains water, then cement or bentonite grout should be placed from the bottom of the well to several feet above the water*

level, followed by fill material to 5 feet below the surface, and in turn covered by a concrete "cap" extending to the surface, or below "plowing" depth. Well destruction methods of these type wells (cased wells extending beyond the bottom of large diameter hand-dug wells) are to be the same as other cased wells as discussed in the sections above.

C. For the destruction of monitoring wells, cathodic protection wells or exploratory holes, refer to Bulletin 74-90 for requirements.

13.12.490 Alternative well or test hole destruction methods: Other methods of destroying wells, including large diameter wells and wells considered to pose a higher degree of risk to the ground water may be approved by the director if in his opinion an equivalent effect will result, and no contamination or pollution to the ground water will occur.

WELL OWNERS GUIDE

A Guide for Private Well Owners in Napa County

Napa County Public Works
Natural Resources Conservation

Groundwater Sustainability Program

July 2017

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Acknowledgements

Napa County Planning, Building and Environmental Services Department

Napa County Public Works

Napa County Resource Conservation District

Napa County Flood Control District

Santa Clara Valley Water District

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Introduction

This guide is intended to make private well ownership a little easier. It is designed to:

- Alert private well owners to the potential for contamination and the need for water quality testing;
- Introduce well owners to the basics of proper well construction, destruction and maintenance;
- Inform well owners of their responsibilities in Napa County.

Nearly half of all water used in Napa County comes from below the Napa Valley floor, where layers of sand and gravel provide a natural reservoir for water in underground aquifers. In addition to being an extraordinary storage facility, the groundwater basin also serves as an inexpensive and efficient water treatment and distribution system. The groundwater basin provides natural treatment and filtration as water percolates through the soil and rock. It also transmits large quantities of water over long distances without the need for tanks, pipes and pumping plants.

The thousands of water supply wells that draw water from the county's groundwater basins have traditionally produced very high quality drinking water. However, our drinking water aquifers can be threatened by toxic chemicals from accidental spills, leaking underground storage tanks, misuse or improper application of chemicals on the land, as well as biological pathogens from sewers, septic systems and confined animal facilities. These contaminants can find their way through the natural protective layers of clay and silt and into our drinking water aquifers. This problem can be intensified by the presence of improperly constructed wells, abandoned wells, or wells located too near a potential contaminant source, such as a septic system. These wells can act as vertical pathways, allowing chemicals and pathogens on the surface or in shallow aquifers to migrate into our deep drinking water aquifers. To help control and prevent the contamination of our groundwater basins and protect public health, the cooperation of private well owners is needed. This guide is intended to help you, and help all of us protect our groundwater resources and our health.

This publication is meant only as a guide. We do not claim that the recommendations made here will work in every situation, or that we have covered every possible scenario or contaminant. Any reference to trade names and companies does not constitute an endorsement.

Well Owner Responsibilities

Why should I protect groundwater?

Groundwater moves very slowly, often only a few feet per year. Because it moves so slowly, once it becomes polluted, it can take decades or longer for it to be naturally flushed clean. Manually cleaning pollutants out of groundwater can be extremely costly and difficult. Often, the only solution is to find a new source of water.

To protect public health and maintain the high quality of our drinking water aquifers, well owners are required to adhere to various state and local laws relating to wells. In general, well owners are required to:

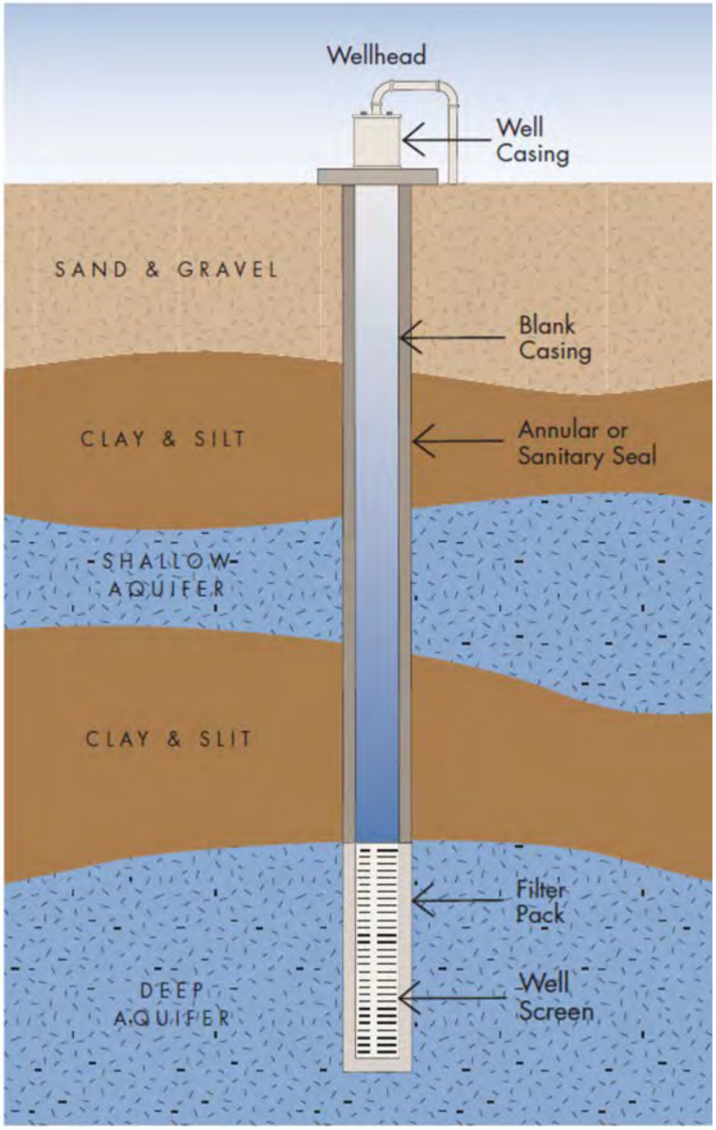
> *For most well owners, groundwater is their only source of water and should, therefore, be protected.*

- Obtain permits from the Napa County Planning Building and Environmental Services Department before any well construction, destruction, or modification.
- Complete any well construction, destruction, or modification according to Napa County regulations and state well standards. Wells must be constructed so that they do not allow poor quality surface water or water from the shallow aquifers to migrate into drinking water aquifers. Specific well construction practices must be followed to ensure that wells are constructed properly. Note: all well construction, destruction, or modification activities must be completed by a licensed well contractor.
- Properly maintain the well so that it remains in compliance with Napa County and state well standards. Wells must be maintained so that they do not allow the introduction of surface waters or other materials into them through improperly sealed well casings or gravel fill/sounding tubes. Wells must be secured so that children and animals cannot enter them.
- If required, file appropriate water usage reports with Napa County.
- Properly destroy any wells that are abandoned or not being used. When no longer in use, wells must be destroyed so that they can never act as vertical conduits or endanger public health.

For more information on your responsibilities as a well owner, contact the Napa County Planning, Building and Environmental Services Department at:

(707) 253-4417 or visit: http://www.countyofnapa.org/PBES/Environmental

Well Construction



The typical domestic well in Napa County is constructed by drilling a hole in the ground to a depth of 100 to 300 feet. As the well driller is drilling the hole, the type and depth of materials that the bit passes through are noted. This information is recorded on the driller log, which is submitted to the permitting agency and provided to the well owner by their drilling contractor.

The well is constructed once the driller finds layers of sand or gravel that produce enough water to meet the well owner's needs. These water producing layers are called aquifers. To construct the well, the driller installs a strip of plastic or steel pipe called the well casing into the hole. The well casing keeps the hole from collapsing and allows pumping equipment to be installed. Regulation requires that the well casing must have a diameter at least four inches smaller than the diameter of the hole.

Where the hole intersects the best water producing layers (the sand and gravel aquifers), the driller installs well casing that has thin cuts, or perforations. This portion of the well is called the well screen. The well screen allows water to pass into the casing, but keeps out sand and gravel. Where the hole intersects layers of clay or fine silt (layers that don't typically produce significant quantities of water), the driller installs un-perforated pipe called blank casing.

To keep fine sand, silt and clay from entering the well screen, the driller installs a sand and gravel mix called the filter pack into the space between the casing and the hole. To protect the water quality in the deeper drinking water aquifers from lesser quality surface water and shallow aquifer water, the driller also installs a concrete or cement seal (annular or sanitary seal) between the blank casing and the hole. In Napa County, the minimum concrete or cement seal depth is 20 feet or at least two feet into the first impervious layer, whichever is greater. In the case of a shallow water well where no water-bearing stratum is encountered below 20 feet, the seal shall extend to a minimum depth of 10 feet. For water wells which will serve a public water system, the seal shall extend to a minimum depth of 50 feet or two feet into impervious soil, whichever is greater.

Your well is a direct connection between you and your water supply.

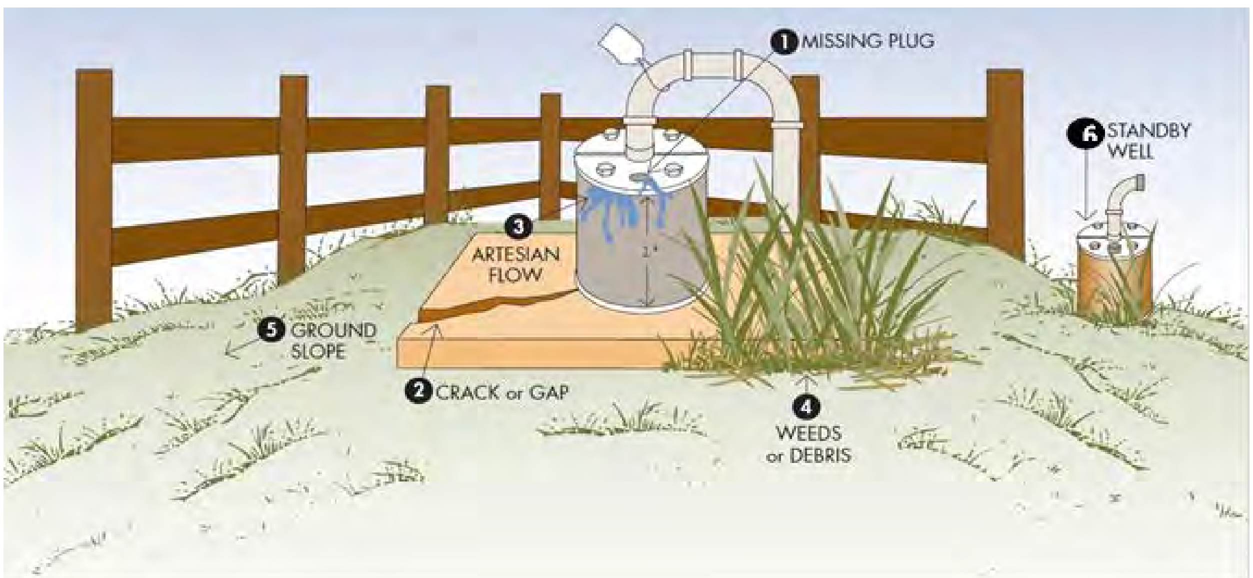
The well seal extends to the surface of the ground, where it is incorporated into a concrete pad around the well casing. These surface features are called the wellhead. At the wellhead, the casing extends at least one foot above the ground surface and is securely capped to prevent anything, including surface water, from entering the well. The concrete pad is sloped away from the casing to protect the well from damage and surface water contamination.

Maintenance

A poorly maintained well can lead to a variety of problems including poor water quality and reductions in the amount of water your well can produce. To minimize these potential problems, a well maintenance program is an important part of a well owner's responsibilities.

Inspect your well head

Get in the habit of doing a visual check on your well at least once a year. More often is better. Below are some of the things to look for when inspecting your well.



1. Look for openings that insects, rodents, water, or anything else can enter. Cap, seal, or otherwise plug them.
2. Look for cracks in the concrete pad that would allow water, and any contaminants it may be carrying, to enter the well casing and down into your drinking water aquifer. Seal cracks, or re-pour a new concrete pad.
3. If water is flowing out the top of the well, call a licensed well contractor to stop the flow. If water can leak out, contaminants can seep in (not to mention a waste of water).

4. Remove weeds, leaves, and other debris from around your well. These can create great homes for rodents and other pests. Do not use herbicides or any other chemical near the well.
5. Make sure the ground slopes away from your well, and that your well casing extends at least one foot above the ground to ensure that surface water does not collect or flow near the well.
6. If you have an inactive well, turn the pump on several times during the year to make sure that everything is functioning properly. Inspect and maintain your inactive well following the same guidelines as an active well. If you plan to never use the well again, you are legally required to properly destroy it. Properly destroying the well will prevent it from becoming an accidental pathway for contamination into the groundwater utilized by your active well, and other nearby wells.

Maintain complete well records

You should work with your water well and/or pump contractor to establish inspection and routine maintenance schedules based on the specific characteristics of your well and water supply needs. Complete well records should include:

Effective maintenance begins with complete records on the construction, testing and maintenance of your well.

1. The driller log (well completion report) - This document describes the construction of the well—how deep it is, from what depth it draws water (the perforated interval) and the soil types encountered while drilling. This information is important to help troubleshoot problems should they arise. The drilling contractor should provide you with a copy of the driller log following completion of the well construction and testing. If you do not have a copy of the driller log (well completion report), it may be available from state or local records. Visit: http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm to learn how to obtain the record for your well, or check with Napa County Planning, Building and Environmental Services Department, (707) 253-4417.
2. Pump test data - The pump test provides an estimate on how much water the well can produce. This information is also useful to assess well performance as the well ages.
3. Distribution map - Draw a map showing the location of all the buried water pipes connected to the well. If you share a well with adjacent properties, it is a good idea to have a map of all the plumbing on your neighbors' properties as well. This information can be invaluable as the properties change hands and repairs to be made or as new wells are added.
4. The physical location of the well - Measure the distance to the well from permanent structures and property lines (e.g. the centerline of the road or corner of the house).
5. Maintenance records - Record whenever you have maintenance done, such as replacing the pump or check valves. This is important information to keep track of how old the various components are, and who repaired them last.
6. Water quality data - Keep all of your past water quality testing information in one place. By comparing results from one year to the next you will be able to better detect changes which may indicate potential problems and/or need for maintenance.
7. Disinfection history - If you disinfect your well, keep track of when, why and how it was done.

Deteriorating well performance

> *The performance of all wells will deteriorate over time, but proper well construction and maintenance can delay this problem.*

The typical causes of performance deterioration include: mineral encrustation or biofouling (bacteriological encrustation) of the well screen, physical plugging of the well screen, filter pack and surrounding soils by fine particles, corrosion of the well casing and pump problems. Many of these problems can be prevented by proper well design and construction, pump sizing, operation and maintenance, or preventative well maintenance. If addressed early-on, most well performance problems can be corrected. To prevent or correct performance problems, you should work with your licensed water well and/or pump contractor.

Well destruction

Because unused, abandoned wells can act as pathways that allow poor quality surface water or shallow groundwater to move into deeper drinking water aquifers, it is very important that they are properly destroyed. This is especially true if other water supply wells are operating in the area. When a well is being used in the vicinity of an abandoned well, the pumping activity in the operating well can actually pull poor quality water down the abandoned well, into the drinking water aquifers, and then into the operating well.

> *Any well that is no longer being used for its intended purpose is required by law to be properly destroyed.*

To eliminate these vertical pathways for contaminant migration, abandoned wells must be properly destroyed. As with all well construction, modification or destruction, work must be completed by a licensed contractor and under permit from Napa County Planning, Building and Environmental Services Department, (707) 253-4417.

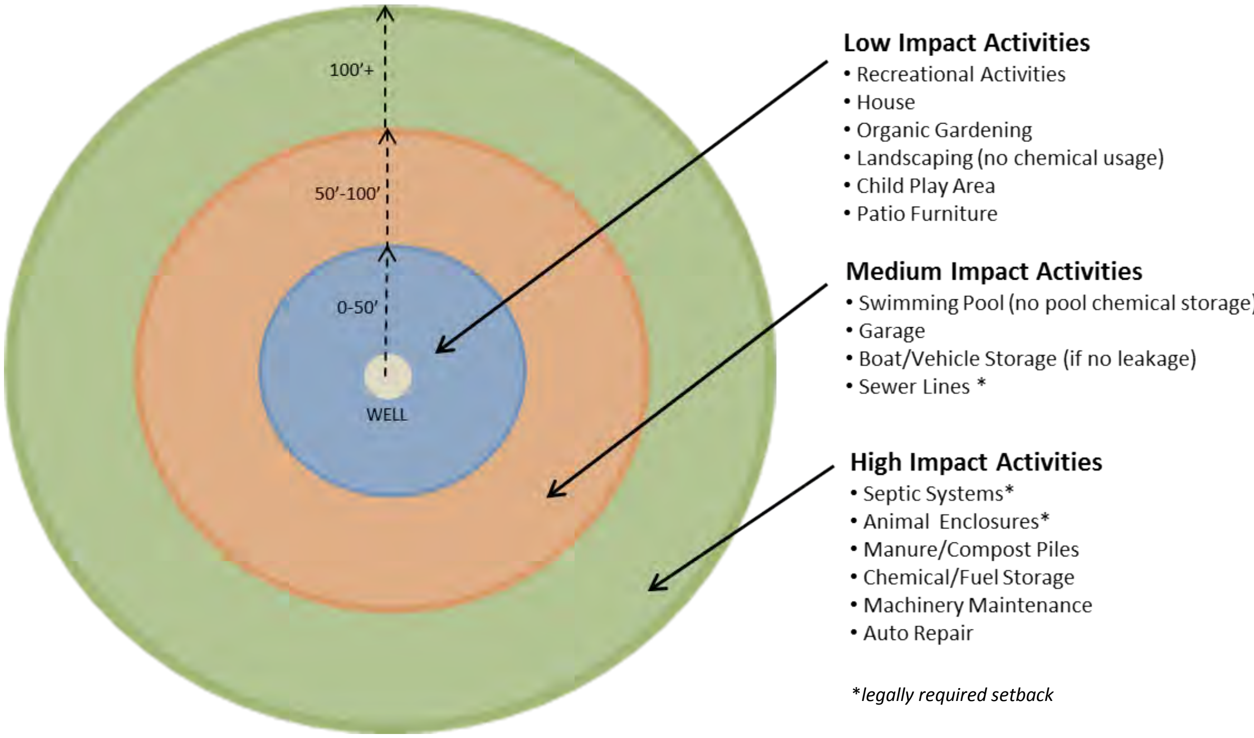
Water Quality Protection

Create a zone of protection around your well

Contaminants can flow down your well as easily as water flows up it. The farther away the contaminants are, the more opportunity for filtration. Create a circle at least 50 feet in diameter around your well where you don't store, mix, spray, spill, bury or dump anything that you don't want to drink. Don't forget to look out for your neighbor's well if it is near your property line. Any contamination in your neighbor's well can travel into your well.

Some activities legally require more than a 50-foot zone of protection. In most cases, septic tanks, leach fields and animal enclosures need to be at least 100 feet away from any well to ensure that no waste products reach your drinking water. There are many activities that do not have formal, legal setback requirements, but require the use of commons sense. For example, don't tie your dog or goat to the well structure - not only do you risk breaking the casing, piping or electrical connections, you risk contamination from urine and feces.

Well Setback Distances



Inspect your wellhead on a regular basis

It is very important to keep any foreign materials, including surface water, out of your well. Therefore, it is important that your well is free from openings and that your concrete well pad is structurally sound. Your well should be inspected annually to be sure that there are no openings in the wellhead or cracks in the well pad. Any openings or cracks should be secured or sealed. Refer to the Well Construction and Well Maintenance section titled “Inspect Your Wellhead” for more information on how to complete a simple inspection.

Protect the well structure

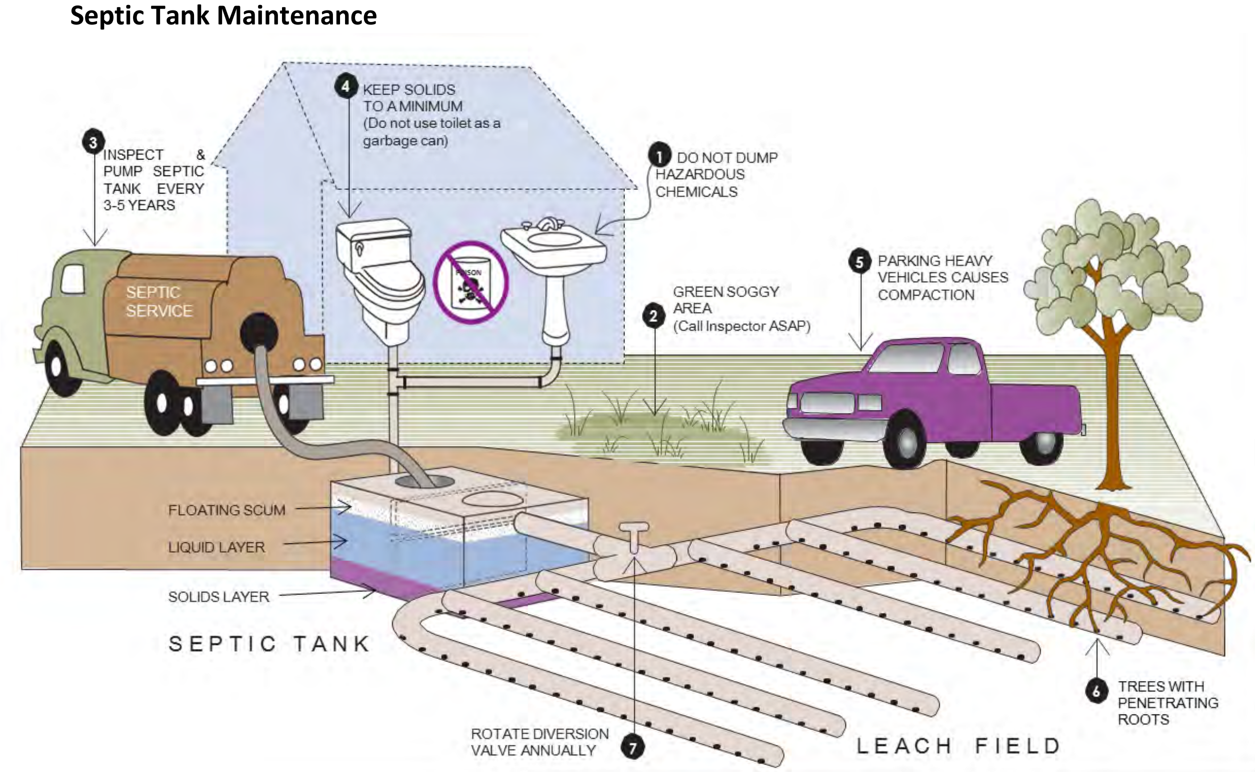
Many well repairs can be very costly, so it pays to protect your well from any physical damage. The safest way to protect your well from being damaged or lost is to build a small structure or fence around it. Keep in mind that you will need easy access to the well for maintenance and repairs. If you don’t have a structure around your well, then clearly mark it so when the weeds grow up in the spring, it doesn’t become buried and lost. Lock the well enclosure to minimize the chance of vandalism.

Maintain your septic system

A septic system consists of a tank and a leach or drain field. All the wastewater from inside the home flows into the septic tank, which is composed of two compartments. The waste is deposited in the first compartment where the solids settle to the bottom and the liquid and scum float on top. Bacteria and other microorganisms break down the solid material. As the liquid separates from the solids, it overflows into the second compartment where more separation and decomposition occur before it flows into the leach/drain field. The leach/drain field is a network of perforated pipes within a trench of washed drain rock buried about one to one and a half feet deep. The liquid waste flows out of the perforated pipe, trickles into the drain rock and filters down through the soil where additional pollutants are removed. By the time the wastewater is naturally cleansed and reaches the groundwater, few impurities should remain.

If you have a septic system, keep in mind that whatever goes down the drain may find its way into your drinking water. The required setback between your well and your septic system provides protection against bacteria and viruses when it is working properly. However, this setback was not designed to protect against things like photographic processing chemicals, hazardous art supplies, hazardous household cleaners, paint and paint cleaners, automotive wastes, pesticides and other hazardous chemicals that may not break down and filter out easily.

Septic Tank Maintenance



Tips on septic system maintenance

> *Always keep in mind that you live on top of your drinking water.*

1. Do not dump hazardous chemicals down the drain. If your drain is plugged try using boiling water or a drain snake instead of chemical drain cleaners. Use less toxic cleaning supplies whenever possible. Take all hazardous chemicals to a hazardous waste drop-off for disposal. See the Resource Guide Section in this guide for drop-off locations.
2. If you notice a sewage smell, continuously wet area in your yard, lush vegetation around the septic tank or leach field, or liquid waste backing up through your drains, then something is not working properly. Use a licensed septic tank inspector immediately.
3. Have your septic tank inspected and pumped every three to five years (more often if you have a garbage disposal). If the solid waste in the tank builds up too high, it can flow into the leach lines, plug them and cause your system to fail.
4. Keep the solids in your system to a minimum. Do not use your toilet as a garbage can. Food wastes, feminine hygiene products and other household solids are better placed in the garbage or compost.
5. Do not park or drive heavy equipment over your leach lines. This may compact the soil around the lines and prevent adequate percolation of the liquid waste, causing your system to fail.
6. Do not plant trees near your leach line. Tree roots often seek out the moist environment inside your leach lines and plug them, causing your system to fail.
7. If you have a dual leach field system, change the diversion valve setting once a year.

Water Quality Sampling and Testing

How do I protect the quality of my water?

The layer of earth between you and the water provides some protection from contamination, but it is not perfect. The safest way to protect your water supply is to teach your family, friends and neighbors: if you don't want to drink it, don't put it on or in the ground!

This section identifies ways to help protect the quality of your water.

As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and can pick up substances resulting from the presence of animals and human activity.

Contaminants that may be present include:

- Microbial contaminants such as viruses and bacteria that come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.
- Inorganic containments, such as salts and metals, that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, animal facility waste generation, mining, or farming.
- Pesticides and herbicides that may come from a variety of sources such as urban stormwater runoff, home owner and agricultural application, and septic systems.

- Organic chemical contaminants, including synthetic and volatile organic chemicals that are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, agricultural application, and septic systems.
- Naturally occurring radioactive contaminants in our area.

Drinking water, including bottled water, may reasonably be expected to contain small amounts of some contaminants. The presence of contaminants does not necessarily indicate that the water poses a health risk. More information about contaminants and potential health effects can be obtained by visiting: https://www.epa.gov/privatewells.

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised individuals such as persons with cancer undergoing chemotherapy, those who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly and infants, can be particularly at risk from infections. These people should seek advice from their health care providers about their drinking water supply.

Common Groundwater Contaminants

The most common groundwater contaminants of concern in Napa County are bacteria, arsenic[1], and to a lesser degree nitrate.

Bacteriological quality of drinking water is determined by analyzing for coliform bacteria. These bacteria occur naturally in the intestinal tracts of humans and animals, and in soil. Although coliform bacteria normally do not cause illness, they should not be present in drinking water. The presence of these bacteria in the drinking water indicates that other potentially harmful bacteria may be present. Bacteria levels can fluctuate seasonally with wet and dry periods.

Arsenic is an element found naturally. Arsenic compounds are used in industry, most commonly as a wood preservative, but also as components of pesticides, paints, dyes, and semiconductors. In Napa County, natural erosion of rocks and minerals is believed to be the primary source of the arsenic found in drinking water supplies. The current Maximum Contaminant Level (MCL) for arsenic is 10 ug/l. If your drinking water source is a private well extracting hot groundwater in the Calistoga area or possibly in the deeper aquifers in the Sarco-Tulocay Basin, it is a good precaution to have your water tested for arsenic. Once the water is tested, the Department of Planning, Building and Environmental Services can help interpret the results and water treatment companies can review treatment options with you. Several point-of-use filters can be installed and, if maintained correctly, can reliably remove arsenic from your drinking water.

Nitrate is a naturally-occurring compound, but high amounts of nitrate in groundwater are typically due to human activity such as excessive fertilizer applications, septic systems and animal enclosures. Nitrate in drinking water at levels above 45 milligrams per liter is a health risk for infants less than six months of age, pregnant women and people with certain specific enzyme deficiencies. Nitrate concentrations in

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[1] County of Napa Public Works Flood Control and Water Resources, *2016 Napa Annual GW Report* (Napa: 2016) and Planning, Building and Environmental Services Staff.

groundwater may rise quickly for short periods of time because of rainfall or agricultural activity. If you are caring for an infant or are pregnant, you should seek advice about your drinking water from your health care provider.

Electrical conductivity (EC) is a measure of all the dissolved ions in your water. By itself, EC does not tell you if your water is safe to drink. However, since the electrical conductivity test is easy and inexpensive, it can be used as an indicator of changing conditions that may require further testing.

Fecal coliforms are bacteria that are associated with human or animal wastes. They usually live in human or animal intestinal tracts, and their presence in drinking water is a strong indication of recent sewage or animal waste contamination. Escherichia coli or E. coli is a type of fecal coliform and although most strains of E. coli are harmless, the E. coli 0157:H7 strain produces a powerful toxin and can cause severe illness.

During rainfall events, coliform from animal or human waste may be washed into creeks, rivers, streams, lakes, or shallow groundwater. Inadequately sealed wells or wells of unknown construction are especially vulnerable. Your well is also vulnerable if it has been inadequately disinfected after construction, repair work, or other work that allows surface contamination to enter the well. When this water is used as a source of drinking water, E. coli may end up in drinking water.

When water is tested, it is initially screened for total coliform. Total coliforms are generally harmless; they are not usually found in water that is free of surface water or fecal contaminants. If total coliforms are found in the water, pathogens could also be present. If the presence of coliform is detected, the water is then tested to see whether or not fecal coliform is present.

What are the health effects of E. coli 0157:H7? Infection often causes severe bloody diarrhea and abdominal cramps. Often, no fever is present. However, it should be noted that these symptoms are common to a variety of diseases, and may be caused by sources other than contaminated drinking water. In some people, particularly children under 9, the elderly and those with compromised immune systems, an infection can also cause a life-threatening complication called hemolytic uremic syndrome, in which the red blood cells are destroyed and the kidneys fail.

What should I test my water for?

There are dozens of tests that can be performed on drinking water and no one analysis can assure that your water is "safe to drink." We have tried to compile the most commonly performed tests and their recommended testing frequencies below. This table should be used for general guidance only. Since coliform bacteria and nitrate are the most commonly found contaminants of concern in this area, we recommend testing for them most frequently. Testing for electrical conductivity and minerals is recommended in order to establish a baseline understanding of the water quality in your well and as a mechanism to indicate water quality changes.

Recommended Test			Interpreting Your Results	
Test	**Recommende dFrequency**	**Cost**	**If the lab report shows:**	**Then you may want to consider one or more of the following options:**
Total Coliform Bacteria	Twice per year: Wet season Dry season	$20 – 60	Total coliform present Note: If **e.coli** is present, the County Department of Environmental Health recommends using bottled water for drinking and cooking until the bacteria is eliminated.	Eliminate cause, disinfect and retest (see page 15). Increase testing frequency. Install a treatment system or find an alternative water supply. Consult a water treatment professional for more advice.
Nitrate	Annually	$15 – 50	≥ 45 mg/l as nitrate (NO_3)* or ≥ 10 mg/l as nitrogen (N)*	Install a treatment system or find an alternate water supply. Reverse osmosis, distillation, or anion exchange, will remove some of the nitrate. Consult a water treatment professional for more advice. Increase testing frequency.
Electrical Conductivity (EC)	Annually	$15 – 30	≥ 900 umhos/cm or significantly different from previous year result	Conduct further testing, such as nitrate and/or minerals to determine the cause of the high EC, or the change in EC.
MINERALS Aluminum (Al) Arsenic (As) Barium (Ba) Cadmium (Cd) Chromium, total (Cr) Fluoride (F) Iron (Fe) Lead (Pb) Manganese (Mn) Mercury (Hg) Selenium (Se) Silver (Ag)	Every 5-10 years, or If EC changes significantly, or If taste, color, odor or surrounding land use change	Package $90 – 300 Individual $20 – 35 Mercury $15 – 60	Al ≥ 1.0 mg/l* As ≥ 0.01 mg/l* Ba ≥ 1.0 mg/l* Cd ≥ 0.005 mg/l* Cr ≥ 0.05 mg/l* F ≥ 2.0 mg/l* Fe ≥ 0.3 mg/l Pb ≥ 0.015 mg/l* Mn ≥ 0.05 mg/l Hg ≥ 0.002 mg/l* Se ≥ 0.05 mg/l* Ag ≥ 0.1 mg/l	Compare to previous results. Install a treatment system or find an alternate water supply. The appropriate treatment system is dependent on your overall water chemistry and what constituents you would like to remove. Consult a water treatment professional for more advice.

What do I test for when my water has specific taste, odor, or appearance problems?

Below is a guide for some potential problems in drinking water and substances you can test for (in **bold**). Not all of the problems and possible causes pose a health risk to the consumer.

Problem	Possible Cause	Health Risk*
Water is orange or reddish brown	This may be due to high levels of **iron (Fe)** or iron bacteria.	2
Porcelain fixtures or laundry are stained brown or black	This is commonly a result of high **manganese (Mn)** and/or **iron (Fe)** levels. As little as 50 parts per billion (ppb) manganese and 300 ppb iron can cause staining.	2
White spots on the dishes or white ecrustations around fixtures	High levels of **calcium (Ca)** and **magnesium (Mg)** can cause hard water, which leaves spots. **Hardness** can also be measured directly.	2
Water is blue	Blue water or blue deposits may be due to high levels of **copper (Cu)**, especially if coupled with corrosive water.	1
Water smells like rotten eggs	This is most likely caused by **hydrogen sulfide (H_2S)**.	2
Water heater is corroding	Water can be corrosive, neutral, or noncorrosive. Water that is very corrosive can damage metal pipes and water heaters. The lab can calculate the corrosivity of your water by measuring **calcium**, **pH**, **total dissolved solids (TDS)**, and **alkalinity**.	2
Water appears cloudy, frothy or colored	**Suspended particulates**, measured directly or as **turbidity**, can cause the water to appear cloudy, frothy or colored. **Detergents** and/or **sewage waste** may also be the culprit.	1
Home's plumbing system has lead pipes, fittings, or solder joints	**Corrosive** water can cause **lead (Pb)**, **copper (Cu)**, **cadmium (Cd)**, and/or **zinc (Zn)** to be leached from lead pipes, fittings, and solder joints.	1
Water has a turpentine odor	This may be due to **methyl tertiary butyl ether (MTBE)**.	1
Water has chemical smell or taste	This may be due to **volatile** or **semivolatile organic compounds (VOCs)** or **pesticides**.	1

1 Some of the possible causes can have a detrimental effect on health even if present in low concentrations

2 No known health risk at commonly found concentrations

What do I test for if I'm concerned a nearby activity may be contaminating my well?

Here are some land uses and possible contaminants to test for.

Land Use	Possible Contaminants	Health Risk*
Landfill, industry, or dry cleaning operation	Consider testing for **volatile organic compounds (VOCs)**, **pH**, **total dissolved solids (TDS)**,**chloride (Cl)**, **sulfate (SO_4)**, and **metals**.	1
Agricultural crop production	Consider testing for **pesticides** commonly used near the well (consult the farmer or Department or Agriculture for a list), **nitrate (NO_3)**, **pH**, and **total dissolved solids (TDS)**.	1
Livestock enclosure, manure, or compost storage area	Consider testing for **bacteria**, **nitrate (NO_3)**, and **total dissolved solids (TDS)**.	1
Gas station or automobile repair shop	Consider testing for **total petroleum hydrocarbons (TPHg)**, **total oil**, **grease (TOG)**,**benzene**, **toluene**, **ethylbenzene**, **xylenes (BTEX)**, **MTBE**, **ethylene dibromide (EDB)**.	1

1 Some of the possible causes can have a detrimental effect on health even if present in low concentrations

2 No known health risk at commonly found concentrations

What should you do?

Don't panic. If your water is provided by a public agency, the water is already tested and required to meet safe limits. However, if your drinking water comes from a well and the well has not been tested or if you suspect that your well is vulnerable to contamination, do not drink the water.

Napa County currently does not conduct well water quality testing; however, State Certified Laboratories in the area do provide this service[2]. If you choose to test your well, call the lab directly for instructions on how to collect a sample and submit it for testing. Failure to follow the instructions provided by the lab can lead to inaccurate results. Once the water is tested, the Planning, Building and Environmental Services Department can help you interpret your results, and if necessary, water treatment companies can review your treatment options with you.

[2] A subset of wells enrolled in Napa County's Voluntary Groundwater Level Monitoring Program may be tested for water quality with the owner's permission in order to monitor long-term groundwater quality trends on a basin-level scale. If you are interested in the Voluntary Well Monitoring Program see page 20 of this report.

What if I want to treat my water? Most groundwater does not require any treatment. If you have found a problem that you want to treat, there are many different types of treatment available. Systems require routine maintenance. **Improperly maintained treatment systems can cause more harm than good.** Know what you want to remove and if you will be able to perform the routine maintenance *before* you invest. See the guide below for treatment possible options. Some options remove a greater percent of the concentration than others. Talk with the manufacturer or a water treatment professional to **get a guarantee** the system will work in your situation.

Contaminant[3]	Carbon Filtration	Chlorination/Disinfection	Coagulation/Filtration	Deionization	Distillation	Ion Exchange	Iron Based Media	Oxidation	Ozonation	Reverse Osmosis
Arsenic	X		X		X	X	X			X
Asbestos			X		X					X
Chloride				X	X	X				X
Chromium			X		X	X				X
Coliform Bacteria		X							X	X
Color	X	X			X	X			X	X
Copper			X		X	X				X
Fluoride					X					X
Hardness						X				
Hydrogen Sulfide	X	X					X			
Inorganic Minerals (some)			X	X	X	X				X
Iron/Manganese		X	X			X		X		
Lead			X		X	X				X
MTBE	X									
Mercury	X				X	X				X
Nitrate					X	X		X		X
Odor and Taste	X	X						X		
Perchlorate						X				X
Pesticides (some)	X				X			X		X
Radium 226/Radium 228	X				X	X				X
Radon	X									
Sulfate					X	X				X
Total Dissolved Solids (TDS)				X	X					X
Volatile Organic Chemicals	X									X

[3] This table is meant to provide general guidance. Selection of a treatment technology should be based on site specific conditions. There are many types of treatment systems. The systems shown may not be appropriate for all situations. This table was adapted from the Water Quality Association, the California Department of Public Health, Texas A&M Agrilife Extension, and U.S. Environmental Protection Agency.

Voluntary Groundwater Monitoring Program

Napa County has a Voluntary Groundwater Level Monitoring Program. This Program measures groundwater levels in the spring and fall in approximately 100 wells throughout the Napa Valley. These measurements improve the understanding of groundwater for both the well owner and the County. This network of privately owned volunteer wells, along with a handful publicly owned wells, provides a greater understanding of our local aquifers. The program is strengthened by expanding the voluntary well network to areas where additional data is needed or nonexistent. Napa County Natural Resources Division has created a video highlighting the importance of groundwater monitoring in our community and how you can get involved. To view the video visit: https://youtu.be/yyGHAWyegK0.

Why should I measure the water depth in my well?

Many want to know how water depth changes over the course of the year in order to better understand how the groundwater reservoir beneath their land responds to winter recharge and use over the dry summer months. Measurements are best taken in the spring and fall over multiple years to understand the long-term trends in recharge that occur with annual rainfall.

Will someone curtail my well use if I participate?

No. The Voluntary Groundwater Level Monitoring Program is a non-regulatory, voluntary program that measures the depth to groundwater (level only). Groundwater usage is not being measured or monitored as part of this program.

Will my well information be kept confidential?

Napa County will make every effort to maintain the confidentiality of a well owner's information. However, such information could be accessed through a public records request. In such a case the County will notify the well owner.

How long is the voluntary groundwater level monitoring program going to last?

The monitoring program will last as long as funding and resources are available. A well owner may leave the program at any time.

Who is eligible to participate?

If your well is in an area where data is lacking and well construction information is available, your well may be eligible to participate in the program.

How will the collected information be used?

The information will be used to monitor and track groundwater levels to help the County better understand relationships between surface water and groundwater, maintain a centralized data management system, and improve the accuracy and reliability of relevant water resource models.

Well owners who participate in the voluntary groundwater level monitoring program:

- Receive accurate groundwater level readings twice per year (spring and fall);
- See seasonal and long-term groundwater level trends for their well;
- Receive water quality data for their well (if testing is agreed to and conducted); and
- Receive notification if anyone submits a public records request for information.

The County monitors approximately 100 wells throughout the community. If you are interested in volunteering your well for County monitoring, please contact us, as we periodically update our monitoring network. The County publishes an annual report on the status of overall groundwater conditions. The report can be found by visiting http://www.countyofnapa.org/groundwater.

You can also sign-up to be on the County's Groundwater List-Serve to receive updates regarding the Groundwater Monitoring Program and other information about our local groundwater resources. You can scan the code below with your mobile phone or contact Napa

Do it Yourself (DIY) Groundwater Level Monitoring:

Napa County has a Groundwater Self-Monitoring Program. This DIY program offers training and a special hand-held sonic measuring device to determine the depth to water in most wells.

How do I borrow the tool from the County?

1. Contact County staff and indicate your interest ,
2. Napa County Resource Conservation District staff will demonstrate the equipment at your well and help with initial tool calibration,
3. Then you can borrow the equipment seasonally to measure your water level.

Reserve the tool or learn more:

Paul Blank, 707-252-4189 x3121, paul@naparcd.org

Jeff Sharp, 707-259-5936, jeff.sharp@countyofnapa.org

Groundwater Resource Information

You can sign-up to receive updates and informational emails regarding the County's Voluntary Groundwater Monitoring Program, annual monitoring updates, and other information about our groundwater resources and sustainability planning. Join the Napa County Groundwater Email List by visiting: http://eepurl.com/bWgdin.

Another way to learn more about our County's groundwater, along with other watershed news and events, is by visiting the Watershed Information and Conservation Council (WICC) website: www.napawatersheds.org. The WICC website hosts a special section devoted to groundwater that can be found at www.napawatersheds.org/groundwater.

You may also contact Napa County Public Works, Natural Resources Conservation Division for additional information about the County's groundwater resources at (707) 259-8600, or visit their office at 804 First St., Napa CA 94559.

Additional Resources

Regional and State Government

State Water Resources Control Board - SWRCB's Drinking Water Program regulates public drinking water systems. SWRCB certifies drinking water treatment devices which claim to treat water for contaminants related to public health, such as lead, bacteria, pesticides and heavy metals. SWRCB maintains a directory of certified residential water treatment devices, which can be found at the link below by searching "Residential Treatment". (916) 449-5577
https://www.waterboards.ca.gov/drinking_water/programs/index.shtml

SWRCB Well Owner Guide http://www.waterboards.ca.gov/gama/docs/wellowner_guide.pdf

California Department of Water Resources – Groundwater resources play a vital role in maintaining California's economic and environmental sustainability. During an average year, California's 515 alluvial groundwater basins and subbasins contribute approximately 38 percent toward the State's total water supply. During dry years, groundwater contributes up to 46 percent (or more) of the statewide annual supply, and serves as a critical buffer against the impacts of drought and climate change. DWR
http://www.water.ca.gov/groundwater/index.cfm

The Sustainable Groundwater Management Act (SGMA) established a framework for sustainable, local groundwater management. SGMA requires groundwater-dependent regions to halt overdraft and bring basins into balanced levels of pumping and recharge. Information about Groundwater Sustainability Agencies, resources available to local agencies and the public, the latest tools and guidance in managing groundwater basins sustainably can be found at http://www.water.ca.gov/groundwater/sgm/index.cfm.

The Groundwater Information Center is DWR's portal for groundwater information, groundwater management plans, water well basics, and statewide and regional reports, maps and figures.
http://www.water.ca.gov/groundwater/gwinfo/index.cfm

Department of Toxic Substances Control – The Department of Toxic Substances Control can help answer questions about what is a hazardous waste, how to reduce household hazardous waste, where to report spills and illegal dumping, as well as provide information on specific hazardous waste disposal or handling facilities. (800) 728-6942 www.dtsc.ca.gov

San Francisco Bay Regional Water Quality Control Board – The San Francisco Bay Regional Water Quality Control Board is the branch of the State Water Control Board providing local oversight for the San Francisco Bay Watershed. The San Francisco Bay Region includes the entire Napa River watershed in Napa County. (510) 622-2300 www.swrcb.ca.gov/rwqcb2

Local Government

Napa County Planning, Building and Environmental Services – PBES's Environmental Health Division has information on wastewater disposal and monitoring, protection of public water systems, water wells and pollution prevention within the County. (707) 253-4471 http://www.countyofnapa.org/PBES/Environmental/

Napa County Resource Conservation District – The RCD uses scientifically sound methods to assess and better-understand water quality in Napa County's watersheds as it relates to supporting ecological, agricultural, rural and urban uses. The RCD has reports on the monitoring and assessment results from water quality testing. (707) 252-4189 http://naparcd.org/resources-documents/watershed-assessments/

Napa County Public Works– The Natural Resources Conservation Division has information for residents on the County's groundwater program and sustainable groundwater management, watershed resources, and WIC council, water and energy conservation, clean energy, green business, recycling and waste reduction programs.(707) 259-8600 http://www.countyofnapa.org/FloodControlandWaterResources/

Federal Government

USEPA's Safe Drinking Water Hotline - The U.S. Environmental Protection Agency's Safe Drinking Water Hotline is available to help the public, drinking water stakeholders, and state and local officials understand the regulations and programs developed in response to the Safe Drinking Water Act. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline. The hotline and web page also provide information on testing and protecting private well water and where to find more information. (800) 426-4791 https://www.epa.gov/ground-water-and-drinking-water/safe-drinking-water-hotline

EPA private well publications https://www.epa.gov/privatewells/additional-private-well-publications

Food and Drug Administration - Among other things, the Food and Drug Administration regulates the bottled water industry. Contact the FDA if you have questions about the safety or regulation of bottled water. (888) 463-6332 www.fda.gov

Other Resources

University of CA Davis, Groundwater Information & Educational Resources – UCD offers groundwater, drought, and groundwater quality information and educational resources. http://groundwater.ucdavis.edu

State Licensed Well Contractors – All well construction, destruction, or modification activities must be completed by a C-57 licensed contractor. To check if a contractor is licensed contact the Contractors State License Board at (800) 321-2752 or go to http://www.cslb.ca.gov/

Water Quality Association – The Water Quality Association (WQA) is a not-for-profit international trade association. WQA is a resource and information source for residential, commercial and industrial water treatment industry. The website includes a diagnostic tool to diagnose many types of water problems and offer potential treatments and solutions. The website also has a tool to help you find a water professional in your area. (630) 505-0160 www.wqa.org

The Private Well Class –The Private Well Class provides rural residents with training webinars, events and resources to maintaining and protecting their private well. http://privatewellclass.org/

National Sanitation Foundation – The National Sanitation Foundation (NSF) is a not-for-profit organization that tests products relating to health and the environment. NSF certifies that home treatment units meet the manufacturers' performance claims. Contact the NSF for a list of treatment units that are certified to remove your contaminant of concern. (800) 673-6275 www.nsf.org

California Groundwater Association – The California Groundwater Association is a non-profit organization, whose members include water well drilling and pump contractors, suppliers and manufacturers, geologists, engineers, hydrologists, government employees and others working in the groundwater field throughout California. Contact CGA for information on the quantity, quality and availability of California's groundwater resources. www.groundh2o.org

The Groundwater Foundation – The Groundwater Foundation (GWF) is a not-for-profit that is dedicated to informing the public about groundwater resources. They provide numerous educational programs and publications for all ages on the importance of groundwater and groundwater protection. The GWF also offers recognition and support for the Groundwater Guardian Communities and Affiliates. (800) 858-4844 www.groundwater.org

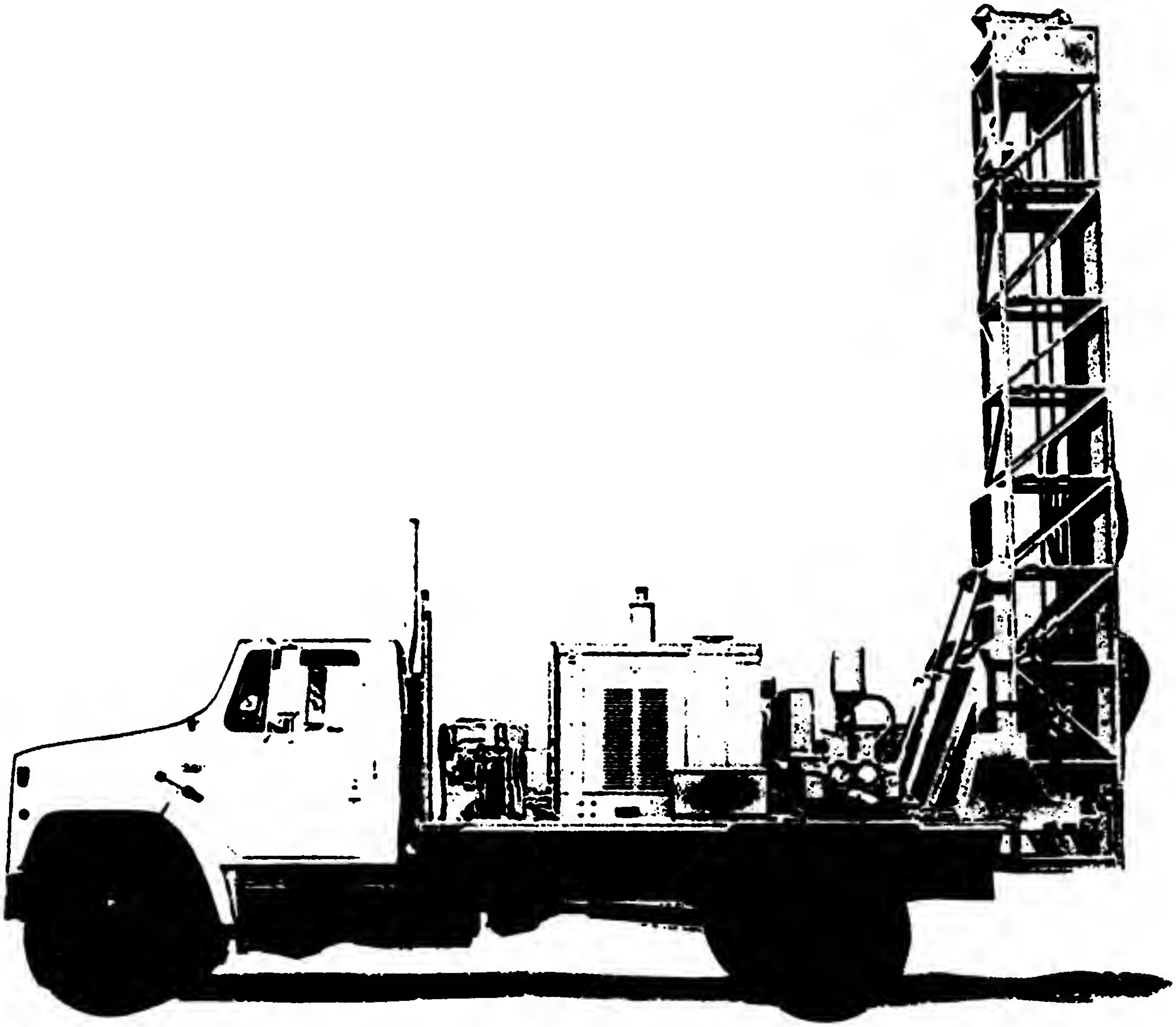
National Ground Water Association – The National Ground Water Association (NGWA) is a not-for-profit organization whose mission is to enhance the skills and credibility of all groundwater professionals, develop and exchange industry knowledge, and promote the groundwater industry and understanding of groundwater resources. Contact the NGWA for information on groundwater studies and publications nationwide, for answers to frequently asked questions about groundwater, and for the latest groundwater news and legislation. (800) 551-7379 http://www.ngwa.org/Pages/default.aspx

APPENDIX 3E

California Well Completion Standards

California Well Standards

Water wells   Monitoring wells   Cathodic protection wells



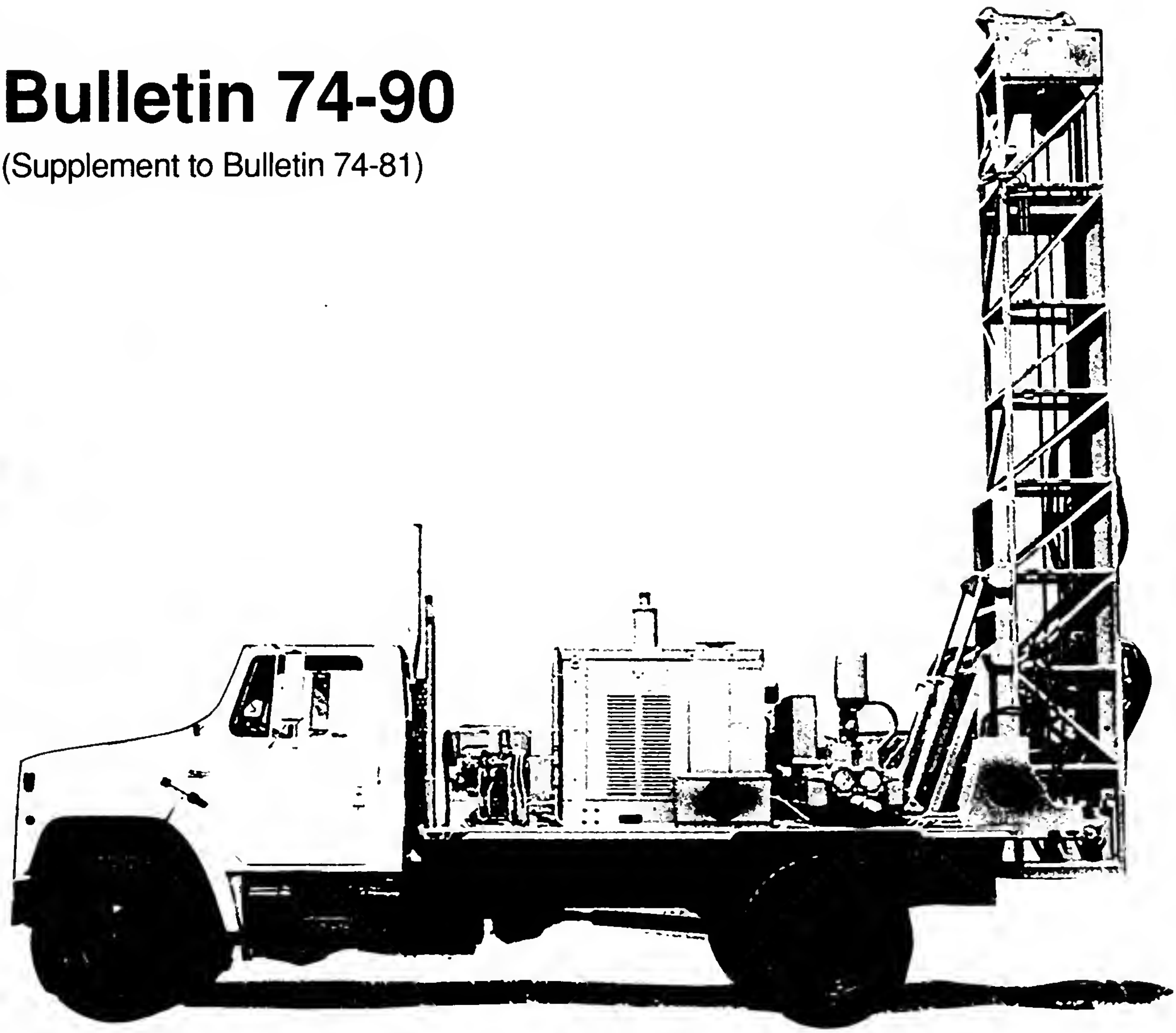
California
Department
of Water Resources

California Well Standards

Water wells • Monitoring wells • Cathodic protection wells

Bulletin 74-90

(Supplement to Bulletin 74-81)



California Department of Water Resources
June 1991

This bulletin is available free to all well drillers licensed by the State of California and local agencies that enforce these standards. It is available at a cost of $10 per copy to all others. Make checks payable to Department of Water Resources. California residents add current sales tax.

To order additional copies of this bulletin write or call:

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  Bulletins & Reports Section
  P. O. Box 942836
  Sacramento, CA 94236-0001
  (916) 445-9371

Questions or comments about this bulletin should be directed to:

- Well Standards Coordinator
  California Department of Water Resources
  Division of Local Assistance
  P.O. Box 942836
  Sacramento, CA 94236-0001
  (916) 445-9248

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Notice

This Bulletin is temporarily considered to be a draft. The California Department of Water Resources plans to adopt this Bulletin as final after a public review and comment period. The Department will announce in the future when this Bulletin is final. The Department will also announce any changes to this Bulletin. Announcement will be made through the Department's well standards mailing list.

This page should be removed from this Bulletin when it is announced that the Bulletin has been approved as final.

California Well Standards

Water wells • Monitoring wells • Cathodic protection wells

Bulletin 74-90

(Supplement to Bulletin 74-81)

David N. Kennedy
Director
Department of Water Resources

Douglas P. Wheeler
Secretary for Resources
The Resources Agency

Pete Wilson
Governor
State of California

California
Department
of Water Resources
June 1991

FOREWORD

During an average year about forty percent of California's water supply comes from ground water. Ground water is used for agricultural, industrial, domestic, and municipal water supplies. Protecting the quality of California's ground water is essential to California's future.

Improperly constructed wells can allow pollution of ground water to the point that the water is either unusable or it requires expensive treatment. The California Water Code requires the Department of Water Resources (DWR) to develop minimum standards for water wells, monitoring wells, and cathodic protection wells to protect ground water quality.

This bulletin is a supplement to DWR Bulletin 74-81, *Water Well Standards: State of California, December 1981*. Standards in Bulletin 74-81 and this bulletin are **minimum** requirements for construction, alteration, maintenance, and destruction of water wells, monitoring wells, and cathodic protection wells in California.

This bulletin was prepared in cooperation with the State Water Resources Control Board. The Board adopted a model water well, monitoring well, and cathodic protection well ordinance that implements DWR well standards. All California cities and counties, and some water agencies are required to enact local well ordinances that meet or exceed DWR standards, or they must enforce the Board's model ordinance as if it were their own.

Sometimes well standards adopted by local agencies must be more stringent than DWR's statewide standards because of local conditions. Local agencies play a critical role in protecting ground water quality.

Continued cooperation is needed between the public, industry, local agencies, and the State to ensure that these well standards remain adequate and are put into practice. California's water supply future depends on this cooperation.

David N. Kennedy, Director
Department of Water Resources

State of California
PETE WILSON, Governor

The Resources Agency
DOUGLAS P. WHEELER, Secretary for Resources

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The CALIFORNIA WATER COMMISSION serves as a policy advisory body to the Director of the Department of Water Resources on all California water resource matters. The nine-member citizen commission provides a water resources forum for the people of the State, acts as liaison between the legislative and executive branches of State government, and coordinates federal, State, and local water resources efforts.

CALIFORNIA WELL STANDARDS

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ACKNOWLEDGEMENTS

This bulletin was prepared after consideration of comments and suggestions from public agencies and private parties. State agencies that provided input include:

- State Water Resources Control Board,
- Regional Water Quality Control Boards,
- Department of Health Services, and,
- California Integrated Waste Management Board.

Many comments and suggestions were received from California cities, counties, and water agencies. Private parties that provided input include the California Groundwater Association, individual well contractors, well construction material and equipment suppliers, and consultants. The Department of Water Resources thanks all persons that provided comments during the preparation of this bulletin.

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Improperly constructed, altered, maintained, or destroyed wells are a potential pathway for introducing poor quality water, pollutants, and contaminants to good-quality ground water. The potential for ground water quality degradation increases as the number of wells and borings in an area increases.

Improperly constructed, altered, maintained, or destroyed wells can facilitate ground water quality degradation by allowing:

- Pollutants, contaminants, and water to enter a well bore or casing;
- Poor quality surface and subsurface water, pollutants, and contaminants to move between the casing and borehole wall;
- Poor quality ground water, pollutants, and contaminants to move from one stratum or aquifer to another; and,
- The well bore to be used for illegal waste disposal.

Permanently inactive or "abandoned" wells that have not been properly destroyed pose a serious threat to water quality. They are frequently forgotten and become dilapidated with time, and thus can become conduits for ground water quality degradation. In addition, humans and animals can fall into wells left open at the surface.

History of DWR Standards

The Department of Water Resources has responsibility for developing standards for wells for the protection of water quality under California Water Code Section 231. Water Code Section 231 was enacted in 1949.

Statewide standards for water wells were first formally published in 1968 as DWR Bulletin 74, *Water Well Standards: State of California*. Standards for cathodic protection wells followed in 1973 as Bulletin 74-1, *Cathodic Protection Well Standards: State of California*. Bulletins 74 and 74-1 are now out of print.

A revised edition of Bulletin 74 was published in 1981 as Bulletin 74-81 *Water Well Standards: State of California*. Bulletin 74-81 is enclosed in the back cover of this report.

The law for establishing and implementing well standards was changed significantly in 1986 by Assembly Bill 3127 and Senate Bill 1817 (now Chapters 1152 and 1373, Statutes of 1986). Assembly Bill 3127 (Water Code Section 13801) requires that:

(1) **By September 1, 1989**, the State Water Resources Control Board adopt a model well ordinance implementing DWR standards.

(2) **By January 15, 1990**, all counties and cities, and water agencies where appropriate, adopt a well ordinance that meets or exceeds DWR well standards.

(3) **By February 15, 1990**, the Board's model ordinance is to be enforced by any county, city, or water agency failing to adopt a well ordinance.

Senate Bill 1817 amended the Water Code to specifically include monitoring wells. It was previously assumed that monitoring wells were included in the collective term "well" used in the law.

As a first step in carrying out provisions of the amended law, the State Water Resources Control Board contracted with DWR to:

(1) Review and update water well standards in Bulletin 74-81;

(2) Establish minimum standards for monitoring wells; and,

(3) Update and replace cathodic protection well standards in Bulletin 74-1.

This Bulletin is a supplement to Bulletin 74-81. It was developed to satisfy the Department's contract with SWRCB, to respond to Department responsibilities under the Water Code, and to keep pace with technical advances during the ten-year period following publication of Bulletin 74-81.

An initial draft of this supplement was published in three sections and was sent to interested organizations and individuals for comment during the Fall of 1988. The Department held public hearings in Los Angeles, November 15, 1988 and in Oakland, November 17, 1988 to discuss the draft supplemental standards and receive public comment.

Several sets of written comments for the draft supplemental standards were received by DWR. Written and verbal comments on the standards were reviewed and appropriate changes were incorporated into *Final Draft Bulletin 74-90, California Well Standards; Water Wells, Monitoring Wells, Cathodic Protection Wells; Supplement to Bulletin 74-81*, January 1990.

Final Draft Bulletin 74-90 was published in November 1989 and was sent to interested organizations and individuals for comment. Comments were reviewed and appropriate changes were incorporated into this final bulletin.

Additional discussion on the history of DWR well standards is contained in Bulletin 74-81.

Relationship of DWR Well Standards Publications

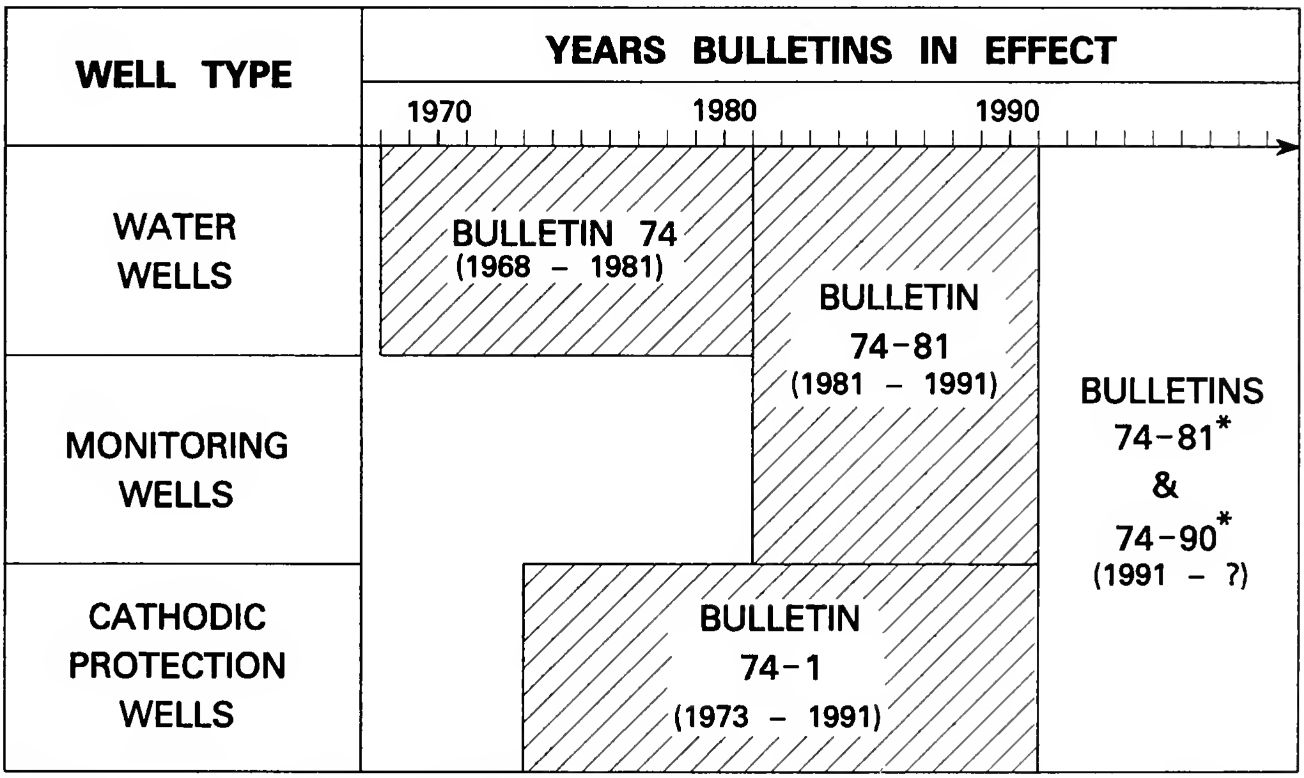
DWR Bulletins 74-81 and 74-1 provided the Department's standards for water wells and cathodic protection wells just prior to this supplement. DWR standards for monitoring wells were generally the same as for water wells prior to this supplement and were included in Bulletin 74-81. The relationship of the various DWR well standards bulletins is illustrated in Figure 1.

Revised standards for water wells in this supplement replace only portions of the water well standards contained in Bulletin 74-81. This supplement is to be used together with Bulletin 74-81 for a complete description of DWR Water Well Standards.

Monitoring well standards are presented separately in this supplement and are in parallel form to the water well standards. Because many physical similarities exist between water wells and monitoring wells, the water well standards are referred to frequently in the monitoring well standards. Water well and monitoring well standards must be considered together for the construction, alteration, maintenance, and destruction of monitoring wells.

Cathodic protection well standards in this supplement replace those in Bulletin 74-1. Because of similarities between cathodic protection wells and water wells, water wells standards are referred to frequently in the cathodic protection well standards. Cathodic protection well standards and water well standards must be considered together for the construction, alteration, maintenance, and destruction of cathodic protection wells.

Figure 1. YEARS DWR WELL STANDARDS BULLETINS IN EFFECT



* Both bulletins are now required for water well, monitoring well, and cathodic protection well standards.

Organization of This Supplement

Standards in this supplement are presented in three parts:

(1) Revisions of some water well standards in Bulletin 74-81.

(2) Standards for monitoring wells.

(3) Updated standards for cathodic protection wells that were originally published in Bulletin 74-1.

Selected technical terms used in this supplement are listed and defined in Appendix A. A list of references is contained in Appendix B.

Limitations of Standards

Well standards contained in Bulletin 74-81 together with well standards in this supplement (Bulletin 74-90) are recommended ***minimum*** statewide standards for the protection of ground water quality. ***The standards are not necessarily sufficient for local conditions.*** Local enforcing agencies may need to adopt more stringent standards for local conditions to ensure ground water quality protection.

In some cases, it may be necessary for a local enforcing agency to substitute alternate measures or standards to provide protection equal to that otherwise afforded by DWR standards. Such cases arise from practicalities in applying standards, and from variations in geologic and hydrologic conditions. Because it is impractical to prepare "site-specific" standards covering every conceivable case, provision has been made for deviation from the standards.

Standards in Bulletin 74-81 and this supplement (Bulletin 74-90) ***do not ensure*** proper construction or function of any type of well. Proper well design and construction practices require the use of these standards together with accepted industry practices, regulatory requirements, and consideration of site conditions.

It is the ultimate responsibility of the well owner and/or the owner's technical and/or contractor representative(s) to ensure that a well does not constitute a significant pathway for the movement of poor-quality water, pollutants, or contaminants; does not constitute a public nuisance or hazard; and, adequately performs a desired function. The Department accepts no responsibility for improper design, construction, alteration, maintenance, function, or destruction of individual wells.

Applicability

Construction standards presented in this supplement apply to all water wells, monitoring wells, and cathodic protection wells constructed after the date of this supplement. Alteration, maintenance, and destruction standards presented in this supplement apply to all water wells, monitoring wells, cathodic protection wells, and "borings" regardless of their original date of construction. Standards contained in Bulletin 74-81 remain in effect except where modified by this supplement (Bulletin 74-90).

WATER WELLS

REVISIONS TO WATER WELL STANDARDS

INTRODUCTION

Revisions to standards in DWR Bulletin 74-81, Chapter II, are presented in this section. All standards in Bulletin 74-81 that are not revised by this supplement (Bulletin 74-90) remain unchanged and in effect. The organization and numbering system used for the revisions is the same as that in Bulletin 74-81.

Table 1, page 10, below, lists portions of Bulletin 74-81 that are replaced by this supplement (Bulletin 74-90). The user of this supplement should strike-out the replaced sections and paragraphs in the copy of Bulletin 74-81 that is enclosed in the back cover of this supplement.

Table 1

Deletions in Bulletin 74-81

Page	Portions of Bulletin 74-81 Replaced by this Supplement, Bulletin 74-90
24	Subsection I
25	Subsections J and L
26	Subsection A of Section 8, and Footnote No. 3
27	Entire Page, Including All Footnotes
29	Entire Page, Including All Footnotes
30	Entire Page, Including All Footnotes
32	Remainder of Item 3
34	Subsection D, and All Footnotes
35	Entire Page, Including All Footnotes
36	Item 2, Item 3, and Item 4
39	Item 5, Subsection B, and All Footnotes
40	Subsection F, and Footnote No. 1
43	Item 3, and Footnote No. 1
44	Remainder of Item 3, and Both Footnotes
45	Item 5, and Item 6, Subsection B, and Both Footnotes
46	Remainder of Subsection B, Section 14
48	Remainder of Section 14
52	Section 21, Footnote No. 2
53	Remainder of Section 21, Item 1
54	Item 1

STANDARDS

Part I. General

Section 1. Definitions.

Definitions A through H, and K (page 23 of Bulletin 74-81) are unchanged. The definition for observation and monitoring wells under Definition I has been deleted and replaced with a definition for "exploration hole." Observation or monitoring wells are now addressed in monitoring well standards in this supplement.

The new definition under Definition I is:

"I. Exploration Hole (or Boring). An uncased, temporary excavation whose purpose is the determination of hydrologic conditions at a site."

Definitions J and L have been revised to read as follows:

"J. Test Wells. Wells constructed to obtain information needed for design of other wells. Test wells should not be confused with "exploration holes", which are temporary. Test wells are cased and can be converted to other uses such as ground water monitoring and, under certain circumstances, to production wells.

L. Enforcing Agency. An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of water wells. The California State Department of Health Services or the local health agency is the enforcing agency for community water supply wells."

Sections 2 through 7 (page 25 of Bulletin 74-81) are unchanged.

Part II. Well Construction

Section 8. Well Location With Respect to Pollutants and Contaminants, and Structures.

Note: The title of Section 8 has been revised.

Section 8 (page 26 of Bulletin 74-81) has been revised to read as follows:

"A. Separation. All water wells shall be located an adequate horizontal distance from known or potential sources of pollution and contamination. Such sources include, but are not limited to:

- sanitary, industrial, and storm sewers;
- septic tanks and leachfields;
- sewage and industrial waste ponds;
- barnyard and stable areas;
- feedlots;
- solid waste disposal sites;
- above and below ground tanks and pipelines for storage and conveyance of petroleum products or other chemicals; and,
- storage and preparation areas for pesticides, fertilizers, and other chemicals.

Consideration should also be given to adequate separation from sites or areas with known or suspected soil or water pollution or contamination.

The following horizontal separation distances are generally considered adequate where a significant layer of unsaturated, unconsolidated sediment less permeable than sand is encountered between ground surface and ground water. These distances are based on present knowledge and past experience. Local conditions may require greater separation distances to ensure ground water quality protection.

Potential Pollution or Contamination Source	Minimum Horizontal Separation Distance Between Well and Known or Potential Source
Any sewer line (sanitary, industrial, or storm; main or lateral)	50 feet
Watertight septic tank or subsurface sewage leaching field	100 feet
Cesspool or seepage pit	150 feet
Animal or fowl enclosure	100 feet

If the well is a radial collector well, minimum separation distances shall apply to the furthest extended point of the well.

Many variables are involved in determining the "safe" separation distance between a well and a potential source of pollution or contamination. No set separation distance is adequate and reasonable for all conditions. Determination of the safe separation distance for individual wells requires detailed evaluation of existing and future site conditions.

Where, in the opinion of the enforcing agency adverse conditions exist, the above separation distances shall be increased, or special means of protection, particularly in the construction of the well, shall be provided, such as increasing the length of the annular seal.

Lesser distances than those listed above may be acceptable where physical conditions preclude compliance with the specified minimum separation distances and where special means of protection are provided. Lesser separation distances must be approved by the enforcing agency on a case-by-case basis.

B. Gradients. Where possible, a well shall be located up the ground water gradient from potential sources of pollution or contamination. Locating wells up gradient from pollutant and contaminant sources can provide an extra measure of protection for a well. However, consideration should be given that the gradient near a well can be reversed by pumping, as shown in Figure 3 (page 28 of Bulletin 74-81), or by other influences.

C. Flooding and Drainage. If possible, a well should be located outside areas of flooding. The top of the well casing shall terminate above grade and above known levels of flooding caused by drainage or runoff from surrounding land. For community water supply wells, this level is defined as the:

> "...floodplain of a 100 year flood..." or above "...any recorded high tide...", (Section 64417, *Siting Requirements*, Title 22 of the California Code of Regulations.)

If compliance with the casing height requirement for community water supply wells and other water wells is not practical, the enforcing agency shall require alternate means of protection.

Surface drainage from areas near the well shall be directed away from the well. If necessary, the area around the well shall be built up so that drainage moves away from the well.

D. Accessibility. All wells shall be located an adequate distance from buildings and other structures to allow access for well modification, maintenance, repair, and destruction, unless otherwise approved by the enforcing agency."

Section 9. Sealing the Upper Annular Space.

Note: Sealing requirements are also described in Appendix B, page 67 of Bulletin 74-81.

Section 9 (page 29 of Bulletin 74-81) has been revised to read as follows:

"The space between the well casing and the wall of the drilled hole, often referred to as the annular space, shall be effectively sealed to prevent it from being a preferential pathway for movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of an annular seal are to protect casing against corrosion or degradation, ensure the structural integrity of the casing, and stabilize the borehole wall.

A. Minimum Depth of Annular Surface Seal. The annular surface seal for various types of water wells shall extend from ground surface to the following minimum depths:

Well Type	Minimum Depth Seal Must Extend Below Ground Surface
Community Water Supply	50 feet
Industrial	50 feet
Individual Domestic	20 feet
Agricultural	20 feet
Air-Conditioning	20 feet
All Other Types	20 feet

1. Shallow ground water. Exceptions to minimum seal depths can be made for shallow wells at the approval of the enforcing agency, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. The annular seal shall be no less than 10 feet in length.

   Caution shall be given to locating a well with a 'reduced' annular seal with respect to sources of pollution or contamination. Such precautions include horizontal separation distances greater than those listed in Section 8, page 12, above.

2. Encroachment on known or potential sources of pollution or contamination. When, at the approval of the enforcing agency, a water well is to be located closer to a source of pollution or contamination than allowed by Section 8, page 12, above, the annular space shall be sealed from ground surface to the first impervious stratum, if possible. The annular seal for all such wells shall extend to a minimum depth of 50 feet.

3. Areas of freezing. The top of an annular surface seal may be below ground surface in areas where freezing is likely, but in no case more than 4 feet below ground surface. 'Freezing' areas are those where the mean length of the freeze-free period described by the National Weather Service is less than 100 days. In other words, 'freezing' areas are where temperatures at or below 32 degrees Fahrenheit are likely to occur on any day during a period of 265 or more days each year. In general, these areas include:

   - portions of Modoc, Lassen, and Siskiyou Counties;
   - portions of the North Lahontan area including the eastern slope of the Sierra Nevada and related valleys north of Mount Whitney and Mono Lake; and,
   - the area of Lake Arrowhead in the San Bernardino Mountains.

4. Vaults. At the approval of the enforcing agency, the top of an annular surface seal and well casing can be below ground surface where traffic or other conditions require, if the seal and casing extend to a watertight and structurally sound subsurface vault, or equivalent feature. In no case shall the top of the annular surface seal be more

than 4 feet below ground surface. The vault shall extend from the top of the annular seal to at least ground surface.

The use of subsurface vaults to house the top of water wells below ground surface is rare and is discouraged due to susceptibility to the entrance of surface water, pollutants, and contaminants. Where appropriate, pitless adapters should be used in place of vaults.

B. Sealing Conditions. The following requirements are to be observed for sealing the annular space.

1. Wells drilled in unconsolidated, caving material. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled and a conductor casing temporarily installed to at least the minimum depth of annular seal specified in Subsection A, page 14, above. Permanent conductor casing may be used if it is installed in accordance with Item 3, page 16, below, and Item 5 (page 32 of Bulletin 74-81) and if it extends at least to the depth specified in Subsection A, above. One purpose of conductor casing is to hold the annular space open during well drilling and during the placement of the well casing and annular seal.

Temporary conductor casing shall be withdrawn as sealing material is placed between the well casing and borehole wall, as shown in Figure 4A (page 31 of Bulletin 74-81). Sealing material shall be placed at least within the interval specified in Subsection A, above. The sealing material shall be kept at a sufficient height above the bottom of the temporary conductor casing as it is withdrawn to prevent caving of the borehole wall.

Temporary conductor casing may be left in place in the borehole after the placement of the annular seal only if it is impossible to remove because of unforeseen conditions and not because of inadequate drilling equipment, or if its removal will seriously jeopardize the integrity of the well and the integrity of subsurface barriers to pollutant or contaminant movement. Temporary conductor casing may be left in place only at the approval of the enforcing agency on a case-by-case basis.

Every effort shall be made to place sealing material between the outside of temporary conductor casing that cannot be removed and the borehole wall to fill any possible gaps or voids between the conductor casing and the borehole wall. At least two inches of sealing material shall be maintained between the conductor casing and well casing. At a minimum, sealing material shall extend through intervals specified in Subsection A, above.

Sealing material can often be placed between temporary conductor casing that cannot be removed and the borehole wall by means of pressure grouting techniques, as described below and in Appendix B (page 67 of Bulletin 74-81). Other means of placing sealing material between the conductor casing and the borehole wall can be used, at the approval of the enforcing agency.

Pressure grouting shall be accomplished by perforating temporary conductor casing that cannot be removed, in place. The perforations are to provide passages for sealing material to pass through the conductor casing to fill any spaces and voids between the casing and borehole wall. Casing perforations shall be a suitable size and density to allow the passage of sealing materials through the casing and the proper distribution of sealing material in spaces between the casing and borehole wall. At a minimum, the perforations shall extend through the intervals specified in Subsection A, above, unless otherwise approved by the enforcing agency.

Temporary conductor casing that must be left in place shall be perforated immediately before sealing operations begin to prevent drilling or well construction operations from clogging casing perforations. Once the casing has been adequately perforated, sealing material shall be placed inside the conductor casing and subjected to sufficient pressure to cause the sealing material to pass through the conductor casing perforations and completely fill any spaces or voids between the casing and borehole wall, at least within the intervals specified in Subsection A, above. Sealing material shall consist of neat cement, or bentonite prepared from powdered bentonite and water, unless otherwise approved by the enforcing agency.

Sealing material must also fill the annular space between the conductor casing and the well casing within required sealing intervals.

2. <u>Wells drilled in unconsolidated material with significant clay layers</u>. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, page 14, above, and the annular space between the borehole wall and the well casing filled with sealing material in accordance with Subsection A, above (see Figure 4B, page 31 of Bulletin 74-81). If a significant layer of clay or clay-rich deposits of low permeability is encountered within 5 feet of the minimum seal depth prescribed in Subsection A, above, the annular seal shall be extended at least 5 feet into the clay layer. Thus, the depth of seal could be required to be extended as much as another 10 feet. If the clay layer is less than 5 feet in total thickness, the seal shall extend through its entire thickness.

If caving material is present within the interval specified in Subsection A, a temporary conductor casing shall be installed to hold the borehole open during well drilling and placement of the casing and annular seal, in accordance with the requirements of Item 1, page 15, above. Permanent conductor casing may be used if it is installed in accordance with Item 3, below and Item 5 (page 32 of Bulletin 74-81) and it extends to at least the depth specified in Subsection A, above.

3. <u>Wells drilled in soft consolidated formations (extensive clays, sandstones, etc.)</u>. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, page 14, above. The space between the well casing and the borehole shall be filled with sealing material to at least the depth specified in Subsection A, above, as shown by Figure 4C (page 31 of Bulletin 74-81).

If a permanent conductor casing is to be installed to facilitate the construction of the well, an oversized hole, at least 4 inches greater in diameter than the outside surface of the permanent conductor casing, shall be drilled to the bottom of the conductor casing or to at least the depth specified in Subsection A, above, and the annular space between the conductor casing and the borehole wall filled with sealing material. In some cases, such as in cable tool drilling, it may be necessary to extend permanent conductor casing beyond the depth of the required depth of the annular surface seal in order to maintain the borehole. Sealing material is not required between conductor casing and the borehole wall other than the depths specified in Subsection A, above, and Section 13, below (page 46 of Bulletin 74-81)."

Items 4 through 7 (page 32 of Bulletin 74-81) are unchanged. Item 8 has been added, as follows:

"8. Wells that penetrate zones containing poor-quality water, pollutants, or contaminants. If geologic units or fill known or suspected to contain poor-quality water, pollutants, or contaminants are penetrated during drilling, and, the possibility exists that poor-quality water, pollutants, or contaminants could move through the borehole during drilling and well construction operations and significantly degrade ground water quality in other units before sealing material can be installed, then precautions shall be taken to seal off or 'isolate' zones containing poor-quality water, pollutants, and contaminants during drilling and well construction operations. Special precautions could include the use of temporary or permanent conductor casing, borehole liners, and specialized drilling equipment. The use of conductor casing is described in Item 1, page 15, above."

Subsection C (page 34 of Bulletin 74-81) is unchanged. Subsections D, E, and F (page 34 of Bulletin 74-81) have been changed to read as follows:

"D. Sealing Material. Sealing material shall consist of neat cement, sand cement, concrete, or bentonite. Cuttings from drilling, or drilling mud, shall not be used for any part of the sealing material.

1. Water. Water used to prepare sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, be free of petroleum and petroleum products, and be free of suspended matter. In some cases water considered nonpotable, with a maximum of 2,000 milligrams per liter chloride and 1,500 mg/l sulfate, can be used for cement-based sealing mixtures. The quality of water to be used for sealing mixtures shall be determined where unknown.

2. Cement. Cement used in sealing mixtures shall meet the requirements of American Society for Testing and Materials C150, *Standard Specification for Portland Cement*, including the latest revisions thereof.

   Types of Portland cement available under ASTM C150 for general construction are:

   Type I - General purpose. Similar to American Petroleum Institute Class A.

   Type II - Moderate resistance to sulfate. Lower heat of hydration than Type I. Similar to API Class B.

   Type III - High early strength. Reduced curing time but higher heat of hydration than Type I. Similar to API Class C.

   Type IV - Extended setting time. Lower heat of hydration than Types I and III.

   Type V - High sulfate resistance.

   Special cement setting accelerators and retardants and other additives may be used in some cases. Special field additives for Portland cement mixtures shall meet the requirements of ASTM C494, *Standard Specification for Chemical Admixtures for Concrete*, and latest revision thereof.

Water wells

Hydrated lime may be added up to 10 percent of the volume of cement used to make the seal mix more fluid. Bentonite may be added to cement-based mixes, up to 6 percent by weight of cement used, to improve fluid characteristics of the sealing mix and reduce the rate of heat generation during setting.

Dry additives should be mixed with dry cement before adding water to the mixture to ensure proper mixing, uniformity of hydration, and an effective and homogeneous seal. The water demand of additives shall be taken into account when water is added to the mix.

Minimum times required for sealing materials containing Portland cement to set and begin curing before construction operations on a well can be resumed are:

- Types I and II cement - 24 hours
- Type III cement - 12 hours
- Type V cement - 6 hours

Type IV cement is seldom used for annular seals because of its extended setting time.

Allowable setting times may be reduced or lengthened by use of accelerators or retardants specifically designed to modify setting time, at the approval of the enforcing agency.

More time shall be required for cement-based seals to cure to allow greater strength when construction or development operations following the placement of the seal may subject casing and sealing materials to significant stress. Subjecting a well to significant stress before a cement-based sealing material has adequately cured can damage the seal and prevent proper bonding of cement-based sealants to casing(s).

If plastic well casing is used, care shall be exercised to control the heat of hydration generated during the setting and curing of cement in an annular seal. Heat can cause plastic casing to weaken and collapse. Heat generation is a special concern if thin-wall plastic well casing is used, if the well casing will be subject to significant net external pressure before the setting of the seal, and/or if the radial thickness of the annular seal is large. Additives that accelerate cement setting also tend to increase the rate of heat generation during setting and, thus, should be used with caution where plastic casing is employed.

The temperature of a setting cement seal can be lowered by circulating water inside the well casing and/or by adding bentonite to the cement mixture, up to 6 percent by weight of cement used.

Cement-based sealing material shall be constituted as follows:

a. <u>Neat Cement</u>. For Types I or II Portland cement, neat cement shall be mixed at a ratio of one 94-pound sack of Portland cement to 5 to 6 gallons of 'clean' water. Additional water may be required where special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

b. <u>Sand Cement</u>. Sand-cement shall be mixed at a ratio of not more than 188 pounds of sand to one 94-pound sack of Portland cement (2 parts sand to 1 part cement, by weight) and about 7 gallons of clean water, where Type I or Type II Portland cement is used. This is equivalent to a '10.3 sack mix.' Less water shall be used if less sand than 2 parts sand per one part cement by weight is used. Additional water may be required when special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

c. Concrete. Concrete is often useful for large volume annular seals, such as in large-diameter wells. The proper use of aggregate can decrease the permeability of the annular seal, reduce shrinkage, and reduce the heat of hydration generated by the seal.

   Concrete shall consist of Portland cement and aggregate mixed at a ratio of at least six-94 pound sacks of Portland cement per cubic yard of aggregate. A popular concrete mix consists of eight-94 pound sacks of Type I or Type II Portland cement per cubic yard of uniform 3/8-inch aggregate.

   In no case shall the size of the aggregate be more than 1/5 the radial thickness of the annular seal. Water shall be added to concrete mixes to attain proper consistency for placement, setting, and curing.

d. Mixing. Cement-based sealing materials shall be mixed thoroughly to provide uniformity and ensure that no 'lumps' exist.

Ratios of the components of cement-based sealing materials can be varied depending on the type of cement and additives used. Variations must be approved by the enforcing agency.

3. Bentonite. Bentonite clay in 'gel' form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture.

   Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volume when hydrated. Only bentonite clay is an acceptable clay for annular seals.

   Unamended bentonite clay seals should not be used where structural strength of the seal is required, or where it will dry. Bentonite seals may have a tendency to dry, shrink and crack in arid and semi-arid areas of California where subsurface moisture levels can be low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.

   Bentonite clay shall not be used as a sealing material if roots from trees and other deep rooted plants might invade and disrupt the seal, and/or damage the well casing. Roots may grow in an interval containing a bentonite seal depending on surrounding soil conditions and vegetation.

   Bentonite-based sealing material shall not be used for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material, unless otherwise approved by the enforcing agency. Bentonite clay shall not be used as a sealing material where flowing water might erode it.

   Bentonite clay products used for sealing material must be specifically prepared for such use. Used drilling mud and/or cuttings from drilling shall not be used in sealing material.

Bentonite used for annular seals shall be commercially prepared, powdered, granulated, pelletized, or chipped/crushed sodium montmorillonite clay. The largest dimension of pellets or chips shall be less than 1/5 the radial thickness of the annular space into which they are placed.

Bentonite clay mixtures shall be thoroughly mixed with clean water ***prior to placement***. A sufficient amount of water shall be added to bentonite to allow proper hydration. Depending on the bentonite sealing mixture used, 1 gallon of water should be added to about every 2 pounds of bentonite. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Bentonite preparations normally require 1/2 to 1 hour to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.

Dry bentonite pellets or chips may be placed directly into the annular space below water, where a short section of annular space, up to 10 feet in length, is to be sealed. Care shall be taken to prevent bridging during the placement of bentonite seal material.

E. Radial Thickness of Seal. A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except where temporary conductor casing cannot be removed, as noted in Subsection B, page 15, above. A minimum of two inches of sealing material shall also be maintained between each casing, such as permanent conductor casing, well casing, gravel fill pipes, etc., in a borehole within the interval to be sealed, unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, for casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

F. Placement of Seal.

1. Obstructions. All loose cuttings, or other obstructions to sealing shall be removed from the annular space before placement of the annular seal.

2. Centralizers. Well casing shall be equipped with centering guides or 'centralizers' to ensure the 2-inch minimum radial thickness of the annular seal is at least maintained. Centralizers need not be used in cases where the well casing is centered in the borehole during well construction by use of removable tools, such as hollow-stem augers.

   The spacing of centralizers is normally dictated by the casing materials used, the orientation and straightness of the borehole, and the method used to install the casing.

   Centralizers shall be metal, plastic, or other non-degradable material. Wood shall not be used as a centralizer material. Centralizers must be positioned to allow the proper placement of sealing material around casing within the interval to be sealed.

   Any metallic component of a centralizer used with metallic casing shall consist of the same material as the casing. Metallic centralizer components shall meet the same metallurgical specifications and standards as the metallic casing to reduce the potential for galvanic corrosion of the casing.

3. Foundation and Transition Seals. A packer or similar retaining device, or a small quantity of sealant that is allowed to set, can be placed at the bottom of the interval to be sealed before final sealing operations begin to form a foundation for the seal.

A transition seal, up to 5 feet in length, consisting of bentonite, is sometimes placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grained sand, usually less than 2 feet in length, is sometimes placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-sized forms of bentonite, such as granules and powder, are usually employed for transition seals if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by use of a tremie pipe, or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in dry form or as slurry for use in transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, 1/2 to 1 hour is required for proper hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sounded to ensure that no bridging has occurred during placement.

4. Timing and Method of Placement. The annular space shall be sealed as soon as practical after completion of drilling or a stage of drilling. In no case shall the annular space be left unsealed longer than 14 days following the installation of casing.

Sealing material shall be placed in one continuous operation from the bottom of the interval to be sealed, to the top of the interval. Where the seal is more than 100 feet in length, the deepest portion of the seal may be installed first and allowed to set or partially set. The deep initial seal shall be no longer than 10 feet in length. The remainder of the seal shall be placed above the initial segment in one continuous operation.

Sealing material shall be placed by methods (such as the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing material, or separation of sand or aggregate from the sealing material. Annular sealing materials shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

5. Ground Water Flow. Special care shall be used to restrict the flow of ground water into a well boring while placing material, where subsurface pressure causing the flow of water is significant.

6. Verification. It shall be verified that the volume of sealing material placed at least equals or exceeds the volume to be sealed.

7. Pressure. Pressure required for placement of sealing materials shall be maintained long enough for cement-based sealing materials to properly set."

Section 10. Surface Construction Features.

Subsection A, Item 5; Subsection B; and Subsection F (page 39 of Bulletin 74-81) have been changed. The remainder of Section 10 (page 36 of Bulletin 74-81) is unchanged.

"A. Openings.

5. Bases. A concrete base or pad, sometimes called a pump block or pump pedestal, shall be constructed at ground surface around the top of the well casing and contact the annular seal, unless the top of the casing is below ground surface, as provided by Subsection B, page 23, below.

The base shall be free of cracks, voids, or other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing, must be water tight and must not cause the failure of the annular seal or well casing. Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

The upper surface of the base shall slope away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency. The base shall be a minimum of 4 inches thick.

A minimum base thickness of 4 inches is normally acceptable for small diameter, single-user domestic wells. The base thickness should be increased for larger wells. Shape and design requirements for well pump bases vary with the size, weight, and type of pumping equipment to be installed, engineering properties of the soil on which the base is to be placed, and local environmental conditions. A large variety of base designs have been used. The Vertical Turbine Pump Association has developed a standard base design for large lineshaft turbine pumps. This design consists of a square, concrete pump base whose design is dependent on bearing weight and site soil characteristics.

Where freezing conditions require the use of a pitless adapter, and the well casing and annular seal do not extend above ground surface or into a pit or vault, a concrete base or pad shall be constructed as a permanent location monument for the covered well. The base shall be 3 feet in length on each side and 4 inches in thickness, unless otherwise approved by the enforcing agency. The base shall have a lift-out section, or equivalent, to allow access to the well. The lift-out shall facilitate inspection and repair of the well.

B. Well Pits or Vaults. The use of well pits, vaults, or equivalent features to house the top of a well casing below ground surface shall be avoided, if possible, because of their susceptibility to the entrance of poor-quality water, contaminants and pollutants. Well pits or vaults can only be used if approval is obtained from the enforcing agency. A substitute device, such as a pitless adapter or pitless adapter unit (a variation), should almost always be used in place of a vault or pit.

Pitless adapters and units were developed for use in areas where prolonged freezing occurs, and below ground (frost line) discharges are common. Both the National Sanitation Foundation and Water Systems Council have developed standards for the manufacture and installation of pitless adapters and units. (See Appendix E, Bibliography, page 85 of Bulletin 74-81.)

If a pit or vault is used it shall be watertight and structurally sound. The vault shall extend from the top of the annular seal to at least ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing, if any, shall not fail or cause the failure of the well casing or annular seal.

Where cement-based annular seal materials are used, the vault shall be set into or contact the annular seal material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault should be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation.

The sealing material surrounding a vault shall extend from the top of the annular seal to ground surface unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be emplaced in a 'continuous pour'. In other words, cement-based sealing material shall be placed between the vault and excavation and contact the cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access. The outside of the lid shall be clearly and permanently labeled 'WATER WELL'. The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at, or above, grade so that drainage is away from the vault. The top of the well casing contained within the vault shall be covered in accordance with requirements under Subsection A, above, (page 36, Bulletin 74-81) so that water, contaminants, and pollutants that may enter the vault will not enter the well casing. The cover shall be provided with a pressure relief or venting device for gases.

F. Backflow Prevention. All pump discharge pipes not discharging or open to the atmosphere shall be equipped with an automatic device to prevent backflow and/or back siphonage into a well. Specific backflow prevention measures are required for drinking water supply wells, as prescribed in Title 17, Public Health, California Code of Regulations (Sections 7583-7585 and 7601-7605, effective June 25, 1987).

Irrigation well systems, including those used for landscape irrigation, and other well systems that employ, or which have been modified to employ, chemical feeders or injectors shall be equipped with a backflow prevention device(s) approved by the enforcing agency."

Section 12. Casing.

Items 3, 5, and 6 of Subsection A (page 43 of Bulletin 74-81) have been revised. The remainder of Subsection A is unchanged. Subsection B (page 45 of Bulletin 74-81) has been revised. The revisions are as follows:

"A. Casing Material.

3. Plastic. Two basic types of plastic are commonly used for plastic well casing: thermoplastics and thermosets. **Thermoplastics** soften with the application of heat and reharden when cooled. Thermoplastics can be reformed repeatedly using heat and sometimes can unexpectedly deform. Attention should be given to the effect of heat on thermoplastic casing from the setting and curing of cement. Additional discussion on sealing material and heat generation is in Section 9, Subsection D, 'Sealing Material'.

Thermoplastics used for well casing include ABS (acrylonitrile butadiene styrene), PVC (polyvinyl chloride), and SR (styrene rubber). PVC is the most frequently used thermoplastic well casing in California. Styrene rubber is seldom used.

Unlike thermoplastics, **thermoset** plastics cannot be reformed after heating. The molecules of thermoset plastic are 'set' during manufacturing by heat, chemical action, or a combination of both. The thermoset plastic most commonly used for well casing is fiberglass.

a. Thermoplastics. Thermoplastic well casing shall meet the requirements of ASTM F480, *Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80,* including the latest revision thereof. (*Note*: A 'dimension ratio' is the ratio of pipe diameter to pipe wall thickness.)

Pipe made in Schedule 40 and 80 wall thicknesses and pipe designated according to certain pressure classifications are listed in ASTM F480, as well as casing specials referencing the following ASTM specifications:

(1) ABS Pipe. ASTM D1527, *Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.*

(2) PVC Pipe. ASTM D1785, *Standard Specification for (Poly Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.*

(3) Pressure-Rated PVC Pipe. ASTM D2241, *Standard Specifications for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).*

Thermoplastic well casing that may be subject to significant impact stress during or after installation shall meet or exceed the requirements for impact resistance classification set forth in Section 6.5 of ASTM F480. Casing that may be subject to significant impact forces includes, but is not limited to; casing that is installed in large diameter, deep boreholes; and casing through which drilling tools pass following installation of the casing in a borehole.

b. Thermoset Plastics. Thermoset casing material shall meet the following specifications, as applicable, including the latest revisions thereof:

(1) Filament Wound Resin Pipe. ASTM D2996, *Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe.*

(2) Centrifugally Cast Resin Pipe. ASTM D2997, *Standard Specification for Centrifugally Cast Reinforced Thermosetting Resin Pipe.*

(3) Reinforced Plastic Mortar Pressure Pipe. ASTM D3517, *Standard Specification for Reinforced Plastic Mortar Pressure Pipe.*

(4) Glass Fiber Reinforced Resin Pressure Pipe. AWWA[1] C950, *AWWA Standard for Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe.*

c. Drinking Water Supply. All plastic casing used for drinking water supply wells, including community supply well and individual domestic wells, shall meet the provisions of National Sanitation Foundation Standard No. 14, *Plastic Piping Components and Related Materials* and any revision thereof. The casing shall be marked or labeled following requirements in NSF Standard No. 14. Standard No. 14 includes the requirements of ASTM F480.

d. Storage, Handling, and Transportation. Plastic casing shall not be stored in direct sunlight or subjected to freezing temperatures for extended periods of time. Plastic casing shall be stored, handled, and transported in a manner that prevents excessive mechanical stress. Casing shall be protected from sagging and bending, severe impacts and loads, and potentially harmful chemicals.

e. Large Diameter Wells. Because large diameter plastic casing has not been used extensively at depths exceeding 500 feet, special care shall be exercised with its use in deep wells.

5. Unacceptable Casing Materials. Galvanized sheet metal pipe such as 'downspout,' tile pipe, or natural wood shall not be used as well casing.

6. Other Materials. Materials in addition to those described above may be used as well casing, subject to enforcing agency approval."

Subsection B (page 45 of Bulletin 74-81) has been revised as follows:

"B. Casing Installation. All well casing shall be assembled and installed with sufficient care to prevent damage to casing sections and joints. All casing joints above intervals of perforations

[1] American Water Works Association.

or screen shall be watertight. Any perforations shall be below the depths specified in Section 9, Subsection A, page 14, above.

Casing shall be equipped with centering guides or 'centralizers' to ensure the even radial thickness of the annular seal and filter pack.

1. Metallic Casing. Metallic casing may be joined by welds, threads, or threaded couplings. Welding shall be accomplished in accordance with the standards of the American Welding Society or the most recent revision of the American Society of Mechanical Engineers Boiler Construction Code. Metallic casing shall be equipped with a 'drive shoe' at the lower end if it is driven into place.

2. Plastic Casing. Plastic casing may be joined by solvent welding or mechanically joined by threads or other means, depending on the type of material and its fabrication. Solvent cement used for solvent welding shall meet specifications for the type of plastic casing used. Solvent cement shall be applied in accordance with solvent and casing manufacturer instructions. Particular attention shall be given to instructions pertaining to required setting time for joints to develop strength.

   The following specifications for solvent cements and joints for PVC casing shall be met, including the latest revisions thereof:

   a. ASTM D2564, *Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.*

   b. ASTM D2855, *Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.*

   Plastic casing or screen shall not be subjected to excessive stress during installation and shall not be driven into place. Care shall be taken to ensure that plastic casing and joints are not subjected to excessive heat from cement-based sealing material.

   A specifically designed adapter shall be used to join plastic casing to metallic casing or screen."

Section 14. Well Development.

Section 14 (page 46 of Bulletin 74-81) has been revised as follows:

"Development, redevelopment, or reconditioning of a well shall be performed with care, by methods that will not damage the well structure or destroy natural barriers to the movement of poor quality water, pollutants, and contaminants.

Acceptable well development, redevelopment, or reconditioning methods include:

- Overpumping;
- Surging or swabbing by use of 'plungers';
- Surging with compressed air;
- Backwashing or surging by alternately starting and stopping a pump;
- Jetting with water;

- Introducing specifically-formulated chemicals into a well; and,
- Combinations of the above.

Hydraulic fracturing (hydrofracturing) is sometimes an acceptable well development and redevelopment method when properly performed. Good quality water shall be used in hydrofracturing. The water shall be disinfected prior to introduction into a well. Material used as 'propping' agents shall be free of pollutants and contaminants, shall be compatible with the use of a well, and shall be thoroughly washed and disinfected prior to placement in a well.

Development, redevelopment, or reconditioning by use of specially designed **explosive charges** is in some cases, another acceptable development method. Explosives shall be used with special care to prevent damage to the well structure and to any natural barriers to the movement of poor-quality water, pollutants, and contaminants. Explosives shall only be used by properly-trained personnel.

Wells subjected to chemicals or explosives during development, redevelopment, or reconditioning operations shall be thoroughly pumped to remove such agents and residues immediately after the completion of operations. Chemicals, water, and other wastes removed from the well shall be disposed of in accordance with applicable local, State, and federal requirements. The enforcing agency should be contacted regarding the proper disposal of waste."

Part III. Destruction of Wells

Section 21. Definition of "Abandoned" Well.

Section 21 (page 52 of Bulletin 74-81) has been revised as follows:

"A well is considered 'abandoned' or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. In accordance with Section 24400 of the California Health and Safety Code, the well owner shall properly maintain an inactive well as evidence of intention for future use in such a way that the following requirements are met:

"(1) The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.

(2) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(3) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

If a pump has been temporarily removed for repair or replacement, the well shall not be considered 'abandoned' if the above conditions are met. The well shall be adequately covered to prevent injury to people and animals and to prevent the entrance of foreign material, surface water, pollutants, or contaminants into the well during the pump repair period."

Section 23. Requirements for Destroying Wells.

Subsection A, Item 1 (page 53 of Bulletin 74-81) and Subsection B, Item 1, (page 54, of Bulletin 74-81) have been changed. The remainder of Section 23 is unchanged.

Subsection A, Item 1 has been revised as follows:

"1. Obstructions. The well shall be cleaned, as needed, so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction are removed for disposal.

The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency.

The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed."

Subsection B, Item 1 has been revised as follows:

"1. Wells situated in unconsolidated material in an unconfined ground water zone. In all cases the upper 20 feet of the well shall be sealed with suitable sealing material and the remainder of the well shall be filled with suitable fill, or sealing material. (See Figure 9A, page 55 of Bulletin 74-81.)"

MONITORING WELLS

MONITORING WELL STANDARDS

INTRODUCTION

Ground water monitoring wells are principally used for observing ground water levels and flow conditions, obtaining samples for determining ground water quality, and for evaluating hydraulic properties of water-bearing strata. Monitoring wells are sometimes referred to as "observation wells."

The quality of water intercepted by a monitoring well can range from drinking water to highly polluted water. In contrast, production or "water wells" are usually designed to obtain water from productive zones containing good-quality water.

The screen or perforated section of a monitoring well usually extends only a short length to obtain water from, or to monitor conditions within, an individual water-bearing unit or zone. Water wells are often designed to obtain water from multiple water-bearing strata. Although there are usually differences between the design and function of monitoring wells and water wells, water wells sometimes are used as monitoring wells, and vice versa.

Monitoring wells, along with other types of wells, can provide a pathway for the movement of poor-quality water, pollutants, and contaminants. Because monitoring wells are often purposely located in areas affected by pollutants and contaminants, they pose an especially significant threat to ground water quality if they are not properly constructed, altered, maintained, and destroyed.

The California Legislature amended the California Water Code in 1986 specifically to include requirements for monitoring well standards. Monitoring wells were previously assumed by the Department to be covered by the collective term "well" in the law.

History of Monitoring Wells

Monitoring wells were first used mainly for water level measurement. These wells were often referred to as piezometers in reference to the "piezometric surface" of ground water. In recent years, the term "piezometric surface" is often replaced by "potentiometric surface." However, the term "piezometer" is still sometimes used for monitoring wells installed only for water level measurement.

Many water level monitoring wells constructed in the past were relatively large in diameter in comparison to today's monitoring wells. Wells up to 10-inches in diameter were often constructed to accommodate various means of water level measurement, including floats for mechanically-operated, continuous water level recorders. Many inactive water wells that could accommodate mechanical water level recording equipment were used as monitoring wells.

Modern electronic water level measuring and recording devices now allow for small-diameter water-level monitoring wells. Some continuous water-level measurement devices can be used in wells less than 2-inches in inside diameter.

The use of monitoring wells for ground water sampling for chemical analysis has increased significantly in the past two decades. The following factors have all served to increase the frequency and scope of ground water quality investigations and the number of monitoring wells constructed:

- Advances in analytical and environmental chemistry;
- Increased knowledge of the adverse effects of chemicals on humans;
- Public awareness of ground water pollution;
- The advent of federal ground water quality protection legislation in the 1970s, and,
- Statutes relating to ground water quality enacted by the California Legislature.

Since the 1970s an entire industry has developed around ground water quality monitoring and monitoring well construction. Numerous private firms are involved in providing technical services for the design and implementation of ground water quality investigations. Many firms are involved in the manufacture, distribution, and marketing of materials and equipment used in constructing and operating monitoring wells.

Most monitoring wells constructed today are used to assess:

- The nature and distribution of pollutants and contaminants in ground water;
- The nature and distribution of naturally occurring chemical constituents;
- Subsurface hydrologic conditions; and,
- Hydraulic properties of strata as they relate to pollutant and contaminant movement.

Some monitoring wells are designed to be multipurpose. Monitoring wells can sometimes be used as "extraction" or "injection" wells for mitigation of pollution or contamination.

Although a significant number of monitoring wells constructed today are for detection and assessment of ground water quality impairment, many monitoring wells are constructed for evaluating ground water supply conditions by allowing ground water level measurement and/or aquifer testing. Still others are constructed for observing water levels associated with excavations and irrigated agriculture.

During 1989, approximately 20 percent of all well drilling in California was for monitoring wells, based on well driller's reports received by the Department of Water Resources. Monitoring wells have been constructed in nearly all California counties. The largest concentrations of water quality monitoring wells occur in metropolitan areas of the State. Large numbers of monitoring wells are installed for detection and assessment of leaks from underground storage tanks.

Types of Monitoring Wells

For the purpose of these standards, the term "monitoring well" is limited to wells designed to monitor subsurface water in the saturated zone, existing at or above atmospheric pressure (ground water); rather than water, water vapor, and/or gases contained in the unsaturated or vadose zone. Monitoring devices used for the unsaturated zone differ significantly from those used for the saturated (ground water) zone.

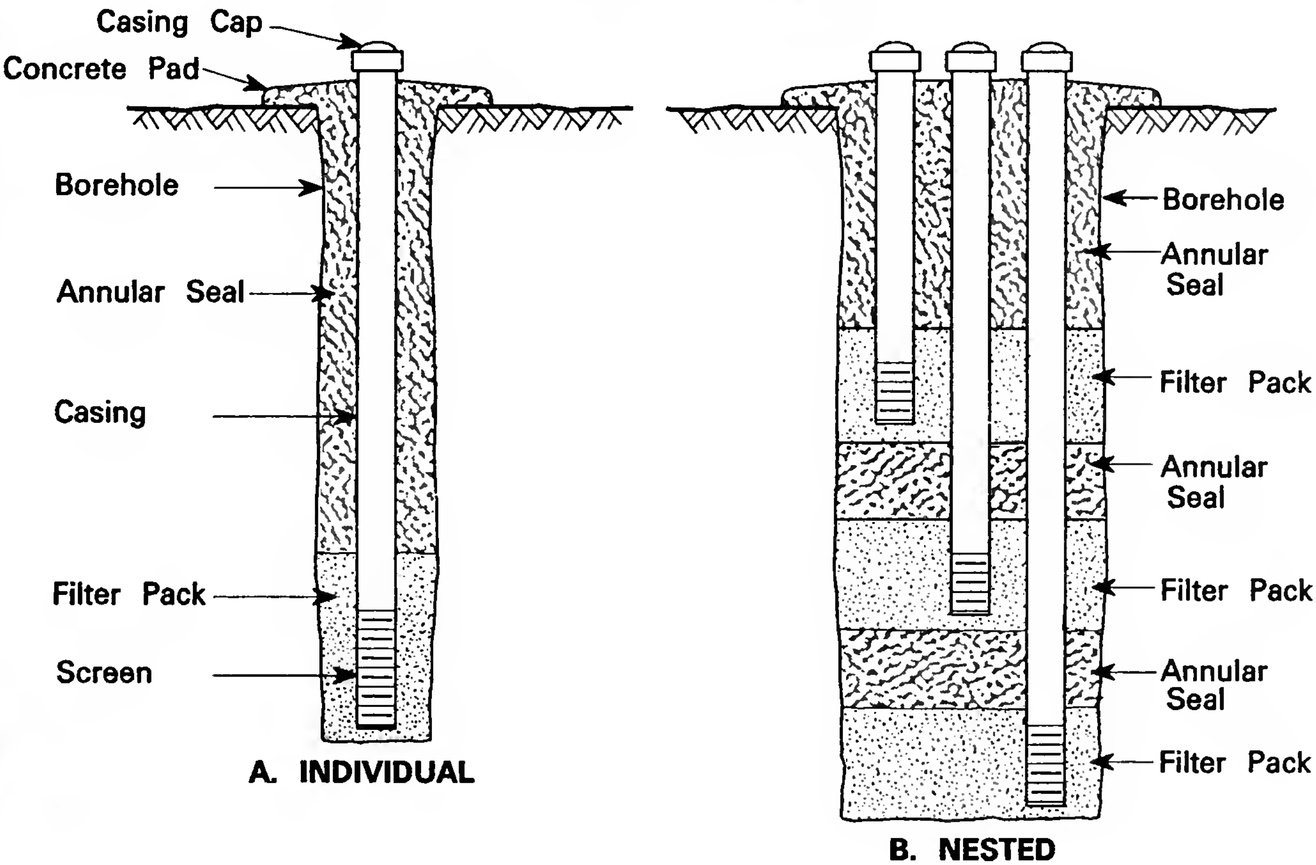
As shown in Figure 2, three basic types of monitoring wells or "installations" are:

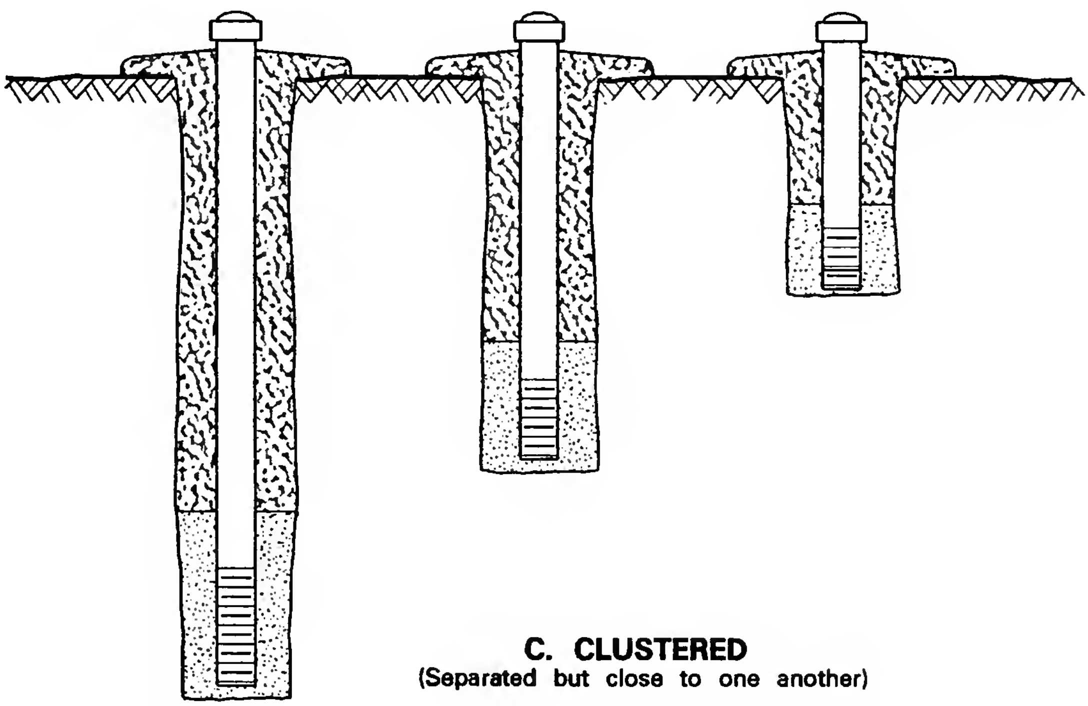
- Individual monitoring wells;
- Nested monitoring wells; and,
- Clustered monitoring wells.

Individual monitoring wells consist of a single casing "string" within a borehole, as illustrated in Figures 2 and 3. Individual monitoring wells are installed in unique locations apart from one another. They are the most common type of monitoring well constructed in California.

Figure 2. MONITORING WELL TYPES

(NOTE: Schematic, not to scale)

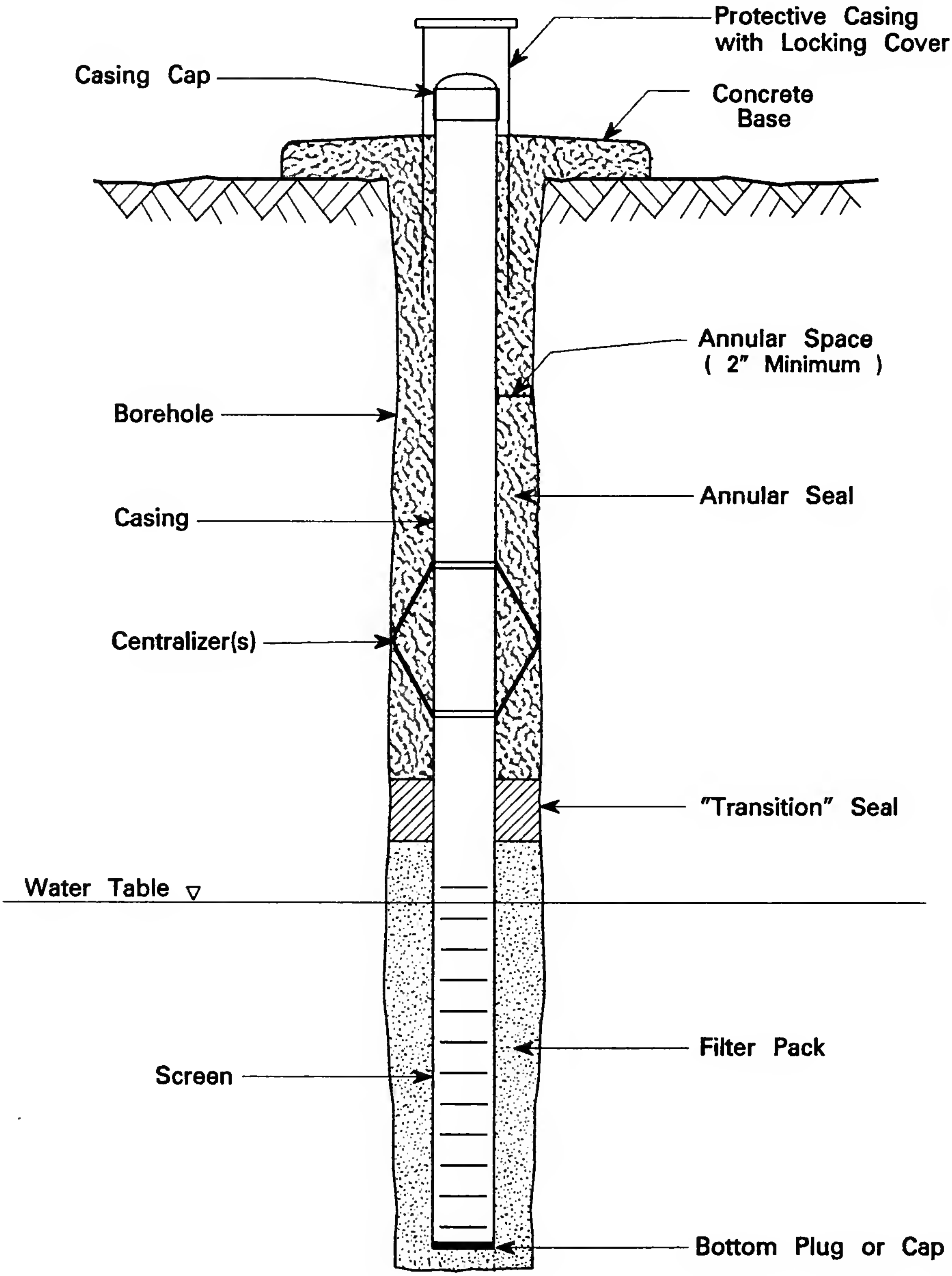




C. CLUSTERED
(Separated but close to one another)

Monitoring wells

Figure 3. CROSS SECTION OF A TYPICAL MONITORING WELL
(NOTE: Schematic, not to scale)



Nested monitoring wells consist of two or more casing strings within the same borehole. Normally the screened interval of each casing string is designed to obtain water from different aquifers or water-bearing zones. The purpose of a nested monitoring well is much the same as clustered monitoring wells.

Clustered monitoring wells consist of individual monitoring wells situated close together, but not in the same borehole. The wells within a cluster are normally constructed to obtain water from different aquifers or water-bearing zones. Clustered wells are most often used for monitoring ground water conditions at various depths in roughly the same area.

A nested monitoring well can be difficult to construct because of multiple casings within the same borehole. Care is required during construction to ensure water-bearing zones for each casing string are hydraulically isolated from one another and the annular seals are effective. Some regulatory agencies may prohibit the use of nested monitoring wells for certain contamination or pollution investigations. Normally this can be due to uncertainties about whether water-bearing strata can be isolated and whether the annular seals in a nested well are always effective.

Individual casing strings for the various types of monitoring wells discussed above, are sometimes designed to obtain water from more than one aquifer or water-bearing unit. These casing strings usually have multiple intervals of openings or screen. Such well casing strings, often referred to as "multi-level monitoring wells," can sometimes serve as a preferential pathway for the movement of poor quality water, pollutants, and contaminants from one unit to another. Some regulatory agencies prohibit the use of multi-level monitoring wells for certain pollution or contamination investigations out of concern for water quality protection and data quality requirements.

Authority and Responsibilities of Other Agencies

As discussed above, Congress enacted major legislation dealing with ground water quality protection during the 1970s. Regulatory programs initiated by federal legislation, such as the Resources Conservation and Recovery Act (RCRA) and its amendments, are administered by the U. S. Environmental Protection Agency. Some administration and enforcement activities related to federal legislation have been delegated to California State agencies.

The California Legislature enacted legislation expanding efforts for ground water quality protection in California beyond federal requirements. The Legislature assigned several State agencies various responsibilities for investigation, mitigation, and control of ground water pollution and contamination.

The lead enforcement agency for most ground water quality protection issues in California is the State Water Resources Control Board (State Board) and the nine California Regional Water Quality Control Boards (Regional Boards). The State Board oversees the activities of the nine regional boards.

The Department of Health Services or, under some circumstances, the U. S. Environmental Protection Agency, is the lead enforcement agency for ground water quality issues related to hazardous wastes.

The EPA, the Department of Health Services, and the State Board have adopted regulations or standards establishing monitoring requirements for "waste facilities". These regulations or standards include requirements for design and performance of monitoring wells that are often more stringent than standards in this bulletin.

Other State government organizations concerned or directly involved with ground water quality assessment or protection in California include:

- Department of Conservation, Division of Oil and Gas,

- Department of Food and Agriculture,
- Integrated Waste Management Board, and,
- Department of Water Resources.

California cities, counties, and local water agencies are also involved with ground water quality assessment and protection.

The Division of Oil and Gas has authority and responsibility for geothermal wells and other special wells constructed in the State's Geothermal Resources Areas (pursuant to Chapter 4, Division 3, California Public Resources Code). Shallow wells drilled for geothermal observation are subject to regulations and standards established by DOG.

After July 17, 1991 the California Environmental Protection Agency will oversee the activities of the State Water Resources Control Board and the Integrated Waste Management Board. Some of the environmental protection activities of the Department of Health Services and the Department of Food and Agriculture will also come under the California Environmental Protection Agency.

Scope, Organization, and Limitations of Standards

Certain standards that apply to water wells also apply to monitoring wells. Therefore the Monitoring Well Standards refer frequently to the Water Well Standards. Standards that apply only to monitoring wells, or that require emphasis, are discussed in detail in the Monitoring Well Standards. The Monitoring Well Standards are arranged in a format similar to the Water Well Standards.

These standards are not intended as a complete manual for monitoring well construction, alteration, maintenance, and destruction. These standards serve only as minimum statewide guidelines towards ensuring that monitoring wells do not constitute a significant pathway for the movement of poor quality water, pollutants, or contaminants. These standards provide no assurance that a monitoring well will perform a desired function. In most cases ground water monitoring practices and monitoring well performance, or functional requirements, fall under the purview of the various agencies mentioned earlier. ***Ultimate responsibility for the design and performance of a monitoring well rests with the well owner and/or the owner's contractor, and/or technical representative(s).***

STANDARDS

Part I. General

Section 1. Definitions[1].

A. Monitoring Well. The term "monitoring well" is defined in Section 13712 of the California Water Code as:

> "...any artificial excavation by any method for the purpose of monitoring fluctuations in groundwater levels, quality of underground waters, or the concentration of contaminants in underground waters."

B. Exploration Hole (or Boring). An uncased temporary excavation whose purpose is the immediate determination of hydrologic conditions at a site.

C. Enforcing Agency. An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of monitoring wells.

Section 2. Application to Well Type.

These standards apply to all types of monitoring wells, except as prescribed in Sections 3, 4, and 5, below. Before a change in use of a well is made, any standards for the new use must be complied with.

Section 3. Exemptions for Unusual Conditions.

Under certain circumstances the enforcing agency may waive compliance with these standards and prescribe alternate requirements. These standards may be waived where they are impractical or ineffective because of unusual conditions or would result in an unsatisfactory condition or well function. In waiving any of these standards the enforcing agency shall, if at all possible, require measures be implemented to provide the same or greater level of water-quality protection that would otherwise be provided by these standards.

Section 4. Exclusions.

Most standards in Part II, "Monitoring Well Construction," page 41, do not apply to "exploration holes." However, provisions of Section 7, "Reports," below and Part III, "Destruction of Monitoring Wells," page 50, do apply directly to exploration holes.

Exploration holes for determining suitability of on-site domestic sewage disposal that are less than 10 feet in depth are exempt from the reporting and destruction requirements of these standards.

Large volume excavations for determining the suitability of on-site domestic sewage disposal, such as backhoe trenches, that exceed ten feet in depth are exempt from the requirements of Part III of these standards. However, such excavations shall be backfilled with the excavated material or other suitable fill material and the backfill compacted in lifts to attain at least 90 percent relative compaction in order to restore physical conditions in the excavation as much as possible. If a layer or layers of material that serve to impede the

[1] Selected technical terms are defined in Appendix A, page 77.

movement of poor-quality water, pollutants and contaminants are penetrated by the excavation, they shall be reestablished to the degree possible to provide protection for underground waters, unless otherwise approved by the enforcing agency. In some cases it may be necessary to backfill all or a portion of the excavation with sealing material meeting these standards to reestablish natural barriers to the movement of poor-quality water, pollutants, and contaminants.

Section 5. Special Standards.

The enforcing agency may prescribe measures more stringent than standards presented here, where needed to protect public safety or protect water quality.

Section 6. Responsible Parties.

Pursuant to Section 13750.5 (Division 7, Chapter 10, Article 3) of the California Water Code; construction, alteration, and destruction of monitoring wells shall be performed by contractors licensed in accordance with the California Contractors' License Law (Division 3, Chapter 9, California Business and Professions Code), except where exempted by law. Construction, alteration, or destruction of monitoring wells to monitor hazardous waste facilities, other waste facilities, or underground storage tanks, shall be performed under the supervision of a California Registered Professional Engineer, California Registered Geologist, or California Certified Engineering Geologist, where specified by law.

Section 7. Reports.

Monitoring well construction, alteration, and destruction reports shall be completed on forms provided by the California Department of Water Resources. Other types of forms may be used for submission to the Department with the prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant provisions of Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in *Guide to the Preparation of the Water Well Drillers Report*, Department of Water Resources, October 1977, or its latest revision.

Part II. Monitoring Well Construction

Section 8. Well Location With Respect to Pollutants and Contaminants, and Structures.

Monitoring wells are usually constructed to observe conditions at defined or required locations. Monitoring well locations are usually selected on the basis of known or expected hydrologic, geologic, and water quality conditions and the location of pollutant or contaminant sources. Monitoring wells frequently need to be located close to or within areas of pollution or contamination.

A. Separation. Monitoring wells shall be located an adequate distance from known or potential sources of pollution and contamination, including those listed in Section 8 of the Water Well Standards, unless regulatory or legitimate data requirements necessitate they be located closer.

B. Flooding and Drainage. Monitoring wells should be located in areas protected from flooding, if possible. Provisions for locating monitoring wells in areas of flooding and drainage are contained in Section 8 of the Water Well Standards.

C. Accessibility. All monitoring wells shall be located an adequate distance from buildings and other structures to allow access for well maintenance, modification, repair, and destruction, unless otherwise approved by the enforcing agency.

D. Disposal of Wastes When Drilling in Contaminated or Polluted Areas. Drill cuttings and wastewater from monitoring wells or exploration holes in areas of known or suspected contamination or pollution shall be disposed of in accordance with all applicable federal, State, and local requirements. The enforcing agency should be contacted to determine requirements for the proper disposal of cuttings and wastewater.

Section 9. Sealing the Upper Annular Space.

The space between the monitoring well casing and the wall of the well boring, usually referred to as the "annular space," shall be effectively sealed to prevent it from being a preferential pathway for the movement of poor quality water, pollutants, and contaminants. Since monitoring wells are often constructed to obtain water from discrete intervals, a secondary purpose of the annular seal can be to isolate the well intake section or screen to one water-bearing unit. The annular seal can also serve to protect the structural integrity of the well casing and to protect the casing from chemical attack and corrosion. Because monitoring wells are often located close to, or within areas affected by pollutants and contaminants, an effective annular seal is often critical for the protection of ground water quality.

General discussion of sealing methods and requirements for monitoring wells is contained in Section 9, Section 13, and Appendix B, of the Water Well Standards. Special requirements for monitoring wells include the following:

A. Minimum Depth of Annular Seal.

1. Water quality monitoring wells and monitoring wells constructed in areas of known or suspected pollution or contamination. The annular space shall be sealed from the top of the filter pack or monitoring zone to ground surface, unless otherwise approved by the enforcing agency. The top of the filter pack or monitoring zone shall not extend into another water-bearing unit above the single water-bearing unit being monitored unless otherwise approved by the enforcing agency. The filter pack or monitoring zone shall not extend into any confining layers that overlie or underlie the unit to be moni-

Monitoring wells

tored, unless otherwise approved by the enforcing agency. The annular surface seal shall be no less than 20 feet in length.

Seal lengths less than 20 feet are permissible only if shallow zones will be monitored and approval has been obtained from the enforcing agency. If possible, special protection shall be provided where a reduced-length seal is used, as described in Section 8 of the Water Well Standards.

2. Other Monitoring Wells. The upper annular seal shall extend from ground surface to a minimum depth of 20 feet. An annular seal less than 20 feet in length is permissible if provisions in Item 1, above, are followed.

3. Sealing Off Strata. Additional annular sealing material shall be placed below the minimum depth of the upper annular seal, as is needed, to prevent the movement of poor-quality water, pollutants, and contaminants through the well to zones of good-quality water. Requirements for sealing off zones are in Section 13 of the Water Well Standards.

4. Shallow Water Level Observation Wells. Water level observation wells less than 15 feet in total depth that are used to assess root zone drainage in agricultural areas are exempt from an annular surface seal requirement, unless otherwise required by the enforcing agency.

5. Areas of Freezing. The top of the annular seal may be below ground surface in areas where freezing is likely. Such areas include those listed in Section 9 of the Water Well Standards. The top of the annular seal shall not be more than 4 feet below ground surface. The remainder of the space above the seal may be made an integral part of a vault, in accordance with Section 10, Subsection E, page 45, below.

6. Vaults. At the approval of the enforcing agency, the top of the annular seal and well casing can be below ground surface where traffic or other conditions require. In no case shall the top of the annular seal be more than 4 feet below ground surface.

   The top of the annular seal shall contact a suitable, watertight, structurally-sound subsurface vault, or equivalent feature, that encloses the top of the well casing in accordance with Section 10, Subsection E, page 45, below. The vault shall extend from the top of the annular seal to at least ground surface.

B. Sealing Conditions.

1. Temporary Conductor Casing. If "temporary" conductor casing is used during drilling, it shall be removed during the placement of the casing and annular seal materials, as described in Section 9 of the Water Well Standards. If the temporary conductor casing "cannot" be removed, as defined in Section 9 of the Water Well Standards, sealing material shall be placed between the conductor casing and borehole wall, and between the well casing and conductor casing, in accordance with methods described in Section 9 of the Water Well Standards. Sealing material shall extend to at least the depths specified in Subsection A of this section.

2. Permanent Conductor Casing. If a permanent conductor casing is to be installed, the monitoring well borehole diameter shall be at least 4 inches greater than the outside diameter of the conductor casing. The inner diameter of the permanent conductor

casing shall in turn be at least 4 inches greater than the outside diameter of the well casing.

Sealing material shall be placed between the permanent conductor casing and the borehole wall, and the conductor casing and the well casing. The sealing material shall extend to at least the depths specified in Subsection A of this section.

C. Radial Thickness of Seal. A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except as noted in Section 9 of the Water Well Standards. At least two inches of sealing material shall also be maintained between all "casings" in a borehole, within the interval to be sealed unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, to allow casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

D. Sealing Material. Sealing material shall consist of neat cement, sand-cement, or bentonite clay. Cement-based sealing material shall be used opposite fractured rock, unless otherwise approved by the enforcing agency. Concrete shall be used only with the approval of the enforcing agency.

Sealing material shall be selected based on required structural, handling, and sealing properties, and the chemical environment into which it is placed. Used drilling mud or cuttings from drilling shall not be used for any part of sealing material.

1. Water. Water used for sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, shall be free of petroleum and petroleum products, and shall be free of suspended matter. Good-quality water is necessary to ensure that sealing materials achieve proper consistency for placement and achieve adequate structural and sealing properties.

   Nonpotable water can sometimes be used for preparing cement-based sealing materials. In no case shall the concentration of chloride in water used in cement-based sealing material exceed 2,000 milligrams per liter. Sulfate shall not exceed 1,500 mg/l.

   Water used for sealing material shall be chemically analyzed if unknown. Only drinking-quality water of known composition should be used for preparing sealing mixtures for monitoring wells to be used for sensitive water-quality determinations.

2. Cement-Based Sealing Materials. Discussion and standards for cement-based sealing materials are contained in Section 9 of the Water Well Standards. Special considerations that apply to monitoring wells are:

   a. Additives. Care should be exercised in the use of special additives for cement-based sealing materials, such as those used for modifying cement setting times. Some additives could interfere with sensitive water quality determinations.

   b. Cooling Water. In the case of water quality monitoring wells, care should be exercised in the use of circulating cooling water to protect plastic casing from heat build-up during setting of cement-based sealing materials. Water introduced and/or circulated in a well for cooling could interfere with water quality determinations.

3. Bentonite-Based Sealing Materials. Discussion and standards for bentonite-based sealing materials are contained in Section 9 of the Water Well Standards.

E. <u>Transition Seal</u>. A bentonite-based transition seal, up to 5 feet in length, is often placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grain sand, usually less than 2 feet in length, is often placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-grain forms of bentonite, such as granules and powder, are usually employed for a transition seal if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by using a tremie pipe or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in the well annulus in dry form or as slurry for transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where the bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration or to make a slurry shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, 1/2 to 1 hour is required for hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sounded to ensure that no bridging occurred during placement.

F. <u>Placement of Annular Seal Material</u>. All loose cuttings and other obstructions shall be removed from the annular space before sealing materials are placed. Sealing may be accomplished by using pressure grouting techniques, a tremie pipe, or equivalent. Sealing materials shall be installed as soon as possible during well construction operations. Sealing materials shall not be installed by "free-fall" from the surface unless the interval to be sealed is dry and less than 30 feet deep.

Casing spacers shall be used within the interval(s) to be sealed to separate individual well casing strings from one another in a borehole of a nested monitoring well. The spacers shall be placed at intervals along the casing to ensure a minimum separation of 2 inches between individual casing strings. Spacers shall be constructed of corrosion-resistant metal, plastic, or other non-degradable material. Wood shall not be used as spacer material.

Any metallic component of a spacer used with metallic casing shall consist of the same material as the casing. Metallic spacer components shall meet the same metallurgical specifications and standards as the casing to reduce the potential for galvanic corrosion of the casing.

The spacing of casing spacers is normally dictated by casing materials used, the orientation and straightness of the borehole, and the method used to install the casing. Spacers shall not be more than 12 inches in length and shall not be placed closer than 10 feet apart along a casing string within the interval to be sealed, unless otherwise approved by the enforcing agency.

Casing spacers shall be designed to allow the proper passage and distribution of sealing material around casing(s) within the interval(s) to be sealed.

Additional discussion and standards for placement of the annular seal are contained in Section 9, Section 13, and Appendix B of the Water Well Standards.

Section 10. Surface Construction Features.

Surface construction features of a monitoring well shall serve to prevent physical damage to the well; prevent entrance of surface water, pollutants, and contaminants; and prevent unauthorized access.

A. Locking Cover. The top of a monitoring well shall be protected by a locking cover or equivalent level of protection to prevent unauthorized access.

B. Casing Cap. The top of a monitoring well casing shall be fitted with a cap or "sanitary seal" to prevent surface water, pollutants, or contaminants from entering the well bore. Openings or passages for water level measurement, venting, pump power cables, discharge tubing, and other access shall be protected against entry of surface water, pollutants, and contaminants.

C. Flooding. The top of the well casing shall terminate above ground surface and known levels of flooding, except where site conditions, such as vehicular traffic, will not allow.

D. Bases. Unless otherwise approved by the enforcing agency, a concrete base or pad shall be constructed around the top of a monitoring well casing at ground surface and contact the annular seal, unless the top of the casing is below ground surface as provided by Subsection E, below. The base shall be at least 4 inches thick and shall slope to drain away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency.

The base shall be free of cracks, voids, and other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing must be water tight and must not cause the failure of the well casing or annular seal.

Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

E. Vaults. At the approval of the enforcing agency, the top of the well casing may be below ground surface because of traffic or other critical considerations. A structurally-sound watertight vault, or equivalent feature, shall be installed to house the top of a monitoring well that is below ground surface. The vault shall extend from the top of the annular seal to at least ground surface. In no case shall the top of the annular seal be more than 4 feet below ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing, if any, shall not fail or cause the failure of the well casing or annular seal.

Where cement-based annular seal materials are used, the vault shall be set into or contact the annular seal material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault should be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation. Bentonite-based sealing material may be used between the vault and excavation at the approval of the enforcing agency.

Sealing material surrounding a vault shall extend from the top of the annular seal to ground surface, unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be placed in a "continuous pour." In other words, cement-based sealing material shall be placed between the vault and excavation and contact the cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases, unless otherwise approved by the enforcing agency. The lid shall be fitted with a security device to prevent unauthorized access. The lid shall be clearly and permanently marked "MONITORING WELL." The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at or above grade so drainage is away from the vault. The top of the well casing contained within the vault shall be covered in accordance with requirements under Subsections A and B, above, so that water, contaminants, or pollutants that may enter the vault will not enter the well casing.

F. Protection From Vehicles. Protective steel posts, or the equivalent, shall be installed around a monitoring well casing where it is terminated above ground surface in areas of vehicular traffic. The posts shall be easily seen and shall protect the well from vehicular impact.

Additional requirements for surface construction features are in Section 10 of the Water Well Standards.

Section 11. Filter Pack.

Monitoring well filter pack material shall consist of nonreactive, smooth, rounded, spherical, granular material of highly uniform size and known composition. Filter pack material shall not degrade or consolidate after placement. The grain-size of the filter pack shall be matched to the slot size of the well screen so that any movement of filter pack material into the well will be limited to prevent significant voids in the filter pack that could ultimately destabilize the annular seal.

Filter pack material shall be obtained from clean sources. Filter pack material should be washed and properly packaged for handling, delivery, and storage, if used in monitoring wells constructed for sensitive water quality determinations.

Care should be exercised in the storage of filter pack materials at a drilling site to ensure the material does not come into contact with pollutants or contaminants. Care should also be exercised to prevent the introduction of foreign substances, such as clay or vegetative matter, that might interfere with the placement and function of the filter pack.

Filter pack material shall be placed in the well boring by use of a tremie pipe or equivalent. The depth of the top of the filter pack shall be carefully checked and the volume of emplaced filter pack material verified to determine that filter pack materials have not bridged during installation.

Section 12. Casing.

The term "casing" in its broadest sense includes all tubular materials that are permanent features of a well. Screens, collars, risers, liners, and blank casing in monitoring wells maintain the well bore and provide a passage for ground water level measurement and/or sample-collection devices.

Protective casing serves to prevent accidental or intentional damage to a well. Protective casing normally consists of heavy gauge metallic pipe placed over the portion of the well casing that extends above ground surface.

Conductor casing usually functions as a temporary means of shoring the walls of a well boring to allow drilling and the placement of well construction materials. If used, temporary conductor casing is usually driven into place during drilling and is withdrawn at the same time filter pack and annular seal materials are installed around the well casing. Sometimes conductor casing is left in place and is made a permanent feature of the completed well structure. Requirements for sealing permanent conductor casing in place are contained in Section 9.

For the purpose of these standards, the term "casing" applies to screens, collars, risers, and blank casing, and other specialized products used to maintain the well bore. General discussion and standards for casing materials are contained in Section 12 of the Water Well Standards. Special considerations that apply to monitoring well casing are described below:

A. Casing Material.

1. Chemical Compatibility. Special consideration shall be given to the selection of casing materials for monitoring wells installed in environments that are chemically "hostile". The selected casing shall resist chemical attack and corrosion.

   Special consideration should be given to the selection of casing materials for wells to be used for sensitive water-quality determinations. Chemical interaction between casing materials and pollutants, contaminants, ground water, filter pack material, and geologic materials could bias ground-water quality determinations.

2. Used Casing. Used casing may be acceptable in certain cases, at the approval of the enforcing agency.

3. Plastic and Steel Casing. Plastic and steel well casing materials are commonly used for monitoring wells. The principal plastics used for water-quality monitoring wells are thermoplastics and fluorocarbon resins.

   Standards for **thermoplastic** well casing are in Section 12 of the Water Well Standards. The principal thermoplastic material used for water quality monitoring wells is polyvinyl chloride (PVC).

   Fluorocarbon casing materials include fluorinated ethylene propylene (FEP) and polytetrafluoroethylene (PTFE). Fluorocarbon resin casing materials are generally considered immune to chemical attack. Fluorocarbon casing materials shall meet the following specifications, including the latest revisions thereof:

   a. ASTM D3296, *Standard Specification for FEP-Fluorocarbon Tube.*

   b. ASTM D3295, *Standard Specifications for PTFE Tubing.*

Stainless steel is the most common form of metallic casing used in monitoring wells constructed for sensitive water quality determinations. Stainless steel casing shall meet the provisions of ASTM A312, *Standard Specification for Seamless and Welded Austenitic Stainless Pipe*, and shall meet general requirements for tubular steel products in Section 12 of the Water Well Standards.

B. Multiple Screens. Monitoring well casing strings shall not have openings in multiple water-bearing units (multi-level monitoring wells), if poor-quality water, pollutants, or contaminants in units penetrated by the well could pass through the openings and move to other units penetrated by the well and degrade ground water quality, unless otherwise approved by the enforcing agency.

C. Bottom Plugs. The bottom of a monitoring well casing shall be plugged or capped to prevent sediment or rock from entering the well.

D. Casing Installation. Discussion and standards for the installation of casing materials are in Section 12 of the Water Well Standards. Special considerations for monitoring wells are:

1. Cleanliness. Casing, couplings, centralizers, and other components of well casing shall be clean and free of pollutants and contaminants at the time of installation.

2. Joining Plastic Casing. Depending on the type of material and its fabrication, plastic casing shall be joined (threaded or otherwise coupled) in a manner that ensures its water tightness. Organic solvent welding cements or glues should not be used for joining plastic casing if glues or cement compounds could interfere with water-quality determinations.

3. Impact. Casing shall not be subjected to significant impact during installation that may damage or weaken the casing.

Section 13. Well Development.

Monitoring well development, redevelopment, and reconditioning shall be performed with care so as to prevent damage to the well and any strata surrounding the well that serve to restrict the movement of poor-quality water, pollutants, and contaminants. Development, redevelopment, and reconditioning operations shall be performed with special care where a well has been constructed in an area of known or suspected pollution or contamination. Such special care is necessary to prevent the spread of pollutants and contaminants in the environment and to protect public health and safety.

Water, sediment, and other waste removed from a monitoring well for "development" operations shall be disposed of in accordance with applicable federal, State, and local requirements. The enforcing agency should be contacted concerning the proper disposal of waste from development operations.

Appropriate methods of well development vary with the type and use of a monitoring well. Development methods that may be acceptable under certain circumstances include:

A. Mechanical Surging. Plungers, bailers, surge blocks, and other surging devices shall incorporate safety valves or vents to prevent excessive pressure differentials that could damage casing or screen.

B. Overpumping and Pump Surging. Overpumping and surging may not be suitable for development of wells producing large amounts of sediment because of the potential for clogging or jamming of pumps.

C. Air Development. Some air development methods are not acceptable for monitoring wells to be used for sensitive water-quality determinations.

D. Water Jetting. Water used in jetting operations shall be free of pollutants and contaminants. Water-jetting methods are not always acceptable for monitoring wells used for sensitive water-quality determinations.

E. Chemical Development. Extreme care shall be exercised in the use of chemicals for monitoring well development. It is often unacceptable to use chemicals for developing monitoring wells to be used for water-quality determinations. Chemicals introduced for development shall be completely removed from the well, filter pack, and water-bearing strata accessed by the well immediately after development operations are completed.

The various methods described above are sometimes used in combination.

Section 14. Rehabilitation and Repair of Monitoring Wells.

For the purpose of these standards, "well rehabilitation" includes the treatment of a well to recover loss in yield caused by incrustation or clogging of the screen, filter pack, and/or water-bearing strata adjoining the well. Well rehabilitation methods that may, in certain cases, be acceptable for monitoring wells include mechanical surging, backwashing or surging by alternately starting or stopping a pump, surging with air, water jetting, sonic cleaning, chemical treatment, or combinations of these.

Rehabilitation methods shall be performed with care to prevent damage to the well and any barriers that serve to restrict the movement of poor-quality water, pollutants, or contaminants. Chemicals used for rehabilitation shall be completely removed from the well, filter pack, and water-bearing strata accessed by the well immediately after rehabilitation operations are completed. Chemicals, water, and other waste shall be disposed of in accordance with applicable federal, State, and local requirements. The enforcing agency should be contacted regarding the proper disposal of waste from rehabilitation operations.

Rehabilitation methods should be compatible with the use of the monitoring well. Special care should be given to the selection of rehabilitation methods for water-quality monitoring wells.

Materials used for repairing well casing shall meet the requirements of Section 12 of these standards.

Section 15. Temporary Cover.

The well or borehole opening and any associated excavations shall be covered at the surface to ensure public safety and to prevent the entry of foreign material, water, contaminants, and pollutants whenever work is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.

Part III. Destruction of Monitoring Wells

Section 16. Purpose of Destruction.

A monitoring well or exploration hole subject to these requirements that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

(1) Ensure the quality of ground water is protected, and,

(2) Eliminate a possible physical hazard to humans and animals.

Section 17. Definition of "Abandoned" Monitoring Well.

A monitoring well is considered "abandoned" or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. In some cases regulatory agencies may require that an inactive monitoring well be maintained for future use.

In accordance with Section 24400 of the California Health and Safety Code, the monitoring well owner shall properly maintain an inactive well, as evidence of intention for future use, in such a way that the following requirements are met:

"(1) The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.

(2) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(3) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

Section 18. General Requirements.

All permanently inactive or "abandoned" monitoring wells and exploration holes subject to these requirements shall be properly destroyed. The purposes of destruction are to eliminate the well structure and borehole as a possible means for the preferential migration of poor-quality water, pollutants, and contaminants; and, to prevent a possible hazard to humans and animals.

Section 19. Requirements for Destroying Monitoring Wells and Exploration Holes.

General requirements for destroying monitoring wells and exploration holes are contained in Section 23 of the Water Well Standards. Special considerations for monitoring wells and exploration holes are as follows.

A. Monitoring Wells. Monitoring wells shall be destroyed in accordance with the following requirements and Section 23 of the Water Well Standards, **irrespective of their original date of construction.**

1. Preliminary Work. A monitoring well shall be investigated before it is destroyed to determine its condition and details of its construction. The well shall be sounded immediately before it is destroyed to make sure no obstructions exist that will interfere with filling and sealing.

   The well shall be cleaned before destruction as needed so that all undesirable materials, including obstructions to filling and sealing, debris, oil from oil-lubricated pumps, or pollutants and contaminants that could interfere with well destruction, are removed for disposal.

   The enforcing agency shall be notified as soon as possible if pollutants or contaminants are known or suspected to be present in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of all materials removed from a well to be destroyed.

2. Sealing Conditions. The following minimum requirements shall be followed when various conditions are encountered.

   a. The monitoring well casing, and any other significant voids within the well, shall, at a minimum, be completely filled with sealing material, if the following conditions exist:

      - **The monitoring well is located in an area of known or potential pollution or contamination, and,**
      - **The well was constructed and maintained in accordance with these standards.**

      Sealing material may have to be placed under pressure to ensure that the monitoring well is properly filled and sealed.

   b. A monitoring well shall be destroyed by removing all material within the original borehole, including the well casing, filter pack, and annular seal; and the created hole completely filled with appropriate sealing material, if the following conditions exist:

      - **The well is located in an area of known or potential pollution or contamination, and,**
      - **The well's annular seal, casing, screen, filter pack, or other components were not constructed or maintained according to these standards so that well destruction by merely filling the well casing with sealing material, as in "a" above, would not prevent potential water-quality degradation from**

Monitoring wells

the movement of poor-quality water, pollutants, or contaminants through the destroyed well structure.

Material to be extracted from the original borehole shall be removed by means of drilling, including overdrilling, if necessary. The enforcing agency should be contacted to determine requirements for proper disposal of removed materials.

Casing, filter pack, and annular seal materials may be left in place during sealing operations, if the enforcing agency agrees they cannot or should not be removed. In such a case, appropriate sealing material shall be placed in the well casing, filter pack, and all other significant voids within the entire well boring. Casing left in place may require perforation or puncturing to allow proper placement of sealing materials. Sealing material may have to be applied under pressure to ensure its proper distribution.

c. **Monitoring wells shall, at a minimum, be destroyed in accordance with the requirements of Section 23 of the Water Well Standards if located in an area free of any known or potential contamination or pollution.**

B. Exploratory Borings. Exploratory borings shall be completely filled with appropriate sealing material from bottom to top, if located in areas of known or suspected contamination or pollution. Borings located outside such areas shall, at a minimum, be filled with sealing material from ground surface to the minimum depths specified in Section 23 of the Water Well Standards. Additional sealing material shall be placed below the minimum surface seal where needed to prevent the interchange of poor-quality water, pollutants, or contaminants between strata penetrated by the boring.

Appropriate fill or sealing material shall be placed below and between intervals containing sealing material. Sealing material is often economical to use as fill material.

The boring shall be inspected immediately prior to filling and sealing operations. All obstructions and pollutants and contaminants that could interfere with filling and sealing operations shall be removed prior to filling and sealing. The enforcing agency shall be notified as soon as possible if pollutants or contaminants are known or suspected to be in a boring to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of removed materials.

C. Placement of Material. The placement of sealing material for monitoring wells and exploratory borings is generally described in Section 23 and Appendix B of the Water Well Standards. The following additional requirements shall be observed when placing sealing material for monitoring well or exploratory boring destruction.

1. Placement Method. The well or exploratory boring shall be filled with appropriate sealing, and fill material where allowed, using a tremie pipe or equivalent, proceeding upward from the bottom of the well or boring.

   Sealing material shall be placed by methods (such as the use of a tremie pipe or equivalent) that prevent freefall, bridging, and dilution of sealing materials, and/or prevent separation of aggregate from sealants. Sealing material may be placed by freefall only where the interval to be sealed is dry and no more than 30 feet in depth. Fill material shall be placed by methods that prevent bridging and voids.

2. <u>Timing of Placement</u>. Sealing material shall be placed in one continuous operation (or "pour") from the bottom to the top of the well or boring, unless conditions in the well or boring dictate that sealing operations be conducted in a staged manner, and prior approval is obtained from the enforcing agency.

3. <u>Ground Water Flow</u>. Special care shall be used to restrict the flow of ground water into a well or boring while placing sealing and fill material, if subsurface pressure producing the flow is significant.

4. <u>Sealing Pressure</u>. Pressure required for the placement of cement-based sealing materials shall be maintained long enough for cement-based sealing materials to properly set.

5. <u>Verification</u>. It shall be verified that the volume of sealing and fill material placed during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determine whether the well or boring has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.

D. <u>Sealing and Fill Materials</u>. Materials used for sealing exploratory borings and monitoring wells shall have low permeabilities so that the volume of water and possible pollutants and contaminants passing through them will be of minimal consequence. Sealing material shall be compatible with the chemical environment into which it is placed, and shall have mechanical properties consistent with present and future site uses.

Suitable sealing materials include neat cement, sand-cement, and bentonite, all of which are described in Section 9 of these standards. Bentonite shall not be used as a sealing material opposite zones of fractured rock, unless otherwise approved by the enforcing agency. Drilling mud or drill cuttings are not acceptable as any part of sealing material for well destruction. Concrete may be used as a sealing material at the approval of the enforcing agency.

Fill material, if any, shall meet the requirements of Section 23 of the Water Well Standards. Fill material shall be free of pollutants and contaminants and shall not be subject to decomposition or consolidation after placement. Drilling mud or cuttings are not acceptable as any part of fill material.

E. <u>Additional Requirements for Monitoring Wells and Exploratory Borings in Urban Areas</u>. The following additional requirements shall be met for destroying monitoring wells and exploratory borings in urban areas, unless otherwise approved by the enforcing agency:

1. The upper surface of the sealing material shall end at a depth of 5 feet below ground surface; and,

2. If the well casing was not extracted during destruction and sealing operations, a hole shall be excavated around the well casing to a depth of 5 feet below ground surface after sealing operations have been completed and the sealing material has adequately set and cured. The exposed well casing shall then be removed by cutting the casing at the bottom of the excavation. The excavation shall be backfilled with clean, native soil or other suitable material.

F. Temporary Cover. The well or borehole opening and any associated excavations shall be covered at the surface to ensure public safety and to prevent the entry of foreign material, water, pollutants, and contaminants; whenever work is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed, except by equipment or tools.

CATHODIC PROTECTION WELLS

CATHODIC PROTECTION WELL STANDARDS

INTRODUCTION

Most wells in California are constructed to extract ground water, inject water, or monitor ground water conditions. Other, less common types of wells include cathodic protection wells. Cathodic protection wells, sometimes called "deep groundbeds," house devices to minimize electrolytic corrosion of metallic pipelines, tanks, and other facilities in contact with the ground.

Electrolytic Corrosion

For the purpose of these standards, electrolytic corrosion is defined as the deterioration of metallic objects by electrochemical reaction with the environment. The electrolytic corrosion process is illustrated in Figure 4 for a metallic pipeline in a soil-water environment. This process gradually weakens the pipeline and can cause its failure.

In Figure 4, an electric potential is induced on the surface of the pipeline as a result of variations in the concentrations of salts in the soil and water surrounding the pipeline. This potential results in an electric current in the soil-water electrolyte. Current flows from an "anode area" on the pipeline to a "cathode area" on the pipeline. Metal is removed from the anode area by the current.

Cathodic Protection

"Cathodic protection" is a term used for certain measures taken to prevent or minimize electrolytic corrosion of metallic equipment and structures. Cathodic protection devices redirect current to flow from a "sacrificial" anode to the soil-water electrolyte, instead of from an anode area on a pipeline or other metallic structure to be protected. The protective anode's role is to corrode in place of the metallic object it is designed to protect, as shown in Figure 5. The protected facility is made to be a permanent cathode by use of cathodic protection devices. Thus, the facility is said to be "cathodically protected."

Protective or sacrificial anodes can be placed close to ground surface or at significant depth. Anodes have been placed at shallow depths in horizontal and vertical arrays for many years. Shallow arrays are often not well suited for metropolitan areas because of land requirements, or suited for areas where electrical interference may be high.

Deep vertical anode installations, usually referred to as "cathodic protection wells," were first developed and used during the 1940s. They were developed in response to the constraints of shallow anode arrays.

Cathodic Protection Wells

Cathodic protection wells are widely installed to protect metallic objects in contact with the ground from electrolytic corrosion. Such objects include petroleum, natural gas, and water pipelines, and related storage facilities; power lines; telephone cables; and switchyards. Cathodic protection wells are sometimes used to control electrolytic corrosion in large water wells.

Figure 4. ELECTROLYTIC CORROSION OF A BURIED PIPELINE

(NOTE: Schematic, not to scale)

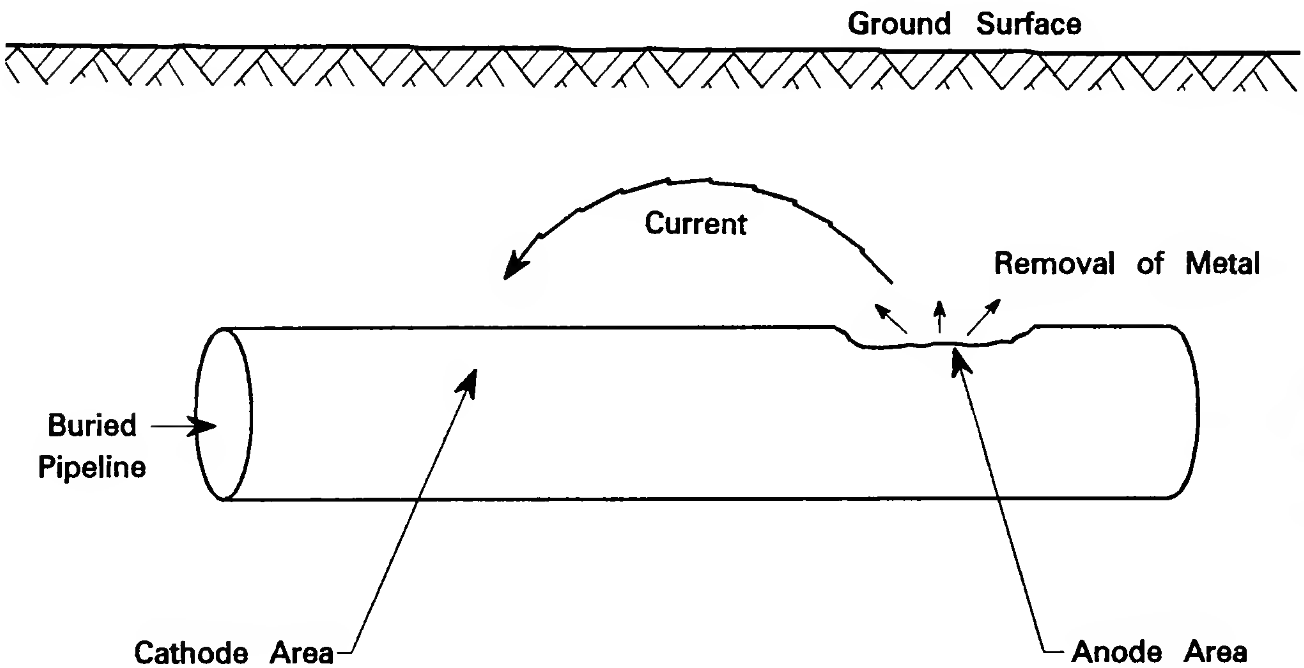
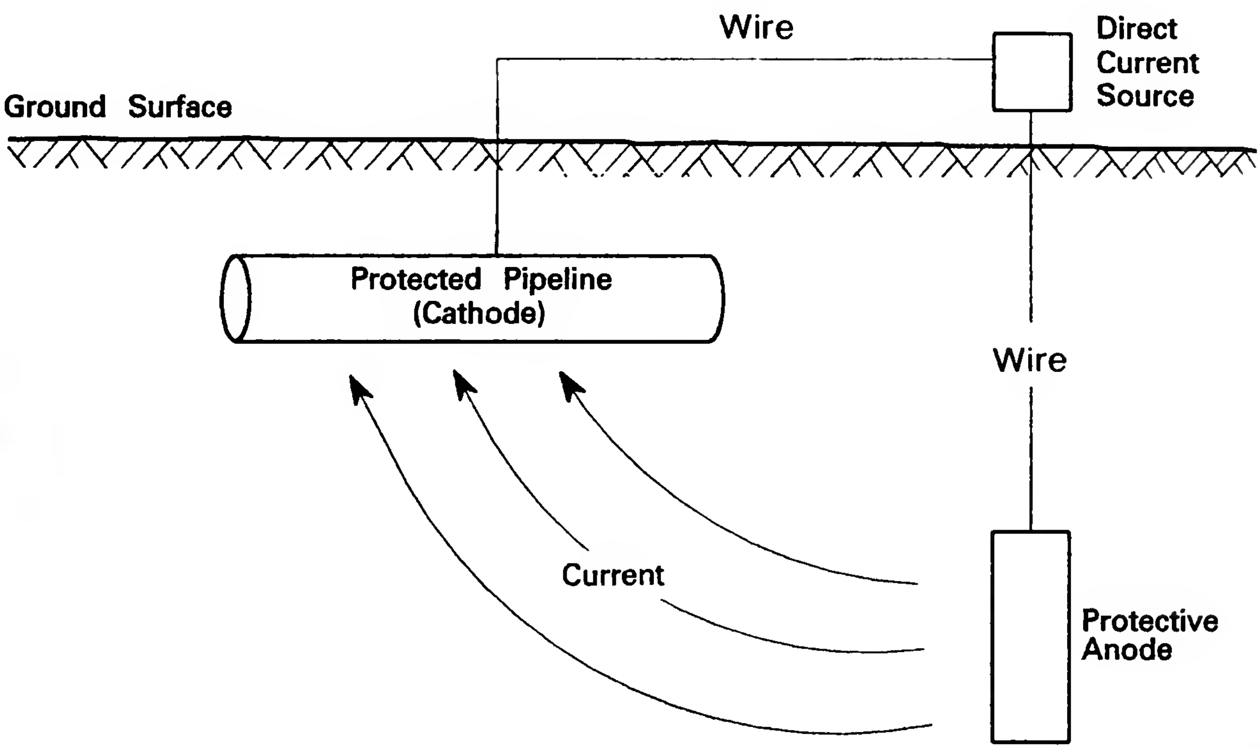


Figure 5. CATHODIC PROTECTION OF A BURIED PIPILINE

(NOTE: Schematic, not to scale)



Cathodic protection wells

Many cathodic protection wells have been constructed to protect pipelines that transport natural gas or other "hazardous" materials. The Natural Gas Pipeline Safety Act, Public Law 90-481 adopted by Congress in August 1968, provides requirements for cathodic protection of certain pipelines.

Most cathodic protection wells in California are located in areas where underground pipelines or "conveyance" systems are numerous and must be protected. These areas include:

- South coastal region from San Diego to Santa Barbara,
- Oil-producing areas of the southern San Joaquin Valley and the Central Coast, and,
- San Francisco Bay Area.

Few cathodic protection wells exist in California north of Sacramento.

Many cathodic protection wells, as illustrated in Figure 6, have been constructed by:

(1) **Drilling a 6- to 12-inch diameter borehole to a desired depth.** Cathodic protection wells normally range from 100 to 500 feet in total depth. A few wells have been constructed to depths of 800 feet.

California Water Code Section 13711 defines a "cathodic protection well" as an anode installation exceeding 50 feet in depth. Installations less than 50 feet deep are "legally" considered "shallow anodes," not cathodic protection wells. Shallow anode installations are not specifically covered by these standards.

(2) **Placing a string of anodes in the borehole within a designated interval, usually referred to as the "anode interval."**

(3) **Backfilling the anode interval around the anodes with an electrically conductive material, such as granular coke.**

(4) **Installing a small-diameter vent pipe that extends from the top of the anode interval to land surface, or above.** The purpose of the vent pipe is to release generated gases. Medium to large-diameter pipe or casing used in water wells to maintain the well bore and house pumping equipment is not normally used for cathodic protection wells.

(5) **Backfilling the annulus between the vent pipe and borehole wall with an electrically non-conductive fill material to a specific height above the anode interval.** Such fill material usually consists of uniform, small-diameter gravel. Its purpose is to provide a permeable medium for migration of gases and to stabilize the walls of the borehole.

In the past this material was sometimes used to fill the annulus between the vent pipe and the borehole wall from the top of the anode interval to land surface. These standards require specific interval(s) of the upper annular space of a cathodic protection well be filled with sealing materials instead of gravel, to protect ground water quality.

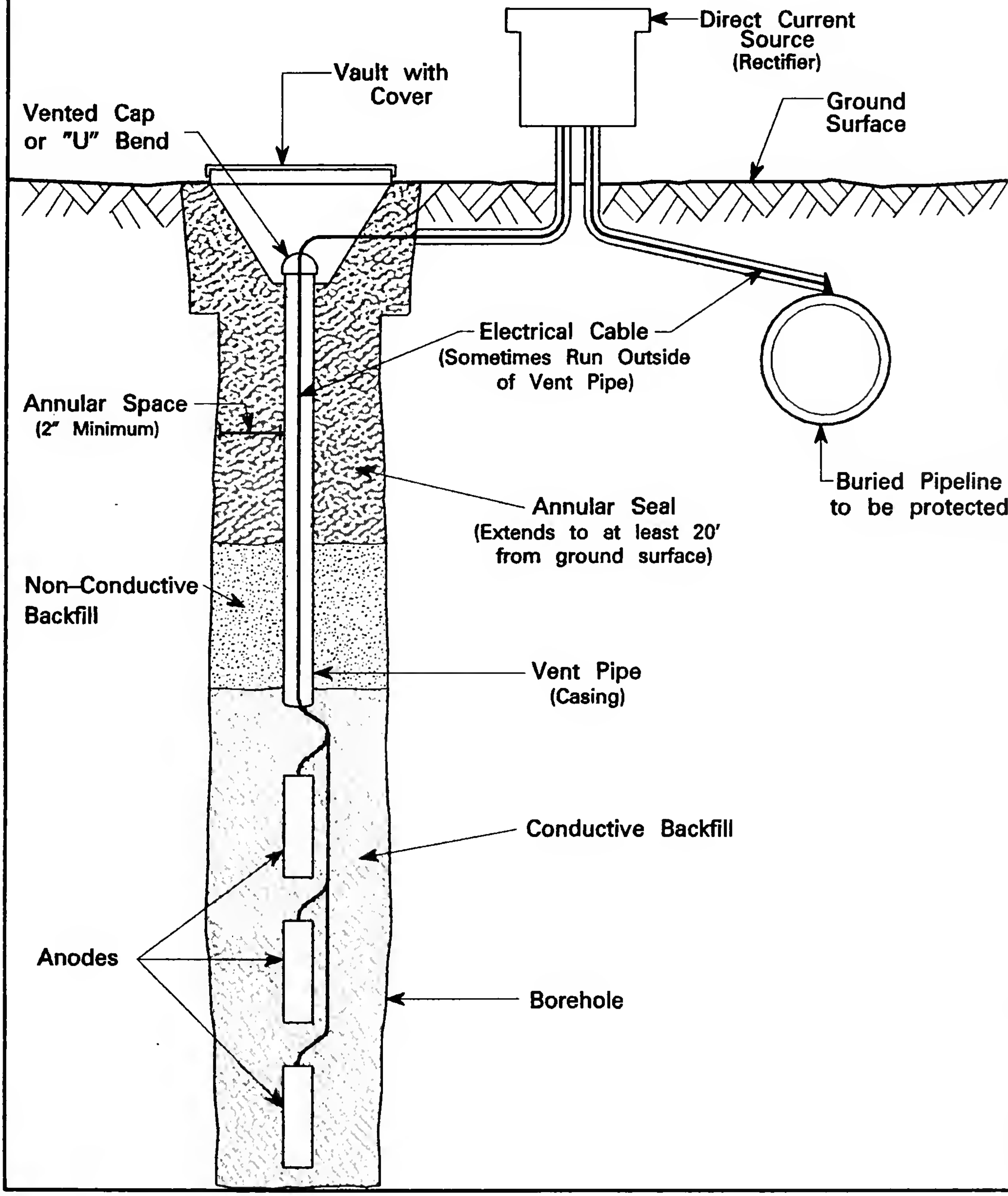
(6) **Sealing the annulus between the vent pipe and the borehole wall, from the top of the non-conductive annular fill to land surface, with sealing material.**

(7) **Installing a permanent cover over the well at ground surface.**

(8) **Connecting the anode leads to the facility to be protected, possibly through an electrical current source.**

Individual designs of cathodic protection wells vary.

Figure 6. CROSS SECTION OF A TYPICAL CATHODIC PROTECTION WELL
(NOTE: Schematic, not to scale)



The protective anodes of a cathodic protection well usually corrode away with time. Thus a cathodic protection well's anodes determine the well's useful life. Anodes are usually designed to last 15 to 20 years.

There has been an increasing tendency to construct cathodic protection wells with large diameter vent pipe or casing so that anodes can be replaced through the casing. Anode replacement through casing eliminates the need to drill replacement wells when anodes have been expended.

Corrosion Coordinating Committees

Serious electrical interference problems can occur where cathodic protection networks criss-cross one another or are too close to one another. Also, stray currents produced from electrical transmission lines and other equipment can sometimes interfere with the operation of cathodic protection systems. Interference problems are usually most pronounced in urban areas.

Corrosion control coordinating organizations have been formed in areas of California to overcome system interferences and other problems. Most organizations are affiliated with or are chapters of the National Association of Corrosion Engineers.

Corrosion control organizations represent the majority of utilities and other groups that install cathodic protection devices, including cathodic protection wells. Organization members coordinate the installation and operation of cathodic protection facilities with the goal of minimizing problems of electrical interference.

Four organizations that deal with Central and Southern California, are:

- **Southern California**

  The Southern California Cathodic Protection Committee is a formal committee covering all of Southern California south of San Luis Obispo, Kern, and Inyo counties, except San Diego County.

- **San Diego County**

  The San Diego County Underground Corrosion Control Committee is an informal organization that deals with the San Diego area.

- **Central California**

  The Central California Cathodic Protection Committee is a formal committee covering all of Central California plus Sacramento Valley counties, and western Sierra Nevada mountain counties south of Plumas County.

- **San Francisco Bay Area**

  The activities of the two committees that formerly covered the San Francisco Bay Area have been assumed by the San Francisco Section of the National Association of Corrosion Engineers. The committees were disbanded in 1985.

No coordinating organizations function in coastal counties north of San Francisco or in the northeastern part of the State.

Unfortunately, not all who install and operate cathodic protection facilities work with a corrosion coordinating organization. Those not associated with an organization are usually individuals or local agencies that are sometimes unaware of the existence of other installations. Non-coordinated facilities can seriously interfere with one another electrically.

Need for Cathodic Protection Well Standards

Cathodic protection wells, along with other types of wells, can allow ground water quality degradation to occur. Improperly constructed or destroyed cathodic protection wells can constitute a preferential pathway for the movement of poor-quality water, pollutants, and contaminants. Cathodic protection wells constructed with gravel backfill to land surface are particularly conducive to the movement of poor-quality water, pollutants, or contaminants.

Water and electrolytes are sometimes introduced into cathodic protection wells through vent pipes, or gravel fill in the annulus, to keep wells functional where natural electrolytes are lacking. Such a practice could be considered "waste disposal" and may be illegal if poor-quality water is used.

Permanently inactive cathodic protection wells pose a threat for the movement of poor-quality water, pollutants, and contaminants, and should be properly destroyed. Permanently inactive cathodic protection wells are a threat to ground water quality because they become dilapidated with time, are sometimes forgotten, and are sometimes used for waste disposal.

Many cathodic protection wells have small diameter vent pipes that prevent entry by persons and most animals. However, large vent pipe sizes can pose a serious safety threat if left open at land surface.

History of Cathodic Protection Well Standards

The California Legislature enacted legislation in 1949 directing the California Department of Water Resources to develop recommended water-quality protection standards for the construction and destruction of wells. The Legislature amended the Water Code in 1968 to require standards for cathodic protection wells.

Cathodic protection well standards for California were first published in 1973 as DWR Bulletin 74-1, *Cathodic Protection Well Standards: State of California*. Standards presented here replace those contained in Bulletin 74-1. Additional discussion on the history of well standards is contained in the "Introduction" section of this supplement (Bulletin 74-90) and Bulletin 74-81, *Water Well Standards: State of California*.

Scope of Standards

The following are recommended minimum standards for construction, alteration, maintenance, and destruction of cathodic protection wells in California. They only serve as minimum guidelines toward ensuring cathodic protection wells do not constitute a significant pathway for movement of poor-quality water, pollutants, and contaminants. These standards do not ensure a cathodic protection well will perform its corrosion protection function adequately.

The functional requirements of cathodic protection wells may conflict with the application of certain standards for the protection of water quality. Consequently, some compromise has been made between well function and resource protection in the development of these standards.

Organization of Standards

These standards are arranged in a format similar to the Water Well Standards. Since many of the standards that apply to water wells also apply to cathodic protection wells, many references are made in these standards to the Water Well Standards. Standards that apply only to cathodic protection wells or that require emphasis for cathodic protection wells, are discussed in detail in these standards.

STANDARDS

Part I. General

Section 1. Definitions[1].

A. Cathodic Protection Well. A cathodic protection well is defined in Section 13711 of the California Water Code as:

> "...any artificial excavation in excess of 50 feet constructed by any method for the purpose of installing equipment or facilities for the protection electrically of metallic equipment in contact with the ground, commonly referred to as cathodic protection."

B. Enforcing Agency. An agency designated by duly authorized local, regional, or State government to administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of cathodic protection wells.

C. Casing. All vent pipe, anode access tubing, electrical cable conduit, and other tubular materials that pass through the interval to be sealed.

D. Conductor Casing. A tubular retaining structure temporarily or permanently installed in the upper portion of the well boring between the wall of the well boring and the inner well casing. Conductor casing is often installed to keep the borehole open during drilling if caving conditions are expected. Despite its title, conductor casing does not normally serve an "electrical" function for cathodic protection wells.

Section 2. Exemptions Due to Unusual Conditions.

Under certain circumstances the enforcing agency may waive compliance with these standards and prescribe alternate requirements. These standards may be waived only where they are impractical or ineffective because of unusual conditions, or would result in unsatisfactory condition or well function. In waiving any of these standards, the enforcing agency shall, if at all possible, require that measures be implemented to provide the same or greater level of water-quality protection that would otherwise be provided by these standards.

Section 3. Special Standards.

The enforcing agency may prescribe measures more stringent than standards described here, where needed to protect public safety or protect water quality.

Section 4. Responsible Parties.

Corrosion control engineers are normally responsible for the design and supervision of corrosion control facilities incorporating cathodic protection wells. Pursuant to Section 13750.5 (Division 7, Chapter 10, Article 3) of the California Water Code, construction, alteration, and destruction of cathodic protection wells shall be performed by contractors licensed in accordance with the California Contractors' License Law

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[1] Technical terms are defined in Appendix A, page 77.

(Division 3, Chapter 9, California Business and Professions Code), except where exempted by law. Above-ground electrical facilities for cathodic protection wells should be installed by an appropriately licensed contractor.

Section 5. Reports.

Cathodic protection well construction, alteration, and destruction reports shall be completed on forms provided by the California Department of Water Resources. Other types of forms may be used for submission to the Department with the prior approval of the Department. The completed forms shall be submitted to the Department in accordance with relevant provisions of Sections 13750 through 13754 (Division 7, Chapter 10, Article 3) of the California Water Code. Information concerning completion and submission of well construction, alteration, and destruction reports is contained in *Guide to the Preparation of the Water Well Drillers Report*, Department of Water Resources, October, 1977, or its latest revision.

Part II. Cathodic Protection Well Construction

Section 6. Well Location With Respect to Pollutants and Contaminants, and Structures.

A. Separation. Cathodic protection wells shall be located an adequate distance from known or potential sources of pollution or contamination, where site constraints and corrosion control considerations allow. Potential sources of pollution and contamination include those listed in Section 8 of the Water Well Standards.

As specified in Section 7 below, the length of the annular seal for a cathodic protection well shall be increased if the well is located in a congested urban area, or is located within 100 feet of any potential source of pollution or contamination.

B. Flooding and Drainage. Cathodic protection wells should be located in areas protected from flooding, if possible. Wells located in areas of flooding shall be protected from flood waters and drainage, including protective measures outlined in Section 8, below.

Ground surface surrounding a cathodic protection well shall slope away from the well. Drainage from areas surrounding a cathodic protection well shall be directed away from the well.

C. Accessibility. All cathodic protection wells shall be located an adequate distance from buildings and other structures to allow access for well maintenance, modification, repair, and destruction, unless otherwise approved by the enforcing agency.

Section 7. Sealing the Upper Annular Space.

The space between the cathodic protection well casing and the wall of the well boring, often referred to as the "annular space," shall be effectively sealed to prevent it from being a preferential pathway for the movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of the annular seal are to stabilize the borehole wall, protect casing from degradation or corrosion, and ensure the structural integrity of the casing.

General discussion of sealing requirements and methods is contained in Section 9, Section 13, and Appendix B of the Water Well Standards. Special requirements for sealing cathodic protection wells are:

A. Minimum Depth of Annular Seal.

1. Minimum Depth. The annular space shall be filled with appropriate sealing material from ground surface to a depth of at least 20 feet below land surface. The annular space shall be sealed to a depth of at least 50 feet below land surface in congested urban areas, or where a cathodic protection well is within 100 feet of any potential source of pollution or contamination. Additional annular sealing material shall be installed to greater depths where adverse conditions exist that increase the risk of pollution or contamination of ground water.

2. Fill. Any annular space existing between the base of the annular surface seal and the top of the anode and conductive fill interval shall be filled with appropriate fill or sealing material. Fill material should consist of washed granular material such as sand, pea gravel, or sealing material. Fill material shall not be subject to decomposition or

consolidation after placement and shall be free of pollutants and contaminants. Fill material shall not contain drill cuttings or drilling mud. Sealing material is often more practical and economical to use for filling the annular space than granular material.

3. Sealing-Off Strata. Additional annular sealing material shall be placed below the minimum depth of the annular surface seal, as needed, to prevent the movement of poor-quality water, pollutants, and contaminants through the well to zones of good-quality water. Requirements for sealing off zones are in Section 10, below.

B. Sealing Conditions. Requirements for sealing the annular space under varied conditions are detailed in Section 9, Subsection B of the Water Well Standards.

C. Radial Thickness of Seal. A minimum of 2 inches of sealing material shall be maintained between all casings and the borehole wall within the interval to be sealed, except where temporary conductor casing cannot be removed as noted in Section 9 of the Water Well Standards. At least 2 inches of sealing material shall be maintained between all casings in a borehole, within the interval to be sealed unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, to allow casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

D. Sealing Material. Sealing material shall consist of neat cement, sand-cement, concrete, or bentonite clay as discussed in Section 9 of the Water Well Standards. Cement-based sealing material shall be used opposite zones of fractured rock used. Concrete shall only be used at the approval of the enforcing agency. Drill cuttings and used drilling mud shall not be used as any part of sealing material.

E. Placement of Seal. Standards for the placement of annular seals are described in Section 9 and Appendix B of the Water Well Standards.

Section 8. Surface Construction Features.

Surface construction features of a cathodic protection well shall serve to prevent physical damage to the well; prevent the entry of surface water, pollutants, and contaminants; and prevent unauthorized access.

A. Locking Cover. The top of a cathodic protection well shall be protected by a locking cover or equivalent level of protection to prevent unauthorized access. All such covers shall allow the venting of gases.

B. Casing Cap. The top of a cathodic protection well casing shall be fitted with a watertight cap, cover, "U" bend, or equivalent device to prevent the entry of water, pollutants, and contaminants into the well bore. All such covers shall allow venting of gases from the well.

C. Flooding. The top of the well casing shall terminate above ground surface and known levels of flooding, except where site conditions, such as vehicular traffic, will not allow.

D. Bases. A concrete base or pad shall be constructed around the top of a cathodic protection well casing at ground surface and contact the annular seal, unless the top of the casing is to be below ground surface as provided by Subsection E, below. The base shall be at least 4 inches thick and shall slope to drain away from the well casing. The base shall extend at least

2 feet laterally in all directions from the outside of the well boring, unless otherwise approved by the enforcing agency.

The base shall be free of cracks, voids, and other significant defects likely to prevent water tightness. Contacts between the base and the annular seal, and the base and the well casing must be water tight and must not cause the failure of the well casing or annular seal.

Where cement-based annular sealing material is used, the concrete base shall be poured before the annular seal has set, unless otherwise approved by the enforcing agency.

E. Vaults. At the approval of the enforcing agency, the top of a cathodic protection well may be below ground surface because of traffic or other critical considerations. A watertight, structurally-sound vault, or equivalent feature, shall be installed to house the top of the well casing if it terminates below ground surface.

The vault shall extend from the top of the annular seal to at least ground surface. In no case shall the top of the annular seal be more than 4 feet below ground surface.

The vault shall contact the annular seal in a manner to form a watertight and structurally-sound connection. Contacts between the vault and the annular seal, and the vault and the well casing (if any), shall not fail, or cause the failure of the well casing or annular seal.

Where cement-based annular sealing materials are used, the vault shall be set into or contact the annular sealing material before it sets, unless otherwise approved by the enforcing agency. If bentonite-based sealing material is used for the annular seal, the vault shall be set into the bentonite before it is fully hydrated.

Cement-based sealing material shall be placed between the outer walls of the vault and the excavation into which it is placed to form a proper, structurally sound foundation for the vault, and to seal the space between the vault and excavation.

Sealing material surrounding the vault shall extend from the top of the annular seal to ground surface, unless precluded in areas of freezing. If cement-based sealing material is used for both the annular seal and the space between the excavation and vault, the sealing material shall be emplaced in a "continuous pour." In other words, cement-based sealing material shall be placed between the vault and excavation and contact a cement-based annular seal before the annular seal has set.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access and shall be clearly and permanently labeled "CATHODIC PROTECTION WELL." The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur.

The top of the vault shall be set at grade, or above, so that drainage is away from the vault. The top of the casing contained within the vault shall be capped in accordance with requirements of Subsection B, above so that water, contaminants, and pollutants that may enter the vault will not enter the well casing.

F. Protection From Vehicles. Protective steel posts, or the equivalent, shall be installed around a cathodic protection well casing where it is terminated above ground surface in areas of vehicular traffic. The posts shall be easily seen and shall protect the well from vehicular impact.

Additional requirements for surface construction features are contained in Section 10 of the Water Well Standards.

Section 9. Casing.

Vent pipe, anode access tubing, and any other tubular materials that pass through the interval to be filled and sealed are all considered casing for the purpose of these standards. Materials used for cathodic protection well casing generally shall meet the requirements for casing materials and their installation in Section 12 of the Water Well Standards. Variance from the standards shall be at the approval of the enforcing agency. It is recommended that practices prescribed by the National Association of Corrosion Engineers also be followed in the design and installation of gas vents and electrical conduit.

Cathodic protection well casing should be at least 2 inches in internal diameter to facilitate eventual well destruction.

Section 10. Sealing-Off Strata.

If a cathodic protection well penetrates a stratum or strata below the minimum required annular surface seal depth specified in Section 7, above and that stratum contains poor-quality water, pollutants, or contaminants that could mix with and degrade water contained in other strata penetrated by the well, additional annular sealing material shall be placed below the minimum required annular surface seal to prevent mixing and water-quality degradation.

The following minimum requirements shall be observed for isolating zones containing poor-quality water, pollutants, or contaminants for various cases:

Case 1. Upper Stratum. If a stratum containing poor-quality water, pollutants, or contaminants lies above a stratum to be protected, annular seal material shall extend from the top of the stratum containing the poor-quality water, pollutants, or contaminants down to at least 10 feet into the confining layer separating the two strata, or through the entire thickness of the confining layer, whichever is least.

Case 2. Lower Stratum. If a stratum containing poor-quality water, pollutants, or contaminants lies below a stratum to be protected, the annular space opposite the stratum to be protected shall be sealed along its full length. The seal shall extend at least 10 feet into the confining layer separating the two strata, or through the entire thickness of the confining layer, whichever is least.

Case 3. Multiple Strata.

a. **Where two or more strata containing poor-quality water, pollutants, or contaminants are adjacent to one another and overlie a stratum to be protected,** the annular space opposite the strata containing poor-quality water, pollutants, or contaminants and opposite all interbedded confining layers shall be sealed. The annular seal shall extend at least 10 feet down into, or completely through, whichever is least, the confining layer separating the strata containing poor-quality water, pollutants, or contaminants and the underlying stratum to be protected.

b. **Where two or more strata containing poor-quality water, pollutants, or contaminants underlie a stratum to be protected**, the annular space opposite the stratum to be protected shall be sealed. The seal shall continue down at least 10 feet into, or completely through, whichever is least, the confining layer separating the stratum to be protected and the underlying strata containing poor-quality water, pollutants or contaminants.

c. **Where two strata containing poor-quality water, pollutants, or contaminants are separated by a stratum to be protected,** the annular space opposite the stratum to be protected, the confining strata underlying and overlying the stratum to be protected, and the upper stratum containing poor-quality water, pollutants, or contaminants shall be sealed off.

The supplementary seals described in the cases above shall be extended up to and contact the base of the required minimum annular surface seal described in Section 7 above, if they are otherwise required to be within 10 feet of the surface seal. Sealing the entire annulus above the anode interval will often economically fulfill the conditions outlined above.

Requirements for sealing materials and their placement are described in Section 7, above.

Section 11. Repair of Cathodic Protection Wells.

Materials used for repairing cathodic protection well casing shall meet the requirements of Section 9, above.

Section 12. Temporary Cover.

The well or borehole opening and any associated excavations shall be covered at the surface to prevent the entry of foreign material, water, pollutants, and contaminants, and to ensure public safety whenever work is interrupted by such events as overnight shutdown, poor weather and required waiting periods to allow setting of sealing materials and the performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.

Part III. Destruction of Cathodic Protection Wells

Section 13. Purpose of Destruction.

A cathodic protection well that is no longer useful, permanently inactive or "abandoned" must be properly destroyed to:

(1) Ensure the quality of ground water is protected, and,

(2) Eliminate a possible physical hazard to humans and animals.

Section 14. Definition of "Abandoned" Cathodic Protection Well.

A cathodic protection well is considered "abandoned" or permanently inactive when its anodes are exhausted and cannot, or will not, be replaced. A cathodic protection well is also considered "abandoned" or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use it again. To provide evidence of intention for future use of a well, the well owner, in accordance with Section 24400 of the Health and Safety Code, shall maintain the well in such a way that the following requirements are met:

"(1) The well shall not allow impairment of the quality of water within the well and ground water encountered by the well.

(2) The top of the well or well casing shall be provided with a cover, that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, to prevent unauthorized access, to prevent a safety hazard to humans and animals, and to prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.

(3) The well shall be marked so as to be easily visible and located, and labeled so as to be easily identified as a well.

(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

Section 15. General Requirements.

All permanently inactive or "abandoned" cathodic protection wells shall be properly destroyed. The purpose of destruction is to prevent a possible safety hazard to humans and animals and to eliminate the well structure as a possible means for the preferential migration of poor-quality water, pollutants, and contaminants.

Section 16. Requirements for Destroying Cathodic Protection Wells.

General requirements for well destruction are contained in Section 23 of the Water Well Standards. Special considerations for cathodic protection wells are as follows:

A. <u>Preliminary Work</u>. A cathodic protection well shall be investigated before it is destroyed to determine its condition, details of its construction and whether conditions exist that will interfere with filling and sealing.

The well shall be sounded immediately before it is destroyed to make sure that no obstructions exist that will interfere with filling and sealing. The well shall be cleaned before destruction, as needed, to ensure that all undesirable materials, including obstructions to filling and sealing, debris, and pollutants and contaminants that could interfere with well destruction are removed for disposal. The enforcing agency shall be notified as soon as possible if pollutants and contaminants are known or suspected to be in a well to be destroyed. Well destruction operations may then proceed only at the approval of the enforcing agency. The enforcing agency should be contacted to determine requirements for proper disposal of materials removed from a well to be destroyed.

B. Filling and Sealing Conditions. The following minimum requirements shall be followed when various conditions are encountered.

1. Wells that only penetrate unconsolidated material and a single "zone" of ground water. At a minimum, the upper 20 feet of the well casing and the annulus between the well casing and borehole wall (if not already sealed) shall be completely sealed with suitable material. Sealing material shall extend to a minimum depth of 50 feet below land surface if the well to be destroyed is located in an urban area, or is within 100 feet of any potential source of pollution or contamination. Additional sealing material may be needed if adverse conditions exist. The remainder of the well below the minimum surface seal shall be filled with suitable granular fill material, such as clean sand or pea gravel, or with sealing material.

2. Wells that penetrate several water-bearing strata. The upper portion of the well casing and annular space shall be filled with sealing material as described in Item 1, above. Strata encountered below the surface seal that contain poor-quality water, pollutants, or contaminants that could mix with and degrade water in other strata penetrated by the well, shall be effectively isolated by sealing the well bore and annulus within intervals specified in Section 10, above. The remainder of the well shall be filled with suitable granular fill or sealing material.

3. Wells penetrating fractured rock. Sealing material shall be installed as outlined in Items 1 and 2, above. Cement-based sealing material shall be used opposite fractured rock. The remainder of the well shall be filled with fill or sealing material, as appropriate.

4. Wells in nonfractured consolidated strata. Sealing material shall be installed as outlined in Items 1 and 2, above. The remainder of the well shall be filled with fill or sealing material, as appropriate.

5. Wells penetrating water-bearing zones or aquifers of special significance. The enforcing agency may require that specific water-bearing zones be sealed off for well destruction.

C. Placement of Material. The placement of sealing materials for cathodic protection well destruction is generally described in Section 23 and Appendix B of the Water Well Standards. The following additional requirements shall be observed in destroying cathodic protection wells.

Casing, cables, anodes, granular backfill, conductive backfill, and sealing material shall be removed as needed, by redrilling, if necessary, to the point needed to allow proper placement of sealing materials within required sealing intervals. Removal of some or all well materials will likely be required for cathodic protection wells that were not constructed in accordance with these standards, or standards adopted by the Southern California Cathodic Protection Committee in December 1969.

Casing that cannot be removed shall be adequately perforated or punctured at specific intervals to allow pressure injection of sealing materials into granular backfill and all other voids that require sealing.

The following requirements shall be observed in placing fill and sealing material in cathodic protection wells to be destroyed.

1. Placement Method. The well shall be filled and sealed with appropriate material upward from the bottom of the well using a tremie pipe or equivalent.

   Sealing material shall be placed by methods (such as by the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing materials, or separation of aggregates from sealants. Sealing materials shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

2. Timing of Placement. Sealing material shall be placed in one continuous operation (or "pour") from the bottom to the top of the well unless conditions in the well dictate that sealing operations be conducted in a staged manner and prior approval is obtained from the enforcing agency.

3. Ground Water Flow. Special care shall be used to restrict the flow of ground water into a well while fill and sealing material is being placed, if subsurface pressure causing the flow of water is significant.

4. Sealing Pressure. Pressure required for placement of cement-based sealing material shall be maintained long enough for the cement-based sealing material to set.

5. Verification. Verification shall be made that the volume of sealing and fill material placed in a well during destruction operations equals or exceeds the volume to be filled and sealed. This is to help determine that the well has been properly destroyed and that no jamming or bridging of the fill or sealing material has occurred.

D. Sealing Materials. Materials used for sealing cathodic protection wells for destruction shall have low permeabilities so that the volume of water and possible pollutants and contaminants passing through them will be of minimal consequence. Sealing material shall be compatible with the chemical environment into which it is placed and shall have mechanical properties compatible with present and future site uses.

   Suitable sealing materials include neat cement, sand-cement, concrete, and bentonite, as described in Section 9 of the Water Well Standards. Sealing materials used for isolating zones of fractured rock shall be cement-based, as described in Subsection B, above. Drilling mud or drill cuttings shall not be used as any part of a sealing material for well destruction. Concrete may be used as a sealing material at the approval of the enforcing agency.

E. Fill Material. Many fill materials are suitable for destruction of cathodic protection wells. These include clean, washed sand or gravel or sealing material. Fill material shall be free of pollutants and contaminants and shall not be subject to decomposition or consolidation after placement. Fill material shall not contain drilling mud or cuttings.

F. Additional Requirements for Destruction of Cathodic Protection Wells in Urban Areas. The following additional requirements shall be met at each well site in urban areas, unless otherwise approved by the enforcing agency:

(1) The upper surface of the sealing material shall end at a depth of 5 feet below ground surface, and,

(2) If the casing was not extracted during destruction and sealing operations, a hole shall be excavated around the well casing to a depth of 5 feet below ground surface after sealing operations have been completed and sealing materials have adequately set and cured. The exposed well casing shall then be removed by cutting the casing at the bottom of the excavation. The excavation shall then be backfilled with clean, native soil or other suitable material.

G. Temporary Cover. The well borehole and any associated excavations shall be covered at the surface to prevent the entry of foreign material, water, pollutants, and contaminants and to ensure public safety whenever work on the well is interrupted by such events as overnight shutdown, poor weather, and required waiting periods to allow setting of sealing materials and performance of tests. The cover shall be held in place or weighted down in such a manner that it cannot be removed except by equipment or tools.

APPENDICES

APPENDIX A

Definition of Terms

Protective Anode - A metallic object designed to corrode in place of the object it is designed to protect.

Cathodic Protection[1] - A technique to prevent the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Cement, Portland Cement - A cement that contains oxides of calcium, aluminum, iron, and silicon made by heating a mixture of limestone and clay in a kiln and pulverizing the resultant clinker, as defined in ASTM C150. Portland cement is also considered a hydraulic cement, because it must be mixed with water to form a cement-water paste with the ability to develop strength and harden, even under water.

Centralizer - A device that assists in centering tubular materials in a borehole.

Conductance, Specific - A measure of the ability of water to conduct electric current at 77 degrees Fahrenheit. It is related to the total concentration of ions in the water.

Corrosion[1] - The deterioration of a material, usually a metal, because of a reaction with its environment.

Drilling Fluid - A fluid (liquid or gas) used in drilling operations to remove cuttings from a borehole, to clean and cool the drilling bit, to reduce friction between the drill stem and the borehole wall, and, in some cases, to prevent caving or sloughing of the borehole.

Electrolyte[1] - A chemical substance or mixture, usually liquid, containing ions that migrate in an electric field. The term electrolyte refers to the soil or liquid adjacent to, and in contact with a buried or submerged metallic structure including the moisture and other chemicals contained therein.

Interference[1] - The situation that arises when a foreign substructure is affected in any way by a direct current source.

Rectifier[1] - An electronic device that changes alternating current to direct current.

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[1] Definition from National Association of Corrosion Engineers Standard RP-01-69 or RP-05-72.

APPENDIX B

REFERENCES

Since Bulletin 74-81 was published in mid-1981 several new or revised publications have been issued that address ground water or well construction. This appendix lists publications issued or revised since 1981 and selected other publications that were reviewed during the preparation of this supplement. Publications that were used for Bulletin 74-81 that have since been revised are identified by a number in parentheses. These numbers refer to the publication's original position in the bibliography of Bulletin 74-81 (Appendix E, page 83).

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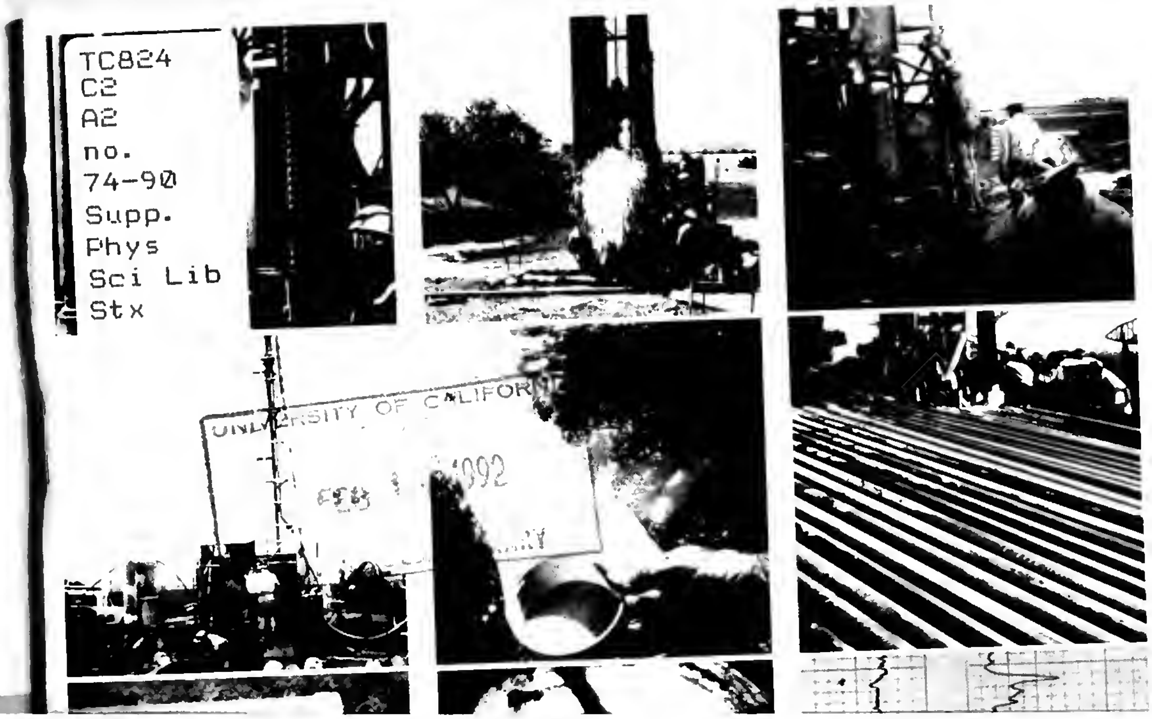
- California Code of Regulations
- California Business and Professions Code
- California Health and Safety Code
- California Public Resources Code
- California Water Code

B. The State Water Resources Control Board Model Water Well Ordinance.

C. Existing ordinances of the counties of California pertaining to the construction, alteration, and destruction of wells.

D. Laws, regulations, and recommendations of the various states pertaining to the construction, alteration, or destruction of wells.



APPENDIX 3F

Public Comments Received on Draft GSP

APPENDIX 3G

NCGSA GSP Advisory Committee Bylaws

RESOLUTION NO. 2020-04 (NCGSA)

RESOLUTION OF THE BOARD OF DIRECTORS OF THE NAPA COUNTY GROUNDWATER SUSTAINABILITY AGENCY, APPROVING CREATION OF THE GROUNDWATER SUSTAINABILITY PLAN ADVISORY COMMITTEE

WHEREAS, the Napa County Board of Supervisors adopted Resolution 2019-152 on December 17, 2019 electing to form the Napa County Groundwater Sustainability Agency (NCGSA) to undertake sustainable groundwater management of the Napa Valley Subbasin; and

WHEREAS, the Board of Supervisors serves as the Board of Directors for the NCGSA which has those powers set forth in California Water Code Section 10725 and following; and

WHEREAS, the NCGSA, under the authority granted in Sustainable Groundwater Management Act of 2014 (SGMA), wishes to provide for the sustainable management of the Napa Valley Subbasin by enhancing local management of groundwater and establishing minimum standards for sustainable groundwater management; and

WHEREAS, the Napa Valley Subbasin (designated basin number 2-002.01 in the California Department of Water Resources (DWR) groundwater basin system), which has been designated by DWR as a high-priority basin, requires the development and implementation of a Groundwater Sustainability Plan pursuant to SGMA regulations; and

WHEREAS, the NCGSA will directly oversee Napa County's Groundwater Sustainability Program and the development and implementation of a Groundwater Sustainability Plan for the Napa Valley Subbasin to maintain Napa County's compliance with California's Sustainable Groundwater Management Act; and

WHEREAS, the Board desires to establish an ad hoc advisory committee that is representative of various stakeholders and beneficial users of groundwater within the Subbasin to complement the work of agency staff and technical experts in developing the Groundwater Sustainability Plan; and

WHEREAS, on March 17, 2020 the Board provided direction to staff on seeking applicants to comprise the Groundwater Sustainability Plan Advisory Committee (GSPAC) and on April 6, 2020 a recruitment was posted describing the mission of the Committee and the makeup of its membership; and

WHEREAS, to facilitate compliance with the Maddy Act, the Board desires to formalize the creation of the GSPAC, including its purpose and the number, terms and qualifications of the members, in this Resolution as set forth below; and

WHEREAS, procedures relating to the formation and operation of the GSPAC are defined by Section 15378 (b)(2) of Title 14 of the California Code of Regulations as administrative procedures not subject to the California Environmental Quality Act:

NOW, THEREFORE, BE IT RESOLVED, that the Board of Directors hereby creates the GSPAC as follows:

Section 1. Purpose.

The GSPAC is hereby created to advise the NCGSA Board of Directors on the preparation of a Groundwater Sustainability Plan (GSP), with policies and recommendations to manage the groundwater within the Napa Valley Subbasin to ensure its long-term protection and availability. Working with staff, consultants, and a facilitator in a public forum, the Committee shall submit a recommended GSP to the Board of Directors for consideration no later than November 1, 2021.

The GSPAC shall cease to exist upon completion of these purposes or on January 31, 2022, whichever occurs first, unless the GSPAC is affirmatively perpetuated by resolution of the Board of Directors.

Section 2. Member Qualifications.

The GSPAC shall be comprised of twenty-five (25) members appointed by the Board of Directors representing diverse interests of all beneficial uses and users of groundwater including, but not limited to, disadvantaged communities, public water systems, agricultural interests, environmental interests, and community interests. A familiarity with groundwater resources is desired but not required. When possible, membership priority shall be given to those residing within the Napa Valley Subbasin. In the event after proper recruitment, there is a lack of interest of eligible candidates in specific categories, the Board may select from anyone who has applied.

Members shall collectively address the following requirements (individual members may fulfill more than one requirement):

- Four (4) members shall represent the three cities and town located within the Subbasin (Calistoga, St. Helena, Yountville and Napa);
- One (1) member shall represent the Napa Sanitation District;
- Two (2) members shall represent legal holders of surface water rights along the Napa River within the Subbasin;
- Two (2) members shall represent owners or operators of legally entitled groundwater dependent public water systems within the Subbasin;
- Two (2) members shall represent holders of overlying groundwater rights within the Subbasin;
- Five (5) members shall represent agricultural interests within the Subbasin;
- Five (5) members shall represent environmental users of groundwater within the Subbasin and shall be Napa County residents;
- Two (2) members shall represent disadvantaged communities located within the Subbasin; and
- Two (2) members shall represent the public at large and shall be Napa County residents.

Section 3. Term of Office & Recruitment of Members.

Members shall serve until January 31, 2022.

The Executive Officer shall use the procedures prescribed by the Maddy Act set forth in Government Code Section 54970 et seq. to fill any vacancies that may arise on the GSPAC prior to January 31, 2022.

Section 4. Bylaws.

The GSPAC Bylaws attached hereto as Exhibit "A" and incorporated by reference are hereby approved.

Section 5. First Organizational Meeting.

The GSPAC shall conduct its first organizational meeting no later than July 2020, for purposes of setting its meeting schedule, and taking such other organizational actions as may be required, including the election of a Chair and Vice-Chair and adoption of Committee ground rules. The Secretary of the GSPAC shall be a non-elected office filled by an employee of Napa County designated by the Director of Planning, Building, and Environmental Services.

Section 6. Liaison & Technical Assistance.

The Planning, Building, and Environmental Services Department shall act as a "liaison department" and the Director of Planning, Building, and Environmental Services or designee shall serve as "liaison officer" to the GSPAC for purposes of complying with the Maddy Act.

Agency staff and consultants shall provide technical support to the GSPAC, and shall make staff and consultants with appropriate expertise available to the Committee on an as needed basis as funding permits.

Section 7. Compensation.

Members of the GSPAC shall serve without compensation and shall not receive reimbursement for any expenses incurred while conducting official business.

Continued on Next Page

THE FOREGOING RESOLUTION WAS DULY AND REGULARLY ADOPTED at a regular meeting of the NCGSA Board of Directors, held on the 9th day of June 2020 by the following vote:

AYES:	DIRECTORS	PEDROZA, GREGORY, WAGENKNECHT, RAMOS and DILLON
NOES:	DIRECTORS	NONE
ABSTAIN:	DIRECTORS	NONE
ABSENT:	DIRECTORS	NONE

NAPA COUNTY GROUNDWATER SUSTAINABILITY AGENCY

By: ______________________________

DIANE DILLON, Chair

APPROVED AS TO FORM Office of County Counsel	APPROVED BY THE NCGSA BOARD OF DIRECTORS	ATTEST: JOSE LUIS VALDEZ Clerk of the Board of Directors
By: *Chris R.Y. Apallas* Deputy County Counsel Date: June 3, 2020	Date: June 9, 2020 Processed By: ______________________ Deputy Clerk of the Board	By:

Exhibit "A" – Bylaws

EXHIBIT "A"
BYLAWS OF THE NCGSA
GROUNDWATER SUSTAINABILITY PLAN ADVISORY COMMITTEE

I. **NAME.** The Committee shall be designated the Groundwater Sustainability Plan Advisory Committee, referred to hereafter as the "GSPAC".

II. **PURPOSE.** The GSPAC is hereby created to advise the NCGSA Board of Directors on the preparation of a Groundwater Sustainability Plan (GSP), with policies and recommendations to manage the groundwater within the Napa Valley Groundwater Subbasin (Subbasin) to ensure its long-term protection and availability. Working with staff, consultants, and a facilitator in a public forum, the GSPAC shall submit a recommended GSP to the Napa County Groundwater Sustainability Agency (GSA) Board of Directors for consideration no later than November 1, 2021.

III. **MEMBERSHIP.**

A. **Composition**. The GSPAC shall be comprised of a maximum of 25 members, appointed by the NCGSA Board, as follows:

- Four (4) members shall represent the three cities and town located within the Subbasin (Calistoga, St. Helena, Yountville and Napa);
- One (1) member shall represent the Napa Sanitation District;
- Two (2) members shall represent legal holders of surface water rights along the Napa River within the Subbasin;
- Two (2) members shall represent owners or operators of legally entitled groundwater dependent public water systems within the Subbasin;
- Two (2) members shall represent holders of overlying groundwater rights within the Subbasin;
- Five (5) members shall represent agricultural interests within the Subbasin;
- Five (5) members shall represent environmental users of groundwater within the Subbasin and shall be residents of Napa County;
- Two (2) members shall represent disadvantaged communities located within the Subbasin; and
- Two (2) members shall represent the public at large and shall be residents of Napa County.

B. **Term**. The term of office for GSPAC members shall commence upon appointment by the GSA Board of Directors and end on January 31, 2022. The term of the Committee may be extended by the Board of Directors at their discretion.

C. **Resignation.** Any appointed member may resign by giving written notice to the GSPAC.

D. **Vacancies.** Whenever an unscheduled vacancy occurs, the Board of Directors shall appoint a new member to fill the vacancy. The term for the incoming member will be for the remainder of the original term.

E. **Attendance**. Committee members are expected to attend all regular meetings. Members shall notify the Chair or Secretary of any expected absence by 5:00 p.m. of the day prior to the meeting. Any member of the GSPAC who has two (2) or more unexcused absences shall have their appointment reviewed by the GSPAC, with possible recommendation to the Board of Directors for continuation or removal from the GSPAC. Excused absences will be determined by the Chair.

F. **Compensation.** Members of the GSPAC shall serve without compensation and shall not receive reimbursement for any expenses incurred while conducting official business.

G. **Authority to Bind**. No member of the GSPAC shall have any power or authority to bind the GSPAC by any contract, to pledge its credit, or to render it liable for any purpose in any amount.

IV. OFFICERS. The officers of the GSPAC shall be the Chair, Vice-Chair and Secretary, chosen as follows:

A. **Time of Election.** At the first organizational meeting, the members of the GSPAC shall elect the Chair and Vice-Chair from among their members. The Secretary shall be an employee or consultant of the Napa County designated from time to time by the Napa County Director of Planning, Building, and Environmental Services to perform the functions of Secretary described in these Bylaws.

B. **Term.** The Chair and Vice-Chair nominated and elected at the initial meeting of the GSPAC shall begin their terms of office immediately upon election. Thereafter, the officers shall be nominated and elected in January of each year, beginning with 2021 and shall serve until their successors are elected and assume office. If the office of Chair becomes vacant during the term, the Vice-Chair shall become Chair. Vacancy in the office of Vice-Chair during the term shall be filled by election to serve the remainder of the term.

V. DUTIES.

A. **Duties of the Chair and Vice-Chair.** The Chair, or the Vice Chair in the absence of the Chair, shall:

1. Act as the presiding officer of the GSPAC and in that capacity shall preserve order and decorum;
2. Convene and adjourn meetings;
3. Call for roll and confirm determination of a quorum;
4. Decide questions of order subject to being overruled by a two-thirds vote;

5. Team with the GSPAC Facilitator to maintain a collegial and constructive tone and reinforce work in the pursuit of the GSPAC's Purpose;
6. Team with the Facilitator and staff to develop and finalize the meeting agenda;
7. Turn meetings over to the Facilitator to guide and manage the discussion;
8. Work with the Facilitator to elicit proposals and refinements of proposals;
9. Make requests to the Secretary as to information needs;
10. Team with the Facilitator to summarize conclusions and recommendations; and
11. Perform such other duties as are required by these Bylaws, the resolution(s) of the Napa County GSA creating and/or modifying the composition and purpose of the GSPAC, or by vote of the GSPAC. The Chair shall have all the rights and duties enjoyed by any other member of the GSPAC, including the right to make and second motions.

B. Duties of the GSPAC Members. Members appointed to the GSPAC shall:

1. Review and comment on materials and documents provided;
2. May make suggestions and draft and refine proposals;
3. May request data and analysis to inform deliberations in support of the GSPAC's purpose;
4. May pose clarifying questions to consulting technical presenters or agency staff;
5. Propose topics for informational briefings and discussion for inclusion on future agendas; and
6. Be encouraged to not lobby, in their capacity as GSPAC members, the NCGSA Board of Directors or any State agency for any recommendations or opinions which do not reflect a majority's valid and binding action taken pursuant to Section VIII D.

C. Duties of the GSPAC Secretary. The Secretary of the GSPAC shall:

1. In coordination with the Facilitator and consultant(s), organize, prepare for, and schedule meetings;
2. In consultation with the Chair and Facilitator, develop and distribute draft agendas;
3. Support the work of the GSPAC, as requested by the Chair; and
5. During discussion, may identify points that may lie outside the GSPAC's purpose, or point out County operations, policies, plans or ordinances for clarity, modification or consistency.

D. Duties of the GSA Consultants. The GSA's Consultants supporting the development of the GSP and the Purpose of the GSPAC shall:

1. Prepare documents to be provided to GSPAC as requested by the Secretary;
2. Conduct research, scientific inquiry and advice as requested;
3. Shall respond to GSPAC Members' clarifying questions as framed by the Facilitator; and
4. Shall vet GSPAC recommendations for engineering validity.

E. **Duties of the GSPAC Facilitator.** The Facilitator of the GSPAC shall:

1. Work closely with the Chair and Secretary in all aspects of meeting preparation and execution;
2. Guide and oversee discussions and manage GSPAC Member involvement, including conferring with members between meetings as appropriate;
3. Work with the Chair to ensure consistent application of the Committee ground rules and bylaws;
4. Work with the Chair to recognize members in the queue who wish to speak;
5. Summarize and restate members' comments as appropriate; clarify the basis of member statements;
6. Identify and clarify topics of agreement, areas of divergence and uncertainty, strive to narrow areas of disagreement, and identify areas in need of further information or analysis;
7. Frame straw votes to test preferences and track progress toward emerging agreement;
8. May suggest solutions to bridge and reconcile divergent proposals, and
9. Support the Chair, Secretary, consultant(s) and staff in reporting back to the GSA.

VI. MEETINGS

A. **Date and Location of Regular GSPAC Meetings.** Regular meetings of the GSPAC shall be held every month as shown on a calendar which the GSPAC shall adopt at its first meeting of each calendar year. Notwithstanding the foregoing, any regularly scheduled meeting of the GSPAC may be canceled by majority vote of the GSPAC or, for lack of business or a quorum, by the Chair or Secretary. Meetings shall be held in the Napa County Board of Supervisors Chambers at the Napa County Administration Building.

B. **Time of Regular GSPAC Meetings.** Regular meetings of the GSPAC shall commence at 1:30 p.m. and continue until all agendized business is concluded unless adjourned earlier on motion of the GSPAC for any reason or by the Chair or Secretary for lack of a quorum or unavailability of a meeting location due to an emergency.

C. **Emergency GSPAC Meetings.** Emergency meetings of the GSPAC shall be called in conformance with the provisions of the Brown Act (Government Code Section 54950 and following).

D. **Special GSPAC Meetings.** Special meetings of the GSPAC shall be called in conformance with the provisions of the Brown Act, including 24 hour notice of the meeting posted at the regular meeting location, and in those local newspapers that have requested to be informed of GSPAC meetings.

E. Agendas. The Secretary shall prepare, post, and otherwise give notice of the agenda for each meeting of the GSPAC in accordance with the requirements of the Brown Act. No matter may be considered or acted upon unless it is included on the posted agenda or a supplemental agenda. If not so included, questions or comments regarding the item shall be limited to the scope permitted for "public comment" under the Brown Act. Supplemental agendas will be prepared and considered by the GSPAC only under the following conditions:

1. **Emergencies.** Upon a determination by the GSPAC that an emergency situation exists, as defined in Section 54956.5 of the Government Code.

2. **Recently Continued Item.** The item was properly posted for a prior meeting of the GSPAC occurring not more than five (5) calendar days prior to the date action is taken on the item, and at the prior meeting the item was continued to the meeting at which action is being taken.

F. Public Access. All meetings of the GSPAC shall be open and accessible to the general public in accordance with the Ralph M. Brown Act (Government Code Section 54950, 54950(b), et seq.) and any executive orders issued by the Governor related to the Brown Act which may be in effect. Opportunity for public comment will be included in each agenda with individual presentation being limited to three minutes. The Chair or Committee, by vote, may close the meeting to the public only if in accordance with the Brown Act.

VII. CONDUCT OF MEETINGS

A. Order of Business. The regular order of business of the GSPAC shall be:
1. Call to order.
2. Approval of the minutes of the previous meeting.
3. Public comment on unagendized items.
4. Consideration and action on agenda items.
5. Adjournment.

In the event public comments exceed ten minutes, the Chair may continue public comment on unagendized items to the end of the meeting if desired.

B. Meeting Procedure. Unless otherwise provided by these Bylaws or required by law, all proceedings before the GSPAC shall be conducted in accordance with the adopted GSPAC Ground Rules.

C. Recording of Meetings. Any meeting of the GSPAC, other than a closed session permitted under the Brown Act, may be recorded by any person, unless the GSPAC determines that such recording could constitute a disruption of the proceedings.

D. **Presentations to the GSPAC.** Any person desiring to address the GSPAC shall be requested, when recognized by the Chair, to give their name and address to facilitate preparation of the minutes, although no persons shall be denied recognition or denied the opportunity to speak solely because they decline to state their names and addresses. The Chair may, in the interest of facilitating the business of the GSPAC, set in advance of the presentation of public input reasonable time limits for oral presentations. Persons may submit written comments in lieu of oral comments if the Chair determines that a reasonable opportunity for oral presentations has been provided and, in such a case, the matter may be continued to a later date to allow a reasonable time for such submittals to occur.

E. **Recordation of GSPAC Official Actions.** All official actions or decisions by the GSPAC shall be entered in the minutes of the GSPAC kept by the Secretary. The vote tally on every question shall be recorded, except where a roll call vote is used, the votes of each member of the GSPAC shall be recorded. Only written action minutes will be maintained; however, electronic recordings may be made by the Secretary of each meeting of the GSPAC which shall be available to the public online for inspection. However, the facilitator, in consultation with the Chair, may elicit expressions of interest on tentative proposals prior to their introduction as motions for proposed official actions.

VIII. VOTING AND QUORUM

A. **Roll Call Vote.** A roll call vote may be required for voting upon any motion of the GSPAC, at the discretion of the Chair.

B. **Inaudible Votes.** Any member present who does not vote in an audible voice shall be recorded as voting "aye". A member may abstain from voting only if the member has recused himself or herself from participating due to a conflict of interest under Government Code Section 87100 and following, in which case the member shall not be present in the meeting room during the discussion and action on the item.

C. **Quorum.** A quorum for the transaction of business shall exist only as long as a majority of the GSPAC members are present. For purposes of this Bylaw, "majority of the members" means a majority (13) of the authorized positions, whether or not all of the positions have been filled by the Board of Directors.

D. **Number of Votes Required for Action.** No action or recommendation of the GSPAC shall be valid and binding unless a quorum is present and the action is approved by a two-thirds vote of the members actually present at the meeting. Each member shall have one vote. No votes may be cast by proxy. Tie votes shall be considered as denial of the motion.

E. **Voting Affected by Conflict of Interest.** As a general rule, no member shall participate as a member in any discussion or voting if to do so would constitute a conflict of interest. However, if a quorum cannot be achieved or the required number of affirmative votes for action obtained because conflicts of interest exist that prevent members having such conflicts from discussing or voting on the matter, and the conflicts are such that an insufficient number of non-conflicted members will be available to vote at a later date even if the matter is continued, then the matter shall not be continued and a sufficient number of members having conflicts of interest, selected by lot, shall be allowed to participate to provide enough votes for the GSPAC to form a quorum and take affirmative action.

F. **Motion to Reconsider.** The GSPAC may reconsider a matter during the meeting at which the vote was taken, provided all members who were present when the matter was discussed and voted upon are still present and provided further that the motion to reconsider is made by a member who voted with the prevailing side. A motion for reconsideration shall have precedence over every motion except a motion to adjourn. A final vote on any matter may also be placed on the agenda for reconsideration by the GSPAC upon motion of any member at any later meeting. When the GSPAC approves a motion for reconsideration, the GSPAC may, in its discretion, reconsider the matter immediately or at a later date.

IX. SUBCOMMITTEES.

Ad Hoc Subcommittees. The GSPAC hereby authorizes the creation of ad hoc subcommittees on special subjects from time to time so that GSPAC members having the necessary expertise to conduct field, plan or other specialized reviews, or to investigate, observe, review, or otherwise study and report back their observations and conclusions to the full GSPAC for possible further action. When creating such ad hoc committees, the GSPAC shall specify the subject to be investigated and time to report, and shall appoint those GSPAC members who will serve on the ad hoc subcommittee.

Residents of the County with special expertise or interest who are not members of the GSPAC may be appointed to the subcommittee, but in no instance may the number of non-members exceed the number of GSPAC members on the subcommittee. The number of GSPAC members appointed to any particular ad hoc committee shall be less than the number of members required to constitute a quorum of the full GSPAC. Upon presentation of its report to the full GSPAC, each such ad hoc subcommittee shall cease to exist. Ad hoc subcommittees created pursuant to this subsection shall not be subject to the Brown Act.

X. CHANGES TO BYLAWS

A. **Adoption.** Approval by the Board of Directors of the NCGSA shall be required to adopt changes to these Bylaws.

B. **Amendments**. These Bylaws may be amended or repealed and new Bylaws adopted by the vote of two-thirds (2/3) of the GSPAC at any regular or special meeting, subject to approval by the NCGSA. Any member of the GSPAC may propose amendments to the Bylaws. Written notice of any proposed amendments must be sent to GSPAC members at least fourteen (14) days prior to the meeting at which the proposed amendments will be voted upon.