2023

Sonoma County Water Agency

Local Hazard Mitigation Plan

Sonoma Water

SonomaWater.org/LHMP

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Introduction

On January 8, 2008, the Board of Directors of the Sonoma County Water Agency, a body corporate and politic of the State of California ("Sonoma Water") adopted a local hazard mitigation plan (LHMP) with a vision to incrementally reduce its exposure to natural hazards and improve the reliability of its services to the public. The plan was developed in accordance with the federal Disaster Mitigation Act (DMA) 2000 (Public Law 106-390), Title 44 Code of Federal Regulations (CFR) Part 201, and subsequently approved by the Federal Emergency Management Agency (FEMA) on January 23, 2008. A FEMA-approved LHMP is a prerequisite for receiving grants under FEMA's Hazard Mitigation Assistance programs, and other federal assistance during declared emergencies. FEMA requires LHMPs to be updated every five years. After FEMA's approval of Sonoma Water's first LHMP in 2008, Sonoma Water has maintained a FEMA approved LHMP. This LHMP update process included reviewing the natural hazards with the potential to impact Sonoma Water, assessing progress towards mitigation actions identified in the previous approved plan, development of an updated mitigation action list, and stakeholder and public involvement.

Purpose of the Plan

The purpose of this plan is to provide both Sonoma Water and the public with a comprehensive assessment of the natural hazard risks and vulnerabilities facing Sonoma Water's infrastructure and to articulate a plan of action to address these vulnerabilities. By conducting this assessment, educating the public, and implementing the plan, Sonoma Water will be able to fulfill its responsibilities even in the event of a natural disaster.

Historically, natural disasters can result in enormous costs to the public through loss of life, human suffering, property damage, and economic loss. Lack of preparedness can make recovery a long and arduous process, often lasting for many months or years and depressing a region long after the physical signs of the disaster have disappeared. Recognizing this, the Federal Government passed the Disaster Mitigation Act of 2000 (DMA 2000), which amended the Stafford Act of 1988 (Public Law 100-707), to further encourage and reward pre-disaster planning at all levels of local, tribal, and state government. To implement the DMA 2000 planning requirements, FEMA published an Interim Final Rule in the Federal Register on February 26, 2002. This rule (44 CFR Part 201, Section 201.6) established the current mitigation planning requirements for states, tribes, and local communities. To ensure LHMPs met the requirements of both the DMA 2000 and 44 CFR Part 201, FEMA published the *Local Mitigation Planning Policy Guide* (released April 2022; effective April 2023) to assist local, tribal, and state governments in preparing and reviewing LHMPs. In combination, these documents form the key regulatory foundations for all LHMPs. Sonoma Water's current LHMP meets the requirements of DMA 2000 and 44 CFR Part 201 and has used the *Local Mitigation Planning Policy Guide* to achieve this.

To incentivize pre-disaster mitigation planning, the DMA 2000 established a pre-disaster hazard mitigation program and incorporated new requirements for the national post-disaster Hazard Mitigation

Grant Program (HMGP). Accordingly, HMGP funds are available for communities that have developed a comprehensive LHMP prior to a disaster. States, tribes, and communities must have an approved LHMP in place before receiving HMGP funds. To reward pre-disaster planning, FEMA also instituted the Pre-Disaster Mitigation (PDM) program that provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures while also reducing reliance on funding from actual disaster declarations. PDM grants are awarded on a nationally competitive basis, and an approved LHMP is a pre-requisite for applying.

A comprehensive LHMP is prepared in recognition of Sonoma Water's responsibility to the community and its role in preserving the economic vitality of the region. Sonoma Water's water supply, wastewater, and flood protection systems and infrastructure are distributed over a large geographical area and traverse zones of varying geology and potential hazards. Sonoma County is located in an area impacted by multiple natural hazards. Historically, this area has been regularly subjected to floods, wildfires, landslides, and mudflows. Due to its proximity to the San Andreas Fault system, one of the major active fault systems in the world, Sonoma County also has a very high earthquake hazard.

Sonoma Water Profile

Overview: Water Supply Services

Sonoma Water was created as a special district in 1949 by the California Legislature to provide flood protection and water supply services to portions of Sonoma and Marin counties. Legislation enacted in 1995 added the treatment and disposal of wastewater to its responsibilities. Although the Sonoma County Board of Supervisors acts as Sonoma Water's Board of Directors, Sonoma Water is a separate legal entity created by State law, with specific limited purposes and powers and separate sources of funding. Sonoma Water is thus different from County departments, which are created by the Board of Supervisors for administrative purposes but are not separate legal entities.

Sonoma Water is a wholesale water supplier to nine cities and special districts, several smaller communities and water companies, and a range of surplus (curtailable) customers and off-peak customers. Sonoma Water provides water to its primary water contractors principally from the Russian River. Depending on availability, Sonoma Water also supplies small quantities of water from its transmission system to surplus water customers and allows other entities known as Russian River customers to divert water from the Russian River under Sonoma Water's water rights using their own facilities. The total population served by Sonoma Water exceeds 630,000 people in Sonoma and Marin counties, and the population is projected to increase to more than 770,000 by 2045. The total annual average water deliveries by Sonoma Water to its customers amount to 22,174 acre-feet. According to the Agency's 2020 Urban Water Management Plan (UWMP), the annual average water deliveries are projected to reach 72,588 acre-feet by 2040.

Sonoma Water's primary water supply customers include the City of Santa Rosa, Marin Municipal Water District, North Marin Water District, City of Petaluma, City of Rohnert Park, Valley of the Moon Water District, City of Sonoma, City of Cotati, and Town of Windsor. Approximately 2% of the water supply is provided to customers such as California-American Water Company (Larkfield District), Penngrove Water Company, Lawndale Mutual Water Company, Kenwood Village Water Company, Forestville Water District, and various government entities. Depending upon the transmission system capacity and the availability of water in the Russian River, Sonoma Water sells as much as 12% of its water to the Marin Municipal Water District (MMWD). Less than 1% of the total water deliveries are provided to surplus customers, comprising local vineyards and wineries.

Water is provided to its various contractors through turnouts from Sonoma Water's aqueducts. Each of the water contractors is responsible for maintaining its own retail distribution system, including storage tanks and pumping stations. Many of the water contractors maintain some local supply source in addition to water purchased from Sonoma Water; in most cases, that constitutes a very small percentage of their total water requirements. Therefore, the population served by Sonoma Water's contractors is highly dependent on water provided by Sonoma Water.

Sonoma Water's system is also connected to about 30 unmetered fire hydrants. The primary fire-fighting capability within Sonoma Water's service area is borne upon each contractor's retail distribution system. While Sonoma Water is not responsible for providing the storage and pressures required for firefighting, the contractor dependence on supplies ensures that Sonoma Water has a significant role in fighting fires within its service area. As stated in the Sonoma County Emergency Operations Plan, the public places trust in the operators of water systems to provide high quality drinking water, even after a disaster. An uninterrupted supply of clean drinking water and water for firefighting is essential for the health and safety of the community and for minimizing the potential for loss of life and property damage following a major natural disaster.

Overview: Sanitation Services

In addition to its wholesale water supply function, Sonoma Water also manages and operates eight different sanitation districts and zones throughout Sonoma County. These districts and zones provide wastewater collection, treatment services, recycled water distribution, and disposal services to approximately 31,426 residences and businesses in Airport/Larkfield/Wikiup, Geyserville, Penngrove, Sea Ranch, Occidental, Russian River, Sonoma Valley, and South Park.

Overview: Supply and Flood Control Reservoirs

Sonoma Water is the local sponsor for the two federal water supply and flood control reservoirs in the Russian River watershed: Coyote Valley Dam at Lake Mendocino and Warm Springs Dam at Lake Sonoma. Sonoma Water manages water supply storage within Lakes Mendocino and Sonoma and controls releases from the water supply pools to maintain minimum instream flows in the Russian River and Dry Creek. For flood control purposes, Sonoma Water has helped build and manage Spring Lake Reservoir, Matanzas Creek Reservoir, Piner Creek Reservoir, and Brush Creek Reservoir. Sonoma Water maintains levees, fish ladders, and embankment protection on the Russian River and is responsible for maintenance of more than 75 miles of engineered flood control channels and approximately 100 miles of modified or natural channels.

Geography

Sonoma County covers nearly 1,600 square miles along the Pacific coastline. The county is bordered by the Pacific Ocean to the west, Marin County and San Pablo Bay to the south, Solano, Napa, and Lake Counties to the east, and Mendocino County to the north. Sonoma County has a variety of geographical features including valleys, mountains, plains, forests, rivers, and oceans.

Topography

Sonoma Water's water supply, sanitation, and flood protection infrastructure and systems are distributed over a large geographical area and traverse varying topography including mountains, rolling hills, broad flat river valleys, and bay flats. The Russian River watershed is the largest and most significant watershed in Sonoma County, draining more than 1,485 square miles in Sonoma and Mendocino counties as it flows to the Pacific Ocean.

Climate

Sonoma County's unique geographical makeup results in a number of microclimates throughout the region. The prevailing weather systems and wind typically come from the Pacific Ocean, blowing in from the west and southwest so that areas of the county closer to the ocean and on the windward side of higher elevations tend to receive more rain from autumn through spring and more summer wind and fog. These microclimates are evident during the rainy seasons, with notable variation in the amount of rainfall throughout the county. Generally, much of Sonoma County receives about 25 inches of rain, whereas certain areas, particularly in the north-west portion of the county around the Russian River, receive significantly more rainfall.

Element A. Planning Process

A1. The Planning Process

FEMA requires LHMPs to be updated every five years. After FEMA's approval of Sonoma Water's first LHMP in 2008, Sonoma Water initiated the required LHMP update process in 2012, and final FEMA LHMP approval came on August 8, 2013.

Sonoma Water manages the Russian River County Sanitation District (RRCSD), which began operations in 1983. During a 1995 restructuring of the county government, the Sonoma County Water Agency assumed responsibility for managing the county sanitation zones and districts. Each sanitation zone and district operates under a unique, individual permit from the California Regional Water Quality Control Board (San Francisco and North Coast regions) that sets the requirements for operation. The RRCSD operates under a permit from the North Coast Regional Water Quality Control Board. RRCSD had its own

LHMP until 2022, when the District and Sonoma Water determined it was more cost effective to merge the District's plan into this LHMP.

The current LHMP update process is intended to meet the requirements of DMA 2000 and Title 44 CFR Part 201. Updates to this LHMP are based on a review of the present understanding of natural hazards that impact Sonoma Water and an expanded assessment of infrastructure vulnerability to these hazards. This update also documents the progress towards the mitigation actions identified in the 2018 LHMP and provides a roadmap for the next five years to help further reduce Sonoma Water's exposure to these hazards. Details regarding the current LHMP update process are below in Element A.

During the last five years, Sonoma Water has initiated several high priority projects identified in the 2018 LHMP to help reduce exposure to natural hazards and improve the reliability of its systems. Sonoma Water has also reassessed some of the priorities associated with the mitigation actions and added additional actions for the LHMP mitigation strategy based upon the 2023 vulnerability assessment. A summary of progress made on the 2018 LHMP mitigation actions is provided in Appendix A, and the updated Mitigation Actions for the LHMP are in Appendix B.

A1a. How the Plan was Prepared

Part of the planning process was identifying teams within Sonoma Water to facilitate the update and review technical information. Three teams were created to complete this LHMP. The final "administrative draft" of the current LHMP was released for internal Sonoma Water review on April 24, 2023 and sent out via email to the Technical Review Team (TRT), Oversight Committee, and all staff. This email provided the opportunity and means for involvement in the draft LHMP, and comments received were incorporated before the Public Comment draft was released. Below is a list of the teams and their core functions.

The Core Planning Team (CPT), as presented in Table 1, guided the direction of this LHMP and implemented the majority of the research and text updates. The CPT began meeting in August 2022 to plan the update process, outreach activities, and timeline and begin revisions. The team consisted of Engineers from the Design/Engineering Section and Technical Writing Staff from the Grants and Funded Projects Section of Sonoma Water.

Table 1: Core Planning Team

Name	Title	Meetings Attended	Items Reviewed
Parastou Hooshialsadat	WA Engineer III	• Weekly CPT meetings • TRT meetings • Public and stakeholder meetings in Appendix C	• Survey results • Technical information and documents

			• Presentation material
Mollie Asay	WA Technical Writing Specialist	• Weekly CPT meetings • TRT meetings • Public and stakeholder meetings in Appendix C	• Plan update • Survey results • Revised mitigation actions
Nicole McGloin	WA Technical Writing Specialist	• Weekly CPT meetings • TRT meetings • Public and stakeholder meetings in Appendix C	• Plan update and reformatting • Survey results • Meeting minutes
Andrea Rodriguez	WA Principal Programs Specialist	• Weekly CPT meetings • Public and stakeholder meetings in Appendix C	• Public outreach material • Presentation material • Survey results
Cynthia DeLeon	WA Programs Specialist II	• Weekly CPT meetings • Public and stakeholder meetings in Appendix C	• Public outreach material • Presentation material • Survey results

The Technical Review Team (TRT) as presented in Table 2 first met in July 2022. This team consisted of Sonoma Water technical experts, including Principal Engineers, Operations & Maintenance Coordinators, and Environmental Specialists. The TRT's primary responsibilities were to review specific technical information and conduct technical research and updates. The TRT was convened on July 6, 2022 to review the new vulnerability assessment and mitigation actions for the sanitation system; on August 31, 2022 to review the updated vulnerability assessment and mitigation actions for the water transmission system; and on September 9, 2022 to review the new vulnerability assessment and mitigation actions for the flood protection infrastructure. The agendas, attendance lists, and minutes for these meetings are included in Appendix D. Mitigation action lists were revised after these meetings.

Table 2: Technical Review Team

Name(s)	Title	Items Reviewed
Kent Gylfe	Director of Engineering	• Updated vulnerability assessment and mitigation actions • Final Draft of LHMP

• Kevin Booker • Carlos Diaz • Steven Girard • Dale Roberts • Don Seymour • Mike West	WA Principal Engineers	• Updated vulnerability assessment and mitigation actions • Draft of LHMP
David Royall	WA Maintenance Manager	• Updated vulnerability assessment and mitigation actions • Final Draft of LHMP
Emma Walton	WA Operations Manager	• Updated vulnerability assessment and mitigation actions • Final Draft of LHMP
• Bret Beaudreau • Frank Mello • Ellen Simm • Eric Keel • DeWayne Burgess • Nick Rowan • Danny Colvin • Jon Niehaus • Randy Cullen • Garett Walker • Rolo Unciano • Heather Kelley (CAD/GIS)	WA Coordinators, WA CAD/GIS Coordinator	• Updated vulnerability assessment and mitigation actions
Steven Hancock	Emergency Response Manager	• Updated vulnerability assessment and mitigation actions • Final Draft of LHMP

The Oversight Committee, as presented in Table 3, was also created by the CPT with the purpose of providing high-level oversight of the draft plan. This team consists of Sonoma Water leadership, including the General Manager, Assistant General Managers, and Director of Engineering. The Oversight Committee's primary role was to review the final draft of the current LHMP.

Table 3: Oversight Committee

Name	Title	Items Reviewed
Grant Davis	General Manager	Final Draft of LHMP
Michael Thompson	Assistant General Manager of Maintenance	Final Draft of LHMP
Pam Jeane	Assistant General Manager of Water/Wastewater Operations	Final Draft of LHMP
Brad Sherwood	Assistant General Manager	Final Draft of LHMP
Kent Gylfe	Director of Engineering	Final Draft of LHMP

A2. Opportunities for Communities and Agencies to Be Involved in the Planning Process

Sonoma Water created a public outreach plan prior to drafting the LHMP that would facilitate stakeholder and public involvement. The goal of the outreach plan was to give all stakeholders the opportunity and means to be involved in the planning process. Appendix C includes all documentation of outreach and public/stakeholder involvement efforts

A2a. Opportunities for Stakeholder Involvement in the Planning Process

Notifications of the update process and public comment opportunities were broadcast via email blasts, social media, press releases, and newsletters. The notifications invited review and comment of the draft LHMP either digitally or via hard copies placed at strategic locations throughout the County. Notifications included contact information for providing comments, public meeting dates, public review schedules, and background information.

The first outreach meeting was conducted early in the update process. Sonoma Water notified all Sonoma Water contractors that it was initiating the plan update process by making a presentation at the Contractors' publicly accessible Technical Advisory Committee (TAC) meeting on November 7, 2022. Sonoma Water's contractors are organized into a two-tiered committee: the Water Advisory Committee (WAC) and the Technical Advisory Committee (TAC). Together, the WAC and TAC represent the major cities and water districts that receive water delivered via Sonoma Water's aqueduct system. The committees help make decisions regarding water supply issues in Sonoma Water's service area. The WAC is a committee of elected officials representing the water contractors that meets quarterly, and the TAC is made up of staff members who represent the water contractors that meets monthly. Sonoma Water's water contractors include:

- City of Santa Rosa

- City of Sonoma
- City of Petaluma
- Town of Windsor
- City of Rohnert Park
- City of Cotati
- Marin Municipal Water District
- North Marin Water District
- Valley of the Moon Water District

This presentation outlined the update timeline and provided these neighboring communities, as well as local and regional agencies that have the authority to regulate development, with the opportunity and means to be involved throughout the update process.

Public Meetings

Six public meetings were held during the plan update period to encourage public involvement and provide an opportunity for neighboring communities and local and regional agencies involved in hazard mitigation, including those with the authority to regulate development, to be involved in the planning process. The meeting agendas, minutes, and Committee membership lists are attached in Appendix B.

- Meeting 1: WAC/TAC Meeting, 11/7/22 – initiate LHMP update process
- Meeting 2: Flood Zone 3A, 12/13/22 – introduce LHMP and upcoming public comment period
- Meeting 3: Flood Zone 2A, 12/15/22 – introduce LHMP and upcoming public comment period
- Meeting 4: Flood Zone 1A, 12/8/22 – introduce LHMP and upcoming public comment period
- Meeting 5: WAC-TAC Meeting, 5/1/23 – highlight new mitigation actions and upcoming public comment period
- Meeting 6: Russian River County Sanitation District - Public Outreach meeting, 5/10/23 – discuss merging RRCSD LHMP into SCWA LHMP and upcoming public comment period

The Sonoma Water website was updated in November 2022 in advance of the November 7, 2022 presentation and maintained throughout the plan update process. A dedicated webpage at www.sonomawater.org/secureourwater provided information on key dates. Additionally, a dedicated email was set up to receive comments: lhmp@scwa.ca.gov. On May 15, 2023 the Sonoma Water website was updated with a link to the draft LHMP and information about the public comment period.

Media Outreach

The newsletter was distributed through social media platforms to additional community members including 4,638 Twitter and 3,549 Facebook followers. In March 2023, Sonoma Water also released articles in the Geyserville, Penngrove, and Airport-Larkfield Wikiup Sanitation Zone newsletters to 2,801 property owners, announcing the upcoming release of the draft LHMP and providing contact information for public comment through Sonoma Water's dedicated LHMP webpage described above. Finally, Sonoma Water sent emails providing an invitation to review the draft Plan to individuals listed on the Flood Zone – Interested Parties mailing list for Zones 1A, 2A and 3A.

A press release detailing the current LHMP update process, public comment period, and providing the opportunity and means for public input was issued and distributed on May 20, 2023.

Display advertisements announcing the beginning of the public comment period were published in the Press Democrat (a daily newspaper) the Sonoma Index-Tribune and in the Petaluma Argus-Courier on May 15, 2023.

A3. Public Involvement During Drafting

A3a. Opportunities for Public Involvement During Drafting and Incorporation of Feedback into Plan

Sonoma Water notified neighboring communities, interested stakeholders, and the public of the opportunity to be involved in the May 15, 2023, to June 14, 2023 public comment period using several media outlets, including Sonoma Water's dedicated LHMP webpage described above. Sonoma Water's electronic newsletter was distributed to 3,337 subscribers and included an article on the LHMP update process, inviting review and comments during the public comment period and providing the means to give input by including a link to the LHMP webpage and email.

During the current LHMP update process, the public and other stakeholders were kept fully informed, and their input was sought and incorporated into the draft plan. A public survey was launched in December 2022 and advertised via e-newsletter and social media to invite the public to participate through January 2023. Survey questions were designed to engage respondents' awareness of local natural disasters and the reliability of Sonoma Water services. The introductory text indicated that public input would help Sonoma Water identify and develop projects for the current Local Hazard Mitigation Plan (LHMP). Seventy responses were received. See Appendix C for the survey questions and results.

A4. Incorporation of Existing Plans, Studies, Reports, and Information

A4a. Incorporation of Existing Plans, Studies, Reports, and Information

As part of this LHMP update, new information was sought for hazards with the potential to impact Sonoma Water's infrastructure and functions, and this updated hazard information was integrated into Elements B and C. Updated GIS data for the primary hazards described in Element B was overlaid with the sanitation and flood protection infrastructure and systems, and key vulnerabilities and impacts to the systems were assessed and evaluated among project engineers. The analysis results are provided in Element B. Updated maps of the primary hazards noted in Element B were prepared and overlaid onto Sonoma Water's water supply, flood protection, and sanitation systems, and are provided in Figures 5 - 36. The CPT and TRT evaluated the vulnerabilities and projects listed in the plans and studies and incorporated them into the LHMP as mitigation actions, provided they aligned with the goals and objectives of this plan.

In addition, the climate change vulnerabilities identified in Sonoma Water's Climate Vulnerability Assessment and Adaptation Plan (Climate Adaptation Plan) in 2021 were incorporated into Element B. The Climate Adaptation Plan will serve to guide Sonoma Water in prioritizing practices and projects and allocating resources towards practices and projects that will improve resiliency of Sonoma Water's operations and facilities to climate variability and change. A major component of the CAP is the vulnerability assessment of climate risks to water supply, sanitation, and flood protection infrastructure and operations. This assessment analyzed climate-sensitive vulnerabilities for each system and will serve as a roadmap for developing, evaluating, and implementing adaptation strategies to improve the resilience of Sonoma Water's systems. Vulnerabilities that were rated high and medium are highlighted below under the appropriate system. As such, climate-related vulnerabilities identified in the CAP are incorporated into the mitigation actions.

The Natural Hazard Reliability Assessment (NHRA) was updated in 2022 to incorporate recent seismic hazard data and evaluate direct service disruption impacts to the water system in a major earthquake. The water supply vulnerability information was updated for the present LHMP to include specific new or reassessed conditions--particularly to reflect reductions in vulnerability as a result of progress on past mitigation actions. Thus, the present LHMP's vulnerability assessment for the water supply system in Element B is still largely based on the NHRA; nevertheless, updates to the description of the water supply system and its vulnerabilities were still made throughout Element B.

Below is Table 4, which provides a summary of the plans, studies, reports, and information that were utilized and integrated into this updated LHMP. For a more in-depth description of these plans, please refer to the detailed information provided below the table.

Table 4: Summary of Sonoma Water Resources to Support the LHMP

Resource Name	Ability to Support LHMP
Capital Projects Plan	
Strategic Plan	This plan establishes a framework for the long-term management of Sonoma Water.
Emergency Operations Plan	
Continuity of Operations Plan	
Climate Adaptation Plan	
National Flood Insurance Program (NFIP)	
Natural Hazard Reliability Assessment	

Plans

Capital Projects Plan

Sonoma Water's Capital Projects Plan[1] describes infrastructure projects planned to meet the needs of the water system, wastewater systems, and flood management facilities. Projects are designed to meet regulatory requirements and replace aging facilities. The Capital Projects Plan is modified each year to reflect changes in regulatory requirements and budget constraints. A diverse group of sections in Sonoma Water support Capital Projects, including Design Engineering, Construction Management, CAD/GIS, Land Surveying & Right-of-Way, Technical Writing, and Environmental Resources. Together, these sections ensure that infrastructure projects are implemented in compliance with regulatory requirements and industry standards. More information on Sonoma Water's Capital Projects Plan can be found at https://www.sonomawater.org/capital-projects.

Strategic Plan

In addition to the Capital Projects Plan, Sonoma Water's Strategic Plan, [2] approved by its Board of Directors, identifies key initiatives related to water supply and transmission, wastewater treatment and water reuse, flood protection, energy, climate change, information technology, vehicle fleet and facilities, and organizational effectiveness. These priorities were developed with the intent to remain unchanged for a five-year period. However, the actions identified to address these priorities are reviewed and updated annually.

The 2023 Strategic Plan includes the following goals and strategies that support hazard mitigation:

Water Supply

- Continue to engage in planning efforts and partnerships to protect and enhance our water supply.
- Ensure current and future water supply reliability by complying with the Federal and State Endangered Species Acts.
- Complete and submit to resource agencies the biological assessment for the next Russian River Biological Opinion.
- Implement the 2023 Russian River Biological Opinion.

Sanitation

- Continue to engage in planning efforts to support reliable wastewater and flood management services.

Flood Protection

- Initiate development of business plans to improve flood and sanitation financial and operational stability

Energy

- Continue to identify opportunities to implement renewable and efficiency enhancing energy projects to meet energy policy objectives

Climate Change

- Ensure alignment with the Board-approved Climate Adaptation Plan by establishing interdisciplinary climate resilience teams.
- Support interagency partnership efforts that address regional climate-resiliency planning and projects.

- Collaborate with partners to address sea level rise impacts to services in the Sonoma and Petaluma Baylands.
- Develop inclusive practices for Sonoma Water's climate mitigation and adaptation efforts considering the needs of under-resourced and under-represented communities.
- Continue to seek legislative support and policy development at national, state, regional, and local levels.

Organizational

- Conduct and update natural hazard vulnerability assessments to reliably meet performance requirements and service goals.
- Fully develop and enhance the capabilities of the Emergency Operations Center (EOC).
- Establish operational emergency response functions, procedures, and systems.
- Develop robust, redundant, voice and data communications capabilities to sustain interagency, multi-jurisdictional communication.
- Improve coordination with water contractors, regulatory agencies, and government partners.
- Maintain an emergency management training and exercise program that prepares staff for response and recovery activities.
- Develop and maintain a business continuity program that plans for and minimizes disruptions to Sonoma Water's essential business functions.

More information on Sonoma Water's Strategic Plan can be found at https://www.sonomawater.org/StrategicPlan.

Water Supply Strategy Action Plan

The Water Supply Strategy Action Plan[3] (WSSAP) describes Sonoma Water's strategies and prioritized actions that promote more resilient regional water resources. Its content and scope directly affect the LHMP. The original WSSAP was developed and adopted in 2010 after numerous public meetings and hundreds of comments from stakeholders. The WSSAP was updated in 2011, 2013, and 2018. The plan is implemented in consultation with Sonoma Water's water contractors and is used as a basis for budgeting. Demonstrating the high priority that Sonoma Water places on improving the reliability of its facilities, Strategy Six (Implement Projects to Improve Transmission System Reliability) specifies approximately 15 priority capital projects aimed at improving the natural hazard and operational reliability of Sonoma Water's facilities. In addition, Strategy Six also contains emergency response planning and training programs. These improvement projects and training programs are reflected in the present LHMP.

Groundwater Sustainability Plans (GSPs)

Following the implementation of the Sustainable Groundwater Management Act (SGMA) in 2014 and the formation of Groundwater Sustainability Agencies (GSAs) in 2017, as described below in programs, Sonoma Water has been actively involved in the development of the Groundwater Sustainability Plans

(GSPs) for the three basins in Sonoma County: Santa Rosa Plain, Sonoma Valley, and Petaluma Valley. The GSPs were approved by DWR on January 26, 2023. These plans will be particularly influential for drought mitigation.

Storm Water Resource Plan

In May 2019, Sonoma Water produced a Storm Water Resource Plan that encompasses the Petaluma River and Sonoma Creek watersheds. This plan identifies and prioritizes projects that capture storm water and dry weather runoff. The prioritization process used a metrics-based evaluation of multiple benefits to maximize water supply, water quality, flood management, environmental, and other community benefits within the Sonoma Creek and Petaluma River watersheds. Sonoma Water also participated in the Russian River Watershed Association's preparation of a Storm Water Resource Plan for the Russian River watershed, published in July 2018. This plan identifies and prioritizes projects that capture storm water and dry weather runoff.

Emergency Operations Plan

Sonoma Water Emergency Operations Plan[4] (EOP) addresses the planned response to emergency situations associated with large-scale natural disasters, technological incidents, and national security emergencies in or affecting a Sonoma Water facility or facilities, and/or its service area. The purpose of the plan is to facilitate multi-agency and multi-jurisdictional coordination during emergency operations.

This plan describes the following:

- Sonoma Water's water and wastewater operations and the hazards that threaten their infrastructure, systems, and staff.
- Sonoma Water's emergency management organization required to assist in responding to and recovering from any significant emergency or disaster.
- Authorities, policies, responsibilities, and procedures required to protect the health and safety of customers, personnel, and facility property.
- Operational concepts and procedures associated with field response to emergencies, Emergency Operations Center (EOC) activities, and the recovery process.
- Implementation of the Standardized Emergency Management System (SEMS), the National Incident Management System (NIMS), the Incident Command System (ICS), and the National Response Framework (NRF) for use within the Sonoma County Operational Area, regional, and California state emergency response systems.
- Multi-agency and multi-jurisdictional coordination, particularly between Sonoma Water and local, state, and federal agencies during emergency operations.
- Pre-event emergency planning as well as emergency operations procedures.

The EOP has been designed for conformance with the National Incident Management Systems, SEMS (Government Code Section 8607), and to be used in conjunction with the State Emergency Plan and local emergency plans. This plan was last used during the October 2020 Walbridge and Glass fires, both part of the larger LNU Fire Complex (FM-5331-CA). Additionally, the plan was used in support of the COVID-19 Pandemic Response (DR-4482-CA).

Business Continuity Plan

The purpose of Sonoma Water's Business Continuity Plan[5]is to ensure that the capability exists to continue essential governmental functions across a wide range of potential emergencies.

The objectives of Sonoma Water's Business Continuity Plan include:

- Ensuring safety of employees and customers
- Ensuring the continuous performance of essential business functions/operations during an emergency
- Protecting essential facilities, equipment, records, and other assets
- Reducing or mitigating disruptions to operations
- Achieving a timely and orderly recovery from an emergency and resumption of full service to customers
- Providing foundation for the continued survival of leadership
- Complying with legal and statutory requirements

Urban Water Management Plan

Sonoma Water's Urban Water Management Plan (Plan)[6] update was required by the California Urban Water Management Planning Act and was completed in 2020. Sonoma Water's UWMP discusses and describes the following:

- Existing water supplies and transmission system facilities
- Projected water demands in Sonoma Water's service area over the next 25 years
- Projected water supplies available to Sonoma Water over the next 25 years, the reliability of that supply, and general schedules for water supply projects
- Climate change impacts to water supply
- Energy intensity
- Current and planned Sonoma Water water conservation activities
- An updated and separately adopted Water Shortage Contingency Plan
- A comparison of water supply and water demand over the next 25 years under different hydrological assumptions (normal year, single dry year, multiple dry years)

This plan addresses Sonoma Water's water transmission system and includes a description of the water supply sources, historical and projected water use, and a comparison of water supply to water demands during normal, single-dry, and multiple-dry years. Each of the water contractors and MMWD has prepared its own urban water management plan.

Climate Adaptation Plan

Sonoma Water has developed the Climate Adaptation Plan (CAP) to guide the assessment of climate risks to water supply, flood management, wastewater systems infrastructure and operations, and to serve as a roadmap for developing, evaluating, and implementing adaptation strategies to improve the resilience of its systems.

The key objectives of the CAP:

- Improve the understanding of the relationship between climate variability and change and regional water supply, flood management, and sanitation systems.
- Document and describe the historical and projected climate and hydrologic threats to Sonoma Water's water supply, flood management, and sanitation infrastructure and operations.
- Assess the vulnerability of Sonoma Water's water supply, flood management, and sanitation infrastructure and operations to past and future projected climate conditions.
- Identify high-risk infrastructure and operations and identify inter-related risks between critical system components.
- Identify, prioritize, and cost adaptation measures to improve system resilience.
- Develop a strategy for improving the resilience of Sonoma Water's infrastructure and operations, and to assist in guiding future.

Climate change vulnerabilities identified in Sonoma Water's Climate Adaptation Plan are incorporated into Element C.

Element B. Hazard Identification and Risk Assessment

For the development of the Natural Hazard Reliability Assessment, which informed the original 2008 LHMP, close to 30 natural hazards were considered and their impact on Sonoma Water's infrastructure evaluated. This natural hazard assessment was reviewed and updated through all subsequent LHMPs. To ensure that hazards and vulnerabilities are accurately represented, Sonoma Water's GIS team used an overlaying method for geographically defined hazards, using the most current data layers for the primary hazards to create Figures 1-36. The data used was the most current available. Table 5 provides a summary of the natural hazards evaluated for Sonoma Water in this LHMP. The rating scale for probability and impact that follows is based on the history, frequency, and magnitude of the hazards listed in Table 5.

- Unknown = no history of this event occurring in the coverage area; however, hazards such as terrorism/bioterrorism can occur at any given moment.
- Low = little to no likelihood of hazard event occurring or affecting infrastructure or operations.
- Medium = moderate likelihood of hazard event occurring or affecting infrastructure or operations.
- High = very likely that hazard will occur and affect infrastructure or operations.

Climate Change

Projected climate changes over the next century have the potential to significantly impact flood, fire, and drought related hazards in Sonoma County, and therefore will impact Sonoma Water's infrastructure. Global climate change will likely cause shifts in the timing and amount of flow in the Russian River while accompanying sea-level rise will likely impact the hydraulic response and sediment carrying capacity of the Russian River along with major streams feeding the San Francisco Bay to the south.

Climate change induced sea level rise is projected to proceed at a rate of 50 cm over the next 100 years [7,8], an acceleration of the recent historical rate of 23 cm/century [9]. Projected sea level rise likely will result in changes to stream hydraulic gradients and may increase upstream backwater flooding. Decreased precipitation from climate change in the Russian River watershed and associated decreased flow in the Russian River has the potential to impact Sonoma Water's water supply. Decreased precipitation and increased storm intensity also have the potentially negative impact of increased fire danger, although regional landslide hazards related to rainfall may be decreased.

B1. Natural Hazards Affecting the Jurisdiction

B1a. General Description of All Natural Hazards That Can Affect the Jurisdiction and Omission of Hazards That Can Affect the Jurisdiction

Table 5: Hazards Summary for Sonoma County

Hazards	History	Probability	Impact	Comments
Coastal Erosion	Yes	Low	Low	Very little infrastructure near coast. Not identified as a priority in this LHMP.
Coastal Storm	Yes	Low	Low	Some infrastructure in the Estuary. Not identified as a priority in this LHMP.
Corrosive Soils	Yes	Medium	Medium	Included in the current LHMP as part of Flood Hazard.
Earthquake	Yes	High	High	Included in this LHMP.
Extreme Heat	Yes	Low	Low	Not identified as a priority in this LHMP.
Flood	Yes	High	High	Included in this LHMP.
Hailstorm	Yes	Low	Low	Limited impact to Agency infrastructure. Not identified as a priority in this LHMP.
Landslide	Yes	Medium	Medium	Included in this LHMP as part of Earthquake Hazard and Flood Hazard.
Severe Winter Storm	Yes	Medium	High	"Severe Winter Storms" in Sonoma Water's jurisdiction cause floods.

				Therefore, this hazard is included in this LHMP with the Flood Hazard.
Wildfire	Yes	High	Medium	Included in this LHMP as part of Fire Hazard.
Drought	Yes	High	Medium	Included in this LHMP.
Freeze	Yes	Low	Low	Limited impact to Agency infrastructure. Not identified as a priority in this LHMP.
Hazmat Release	Yes	Low	Medium	Emergency plans in place. Not included in this LHMP. Considered a technological hazard.
Radiological	No	Low	Low	Limited impact to Agency infrastructure. Not included in this LHMP. Considered a technological hazard.
Terrorism/Bioterrorism	No	Unknown	Unknown	Security and Vulnerability Assessment study performed. Not included in this LHMP. Considered a technological hazard.

The hazard assessment considered natural hazards with a medium to high probability to be the primary hazards capable of impacting Sonoma Water infrastructure. None of the other natural hazards assessed in the above table were determined to significantly affect Sonoma Water infrastructure. The following primary hazards can affect Sonoma Water's jurisdiction, and the risks and vulnerabilities associated with these are described in subsequent sections:

- Earthquake Hazard
- Flood Hazard
- Fire Hazard

The location of each primary hazard overlaid on Sonoma Water's infrastructure and systems can be seen in Figures 5 to 36.

Earthquake Hazard

Sonoma County is the northernmost of the nine counties that constitute the seismically active San Francisco Bay Area. Earthquakes in the Bay Area occur due to a sudden slip on one of the several major faults of the San Andreas Fault system. Some of the major faults in the San Andreas Fault system include the Hayward, Rodgers Creek, Calaveras, San Gregorio, and Maacama faults. Several of these faults have been seismically active in historical time and have produced large earthquakes with surface rupture. Figure 1 shows the fault map of the Bay Area.

Surface Fault Rupture Hazard

In large magnitude earthquakes, fault rupture can extend to the ground surface, resulting in one side of the fault moving relative to the other by as much as several feet. Structures located within the fault rupture zone are subjected to excessive ground deformations. Most structures are not designed to withstand such large deformations and can suffer major damage.

From the surface fault rupture hazard viewpoint, Sonoma Water's facilities are most severely impacted by the Rodgers Creek Fault, which passes through Sonoma County and cuts across Sonoma Water's Santa Rosa aqueduct near Doyle Park in the City of Santa Rosa. The California Division of Mines and Geology Special Publication 112, the Planning Scenario for a major earthquake on the Rodgers Creek fault, prepared by the California Geological Survey, [10] considers a Magnitude 7.0 earthquake with an average offset of 3 feet as most likely. Surface displacements on this order of magnitude would have been almost certain to rupture the Santa Rosa aqueduct, which was not originally designed to withstand such large displacements. Sonoma Water received FEMA funding in 2010 for a pre-disaster mitigation project for the Santa Rosa aqueduct. 2,000 linear feet of secondary water supply pipeline were successfully installed, reducing the aqueduct's vulnerability to damage from an earthquake.

In addition to the Rodgers Creek fault, recent studies by the USGS [11, 12] show that a segment of the Bennett Valley Fault, a fault previously considered inactive, may be accommodating fault slip between the Rodgers Creek fault and the Maacama fault to the north. This fault segment has been recently labeled the "Spring Valley Fault" [13] (Figure 7). The Spring Valley fault segment of the Bennett Valley fault zone forms the eastern boundary of a prominent structural pull-apart basin beneath Santa Rosa and Rincon and Bennett Valleys [14]. Mapping of the Spring Valley fault in the Spring Lake area shows that the fault crosses Sonoma Water's Sonoma aqueduct and the Oakmont pipeline near the Sonoma booster stations. The fault is well expressed in this area and crosses beneath the northern dam of the Spring Lake Reservoir. Significant transfer of slip between the Maacama and Rodgers Creek fault zones is believed to occur across the eastern margin of the pull-apart structure on the Spring Valley fault [15]. The inferred high slip rate [16,17] on the fault implies a correspondingly high potential for surface fault rupture.

Strong Ground Shaking

Seismic waves generated as a result of fault rupture propagate through the earth's crust from the rupture front and cause strong shaking of the ground. The intensity of ground shaking at a particular location is measured in terms of ground acceleration that generally decreases with distance from the earthquake source unless modified by local subsurface conditions. The maximum acceleration recorded at a location is referred to as the peak ground acceleration (PGA) and is reported as a fraction of earth's gravitational acceleration (g). The total force experienced by a structure can be related directly to the level of acceleration it experiences. For the probabilities of PGA values at Sonoma Water agencies, see Probability of Earthquake Events in Element B1e, Probability of Future Hazard Events and Effects of Future Conditions on Anticipated Intensities of Hazards.

Liquefaction and Lateral Spread

Liquefaction is a phenomenon in which loose granular soils saturated with water lose their ability to carry load when subjected to strong shaking. The shaking causes an increase in pressure exerted by the entrapped water within the pores of soil matrix and causes the soil to flow as a liquid. This subsurface process manifests itself in the form of large ground deformation and sand volcanoes at the ground surface. When liquefaction occurs near a free face such as a stream or riverbank large horizontal movement of ground can occur as the overlying soil layers slide over the liquefied layer towards the free face. This phenomenon, known as lateral spread, is very detrimental to buried pipelines and poses a much greater hazard to facilities and pipelines than liquefaction alone [18,19] Lateral spreads can develop on gentle slopes (less than 3 degrees) and may produce horizontal displacements equal to tens of feet [20].

The potential for liquefaction depends on both the susceptibility of a soil deposit to liquefy as well as the opportunity for ground motions to exceed a specified threshold level. Given the proximity of Sonoma County to the San Andreas and Rodgers Creek faults, virtually all parts of the County are exposed to long duration peak ground accelerations in excess of 0.15g (Figures 8, 19, 29). A moderate liquefaction susceptibility rating is given to areas that experience greater than .3g. All of the Agency facilities that lie in areas marked as moderate, high, and very high for liquefaction will likely experience liquefaction.

To assess the liquefaction and lateral spread hazard to Sonoma Water's facilities, potentially liquefiable soils that consist of young alluvial deposits and artificial fill present within Sonoma County are overlain on the Agency's water supply system as shown in Figure 9, the sanitation system in Figure 20, and flood protection infrastructure in Figure 30. These figures show locations where streams and open slope faces cross the water transmission pipelines, sanitation systems, and flood protection infrastructure, respectively. Such stream crossing locations coupled with high liquefaction potential have a very high likelihood of lateral spread and resulting pipeline damage. As shown in Figures 9, 20, and 30, significant portions of Sonoma Water's facilities are vulnerable to liquefaction. Areas in red have "Very High" liquefaction susceptibility, orange have "High," yellow have "Moderate," and white have "Very low (none) – not mapped." The maps show that the "High" and "Very High" zones are concentrated next to active creeks, including the Russian River and its tributaries. From a pipeline point of view, the main issues will be:

- Pipes in the red (Very High) and orange (High) zones. These zones can liquefy locally when PGA > 0.15g or liquefy over major areas when PGA > 0.5g.
- Non-seismically-designed pipes in the liquefied zones that are located within 200 feet of an open cut/slope, where lateral spreads occur, will suffer great amounts of damage.
- Pipes in the white zones are generally not susceptible to liquefaction-caused damage.
- Pipes in the yellow zones might be locally susceptible to ground settlements under very strong ground shaking (PGA > 0.3g), but damage will be sporadic.
- Pipes in white areas might be susceptible to landslides

Earthquake-Induced Landslides

Earthquake-induced slope failures or landslides commonly occur over wide areas on hill slopes during large (magnitude 6.5 or larger) earthquakes and can produce significant damage. The most common earthquake-induced failures are rockfalls, rock and soil slides, and soil avalanches, slumps, and flows.

Rockfalls, avalanches, and flow-type failures are especially hazardous because they often occur rapidly and travel great distances from the point of initiation. These types of rapid failures present significant impact to structures sited on slopes or valley areas downhill from the initiation site and can distort or break shallow-buried pipelines crossing the sliding plane of the slope failure. Such damage is likely to result in temporary loss of service to portions of Sonoma Water's respective service areas, jeopardizing public health and safety.

The opportunity for seismically induced slope failure is dependent on the potential for appropriately high levels of ground shaking to initiate movement. The susceptibility for failure is based on conditions that predispose the slope to failure including static stability, local geology, slope inclination, groundwater conditions, rock strength, and the duration and intensity of shaking. The potential for landslides is higher during seasonal wet periods when hill slopes are saturated with water.

Figures 13, 24, and 34 show regional landslide susceptibility mapping for Sonoma County produced by the California Geological Survey. Though various workers have mapped the geology of Sonoma County, most published geologic maps of Sonoma Water's service area do not delineate active or recently active landslides or slope failures. Therefore, there is a possibility of small, localized landslides that could result in damage to pipelines, especially portions of the water transmission pipelines that connect to the tanks located on hills.

Flood Hazard

Floods are the most frequent natural hazard impacting Sonoma County, causing the greatest property losses and accounting for the highest number of local, Gubernatorial, and Presidential disasters. Flooding is defined as the overflow of excess water from a water body onto adjacent lands. Flooding typically results from large-scale weather systems generating prolonged rainfall. Causes of flooding in Sonoma County can include thunderstorms, severe winter storms, tsunamis, sea level rise, dam failures, and, most commonly, atmospheric rivers.

Atmospheric rivers are narrow bands of enhanced water vapor which provide approximately half of the major rainfall in the Russian River watershed. Atmospheric rivers typically form over the North Pacific Ocean. When they make landfall in California, the moisture-laden air results in heavy, localized precipitation; they can transport water vapor as much as 15 times greater than the average flow of water at the mouth of the Mississippi River. Atmospheric rivers have caused nearly all of the floods in the Russian River watershed over the last 65 years. [21]

Floods are capable of undermining buildings and bridges, eroding shorelines and riverbanks, tearing out trees, washing out access routes, and causing loss of life and injuries. A "floodplain" is the area adjacent to a watercourse or other body of water that is subject to recurring inundation from floods. Floods on small streams usually peak and recede quickly in Sonoma County, while floods on the lower Russian River may not peak for two days or more after the start of a storm and may exceed flood stage for four days or more.

The intensity, distribution, and duration of rainfall are the most important factors in determining the magnitude of floods. If a storm event extends many hours or days, flooding can be enhanced as soils become saturated, reservoirs fill, and runoff from the upland and upstream areas accumulates downstream. Table 6 indicates the rainfall levels that are expected to fall in the low and high rainfall areas of the county during a 24-hour period based on the NOAA NWS Precipitation Frequency Data Server.

For detailed discussions of how climate change may impact the probability and impact of flood events at each of Sonoma Water's facilities, see the "Climate Sensitivity" sections under "Russian River System" in Element B2a.

Table 6: NOAA NWS Precipitation Frequency for Rainfall Areas in Sonoma County [22]

Recurrence Interval	Southeast County (inches) (Sonoma)	North Central County (inches) (Healdsburg)
2-year	3.10	4.54
10-year	4.55	6.52
25-year	5.45	7.55
50-year	6.14	8.26
100-year	6.84	8.93

Damaging floods occur most frequently along the Russian River, Petaluma River, and Sonoma Creek, and the tributaries in these watersheds [23]. Floods in Sonoma County occur during the winter months, develop within 24 to 48 hours after the storm event, and recede within three days after the end of the storm. In the lower Russian River, floods are characterized by high velocity and significant depth of flow due to the relatively narrow floodplain.

Flooding frequently occurs in this portion of the Russian River, especially in the residential and commercial districts of Mirabel Park, Duncans Mills, Monte Rio, Rio Nido, and Guerneville. The frequent flooding in these locations is why Sonoma County is the #1 California repetitive flood loss community, accounting for a third of California's total repetitive flood losses. [24]

The most readily available source of information regarding identification of flood hazards are the Flood Insurance Rate Maps (FIRMs) prepared by FEMA to support the National Flood Insurance Program (NFIP). Several areas of flood hazards are identified on these maps. The Special Flood Hazard Area (SFHA) is a high-risk area defined as any land that would be inundated by the 100-year flood, or alternatively, that has a 1-percent chance of flooding in a given year (also referred to as the "base flood"). FIRM maps use water surface elevation models combined with topographic mapping data to represent the flood hazard. Although the identified reoccurrence level (such as the 10-year, 50-year, 100-year) for a given flood hazard area is based on statistical averages, the actual frequency of flood events could occur at significantly shorter intervals.

FEMA [25] prepared a Flood Insurance Study (FIS) for the County of Sonoma to identify and map the flood hazard areas in the County. The FIS was last updated in October 2017. The FIS contains technical data hydraulic analyses used to prepare the FIRMs including discharge data and flood elevation profiles for the 10-, 50-, 100-, and 500-year floods.

The Federal Emergency Management Agency's (FEMA) flood hazard boundaries within Sonoma County are shown in Figures 10, 21, and 31 overlaid with the water transmission system, flood protection infrastructure, and sanitation system, respectively. For information on how Sonoma Water complies with the FEMA National Flood Insurance Program (NFIP) please refer to Element A4, "Sonoma Water's Existing Authorities, Policies, Programs, and Resources."

The Russian River area poses the greatest flood threat to Sonoma Water assets. However, key water production and transmission facilities located in the Russian River floodplain have been elevated to be above the 100-year flood elevation, including pumping facilities and emergency generators. The seven vertical wells located in the Russian River floodplain are vulnerable to flooding but are sealed when flood alerts are issued to prevent contamination. Due to proximity to the Russian River, all six existing water collectors are subject to flooding, but are elevated significantly above the 100-year flood elevation.

Flood Hazards in the Russian River County Sanitation District

The principal source of flooding within the RRCSD is the Russian River. Several pump stations are located along creek crossings and within the 100-year floodplain. These areas pose the highest risk of flood damage to the RRCSD facilities. Debris flowing within the Russian River and its tributaries where the pipelines cross presents a hazard to the crossings. Potential for scour also presents a hazard. As discussed in Elements B2a and B2b, there are specific locations identified where damage to the system could occur.

The most problematic secondary hazard for flooding is bank erosion, which, in some cases, can be more damaging than the actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but the banks can be left scoured, edging properties closer to the floodway or causing them to fall in. Flooding is also responsible for hazards, such as landslides, when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers. Additionally, sewer systems can back up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

Flood Related Landslides

The winters of 1982, 1983, 1986, and 1998 produced significant landslides in Sonoma County. An intense storm in late January 1983 triggered landslides in Blucher Valley, Glen Ellen, and the north Petaluma areas. The most extreme example of Sonoma County's landslide risk occurred during the El

Niño Winter Storms on January 6-7, 1998, in the community of Rio Nido. The upper portion of the slide consisted of a large rotational block failure that occurred near the top of the ridge, approximately 600 feet above the elevation of the canyon floor. Two debris flow failures, which are characterized by fluid and high-speed downhill flows, were initiated from the face of the block simultaneously with or shortly after the initial rotation of the landslide block. The southern debris flow traveled approximately 1,500 feet down a narrow ravine, causing the destruction of three homes and damaging four others in Upper Canyon Three. The northern debris flow traveled down an adjacent drainage ravine north of the homes and came to rest within a logjam 15 to 20 feet high, located about 800 feet from the canyon floor.

Additional debris flows occurred in the same area on February 21 and March 12, 1998 as a result of additional moderate rainfall (McCormick, 1998). Residents were evacuated until the stability of the slides could be determined. Geologic studies were performed and movement of the slides monitored for years. Evacuation zones maps were periodically revised and residents were gradually permitted to return to some areas.

A recent landslide event occurred in Marin County near Olompali State Historic Park on March 25, 2023. The landslide uncovered one of two PG&E gas lines and put pressure on one of the North Marin Water District aqueducts that runs from Sonoma County to Marin County.

Other damaging slides occurred in the communities of Monte Rio, Gold Ridge, Hidden Acres, Blucher Valley, Fitch Mountain, and the coastal community of Gleason’s Beach. The widespread damage caused in both northern and southern California prompted the Federal Emergency Management Agency (FEMA) and CalOES to initiate the first federally funded landslide acquisition program. The program was designed to permanently remove the properties destroyed, damaged, or still at risk from the landslides. Sonoma County received funds for the acquisition of 45 properties in the four communities that suffered the greatest damage.

Hill slopes along portions of Sonoma Water’s facilities have been modified by mass wasting processes, including landslides, debris flows, soil creep, gully and stream erosion, and sheet wash. These processes are episodic, with failures typically occurring during or shortly after periods of heavy precipitation. Types of slope failure caused by prolonged rainfall include rotational slumps, earthflows, and rapidly moving debris flows. Figures 13, 24, and 34 show overall susceptibility of hillslopes in Sonoma County to landslides.

Most of the landslides present along Sonoma Water’s water pipeline corridors fall into two primary types: (1) rotational and translational landslides involving bedrock and colluvium, and (2) debris or earth flows involving colluvium.

Rotational and translational landslides pose the primary slope stability hazard along the water pipeline corridors. The landslides commonly are distinguished by vegetation changes and characteristic slope morphology, including undulating, hummocky ground surface. Deep rotational and translational landslides typically involve underlying bedrock and are mainly associated with steep slopes greater than 15˚ and showing signs of water seepage. As shown in Figure 13 the overall landslide hazard within the water supply and transmission system is low. However, some portions of SW system are in a more elevated risk for landslide hazards.

Debris and/or earthflows typically occur where colluvium collects in topographic swales on hillslopes. During heavy rainfall, saturated colluvium may flow rapidly down drainage channels. Poorly sorted debris within a flow may be deposited where the slope angle decreases or may increase in volume with distance traveled downslope. The primary potential hazard posed by debris flows to a pipeline is the relatively rapid movement of soil surrounding the pipeline, and associated displacement of the pipeline. Pipeline displacement is more likely at the debris-flow headscarp than in lower parts of a debris flow. Debris flows travel downslope and downstream from the source area, extending the hazard areas associated with debris flows beyond the source point.

Corrosive Soils

The corrosive soil data layers indicate that Sonoma Water's infrastructure is susceptible to the risk of corrosive soils; however, there are no known historical events that have been documented in the planning area. Historical corrosive soil events are being further evaluated on a case-by-case basis. Potential external corrosion hazards to pipeline systems are dependent in part on the conductivity of the ground and the corrosive nature of soils in which the pipeline is buried. Corrosivity of soils is dependent on soil texture, soil pH, moisture content, and geochemical composition of fluids within the soil. These factors, in turn, are influenced by the physical and mineralogical composition of soils. In addition, the topography of the land, depth to groundwater, and native vegetation all influence the soil corrosivity potential.

Soil with pH generally less than 9.0 has been found to be among the more corrosive types. Soils with a pH of 0.0 to 4.0 are acidic and, when saturated, typically serve as a corrosive electrolyte. Soils with a near neutral pH of 6.5 to 7.5 and low Redox conditions are optimum for sulfate reduction by bacteria, which can cause localized corrosion.

Soil resistivity also has a strong influence on the corrosion rate. Generally, the higher the resistivity of the soil, the lower is its corrosion rate. Soil resistivity arises from a number of factors, but fine-grained soils (silts and clays) typically have the lowest resistivity and thus the greatest corrosion susceptibility.

The distribution and type of soils within Sonoma County were digitized from Department of Agriculture Soil Conservation Service (SCS) county soil report. Soils are generally sampled only to a depth of 5 to 6 feet (most pipelines are buried within this zone); therefore, soil descriptions are limited to that depth and may not be representative of deeper soil conditions. In the SCS report, soil unit codes were referenced to the shrink-swell and corrosivity engineering properties and the corrosion potential as Low, Medium, or High. Corrosivity values compiled from SCS soil surveys, although unit less, are calculated by the SCS based on the rate uncoated steel and concrete might corrode when buried in a soil. These index values are derived from soil texture, drainage, acidity, and electrical conductivity data. Both sets of values are depicted in the soil corrosion maps for Sonoma Water's service area as shown in Figures 14 and 15 for the water supply system. The figures show that except for the Sonoma aqueduct, which has a limited exposure to corrosive soils, all of Sonoma Water's aqueducts lie in highly corrosive soils. Sonoma Water has an active corrosion control program, and as a result there are no indications of prevalent corrosion related damage to the water transmission system.

Similar observations are made for the sanitation system Figures 25 and 26) and flood protection infrastructure (Figures 35 and 36) in general. However, for the sanitation collection systems, the pipelines typically comprise a larger variety of materials than the water transmission system. A significant portion of those materials are not highly vulnerable to corrosion. The non-earthen portions of the flood protection infrastructure, mostly built of reinforced concrete, would also potentially be vulnerable to a corrosive soil environment. Certain elements of the nearly 60-year-old Central Sonoma Watershed project, which provides the flood protection for much of the City of Santa Rosa, have exhibited evidence of corrosion in recent years. Neither the sanitation system nor flood protection infrastructure have an active corrosion control program like that of the water transmission system, although the sanitation systems do have an active video inspection program. Nonetheless, both the sanitation system and flood protection infrastructure would benefit from a more detailed corrosion assessment to understand present conditions and vulnerability more fully.

Fire Hazard

Fire is relevant to Sonoma Water's water supply and transmission system from a few perspectives: (a) potential damage that fires may directly cause to Sonoma Water's facilities, (b) firefighting demands on Sonoma Water's water supply system – that is, the emergency water supply needs of fire departments who may be relying on Sonoma Water to supply that water, and (c) residual water quality impacts and erosion/sediment filling the reservoirs.

Periodic fires are part of the natural environment and consist of four categories: wildland fires, urban-wildland interface fires, firestorms, and prescribed fires. Wildfires are fueled by naturally occurring trees, brush, and grasses; the urban-wildland interface fires are fueled by vegetation and built environment; firestorms occur during extreme weather and generally burn until conditions change or the available fuel is exhausted, and prescribed fires are controlled burns intentionally set for fire management.

For detailed discussions of how climate change may impact the probability and impact of fire events at each of Sonoma Water's facilities, see the "Climate Sensitivity" sections under "Russian River System" in Element B2a.

The behavior of wildfires is impacted by three principal factors that include topography, fuel, and weather. Topography is important because the movement of air over the terrain tends to direct a fire's course, and gulches and canyons can funnel air and act as a chimney. Saddles and ridgetops tend to offer lower resistance to the passage of air and will draw fires. Water tanks, which are often located on ridge tops, are susceptible to fire with south facing slopes being more susceptible because they receive higher solar radiation. Steeper uphill slopes tend to increase the rate of fire spread, whereas downhill slopes tend to slow down the rate of fire spread.

Fuel for fires is provided by the amount of vegetative material available. Different fuels have different burn qualities. For example, grasses release little energy but can sustain very high rates of spread. Moisture and continuity of fuel are also very important factors affecting the spread of fire.

Figures 12, 23, and 33 show the fire threat map in Sonoma County prepared by the California Department of Forestry and Fire Protection (CAL FIRE), overlain on the water supply, sanitation, and flood protection infrastructure, respectively. The maps show five threat classes that range from no threat to extreme threat.

Because of the wholesale nature of the water supply system, Sonoma Water does not have a direct responsibility to provide water for firefighting, excepting a very limited number of fire hydrants located along the aqueducts. Therefore, the most significant direct impact to Sonoma Water's systems from wildfires is primarily the effects of post-fire sedimentation or landslides into Lake Mendocino, Lake Sonoma, or the Russian River. Lake Sonoma is the main water supply for the Russian River and 600,000 people in Sonoma and northern Marin counties. A stand-replacing wildfire could result in catastrophic post-fire sedimentation or landslides into Lake Sonoma that would threaten the water supply function, infrastructure, downstream forest health, and water quality for both drinking water and habitat including endangered species of this critical watershed. Wildfires often degrade water quality due to increased sedimentation, dissolved organic carbon, metals, and nutrients.

Secondary erosion/landslide effects within a post-fire watershed could also cause sedimentation that will adversely impact flood protection infrastructure managed by Sonoma Water. Communication and electrical power systems such as those for pumping facilities and water storage facilities can also be impacted by wildfires. Further vulnerability details to Sonoma Water's systems from fire are described in Element B.

Omission of Natural Hazards That Can Affect the Jurisdiction

The following hazards are natural hazards identified by FEMA but are of low risk or no risk to the District and do not affect the District's infrastructure. Therefore, a detailed risk assessment was not completed for these hazards. These hazards will be assessed each year and could potentially move out of this category.

Tornadoes – Low Risk

Tornado intensities are rated on a Fujita Scale that ranges from 0-5. A Fujita Scale F0 tornado is defined by a wind speed range from 40-72 mph and is classified by light damage such as broken tree branches, and shallow rooted trees being pushed over. A Fujita Scale F1 is defined by a wind speed range from 73-112 mph and is classified by moderate damage: roof panels start to tear from houses, mobile homes are pushed off their foundations, or moving vehicles pushed off the road. A Fujita Scale F2 is defined by a wind speed range from 113-157 mph and is classified by considerable damage: roof tear from houses, mobile homes demolished, large tree snaps, or light-object missiles generated.

Tornadoes do not regularly occur in California and pose minimal risk to the jurisdiction. In the last 70 years, there have been 337 tornadoes in 48 counties of California, but no deaths have occurred from the incidents. Over half of the tornadoes in California have been rated F0 on the Fujita Scale, about 40% have reached F1, and less than 10% were rated F2 or above. Based on historical tornado data files from the Storm Prediction Center (operating under the National Oceanic and Atmospheric Administration – NOAA), thirteen tornadoes occurred between 1958 and 2011 (the most recent) in Sonoma County, with the highest intensity of F2 from the June 1, 1958 tornado, which resulted in 1 injury.

Hurricanes – No Risk

California is at low risk for hurricanes, primarily because the sea surface temperatures of waters off California are cold even during the summer months. Hurricane, or tropical cyclone, formation requires very warm waters that extend to a depth of 160-feet. Additionally, the general path of hurricanes in the eastern Pacific tends to move north-westward or westward due to steering by the prevailing upper-level winds; therefore, even if a hurricane does form near the coast of California, the wind would steer the hurricane out to sea and away from land. While no hurricanes have been found in NOAA’s recorded history, tropical storms do result from low pressure waves generated from the Gulf of Mexico. The tropical storms that occur are typically a result of subsided hurricanes but would still cause heavy rainfalls that may lead to flooding. Unlike floods or earthquakes, hurricanes primarily cause localized damage that also makes them a low hazard risk for the jurisdiction. In the event of a hurricane or tropical storm, the jurisdiction can continue the system operations using its SCADA system at two alternative locations.

Tsunamis – No Risk

Water displacement that occurs from earthquakes can cause a series of rapid, hazardous waves called tsunamis. As indicated on USGS Tsunami Inundation Maps, areas of tsunami danger in Sonoma County are limited to those with coastal exposure, namely in Archer Rock, Duncans Mills, Bodega Head, Valley Ford, Petaluma River, Sears Point, Cuttings Wharf, Petaluma Point, Mare Island, and Novato. The jurisdiction does not have coastal exposure and therefore are not anticipated to be affected by tsunamis. In the last 70 years, tsunamis have not impacted Sonoma County.

Agricultural and Silvicultural Pests and Diseases – Low Risk

Agricultural silvicultural pests and diseases can pose economic, environmental, and physical risks to agriculture and forests. However, they are unlikely to pose a significant risk to the jurisdiction.

Air Pollution – Low Risk

Air pollution is a gradual process which can be hazardous to public health. However, it is unlikely to pose a significant risk to the jurisdiction.

Aquatic Invasive Species – Low Risk

Non-indigenous species may be transported to new environments and become a permanent part of an ecosystem and result in imbalances. These imbalances can pose a risk to public health, the economy, and ecology. However, they are unlikely to pose a significant risk to the jurisdiction.

Avalanches – No Risk

Avalanches are caused by a large mass of snow, ice, and rocks that fall down steep mountainsides. Due to the mild climate of the county, avalanches are not considered to be a hazard to the jurisdiction.

Energy Shortage and Energy Resiliency – Low Risk

California receives different types of energy from variable sources. Energy risks include electric power disruptions (both intentional and unintentional), natural gas leaks resulting in disruption of service, and decrease in supply and increase in demand due to climate change.

The District is reliant on electric power for wastewater treatment, disposal and reclamation. Although recent power shutoffs have been due to wildfire risk (and not energy shortage), climate change may amplify shortages in energy and electric power disruptions in the future.

Epidemic/Pandemic/Vector Borne Disease – Low Risk

Epidemic, pandemic, and vector-borne disease pose a threat to public health. COVID-19, the most recent (and on-going) pandemic, is a highly infectious disease which can result in mild to severe health complications. Due to its highly contagious nature, many U.S. regions were ordered to shelter-in-place. During this time, non-essential work ceased or transitioned to a remote environment. Although the pandemic had a significant impact on personnel and required the implementation of COVID-19-specific procedures to allow for safe operations of the jurisdiction, it did not directly impact the system.

Extreme Heat – Low Risk

Extreme heat is defined as the occurrence of three or more consecutive severe heat days. Extreme heat may impact public health but is unlikely to impact the system directly.

Freeze – Low Risk

Sustained temperatures below freezing can impact public health and agriculture. Due to the mild climate of the county, freeze is not considered to be a hazard to the jurisdiction.

Severe Weather and Storms – Low Risk

Extreme weather describes a variety of events that are outside of the range of observed weather patterns and can include extreme rainfall events, heat waves, storms, unusually cold temperatures, and wind events. Due to climate change, the frequency of extreme weather and severe storms are expected to increase in the future. The primary hazards related to severe weather and storms are flooding and wildfire hazards.

Tree Mortality – Low Risk

Tree mortality primarily results from drought conditions coupled with high tree density and/or bark beetles. Tree mortality can create dangerous conditions for people who work in, live in, and/or visit the affected area as well as impact roads and power lines. However, tree mortality is unlikely to directly impact the jurisdiction.

Drought – Low Risk

Unlike typical natural disasters such as earthquakes, floods, or fires, drought occurs gradually over a multi-year period. One dry year does not normally constitute a drought in California. For example, the driest single year of California's measured hydrologic record was 1977. Significant portions of California are presently in a drought, with recent multi-year statewide droughts from 2012-2017 and 2008-2011. Following one of the lowest rainfall years on record in 2013, the Governor of the State of California proclaimed a State of Emergency due to drought conditions on January 17, 2014. On April 21, 2021, the State of California proclaimed a State of Emergency Proclamation due to drought conditions for Sonoma and Mendocino counties.

Defining when a drought begins is a function of drought impacts to water users and therefore, there is no universal definition of when a drought begins or ends. Impacts of drought are typically felt first by those most reliant on annual rainfall, such as ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable source. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

On February 25, 2014 and April 27, 2021, the Board of Supervisors of the County of Sonoma proclaimed a local emergency due to drought conditions. Sonoma County is currently experiencing a second consecutive dry year, which was preceded by the third driest water year (October 2019 – September 2020) on record over the last 127 years. In response to the ongoing drought conditions, Sonoma Water is managing both the existing water supplies in both Lake Mendocino and Lake Sonoma as well as the flows in Russian River. In 2021, Sonoma Water has reduced diversions from the Russian River by 24 percent.

The 2014 drought had significant impacts, including risks to water supply and agricultural and ecosystem water demands, as well as water quality and groundwater overdraft. Accordingly, the County's emergency proclamation led to several initiatives aimed at protecting and preserving reliable drinking water supplies, and providing environmental, agricultural, and economic relief to the region.

Droughts can have a significant environmental, social, and economic impacts, including lost jobs and revenues in the landscaping and nursery industries, unemployment, and other impacts in farming dependent regions, increased risk of wildfire, additional cost for homeowners to replace lawns and landscaping, loss of forests, decline in fish population, lost revenues to water-based recreation businesses and reduced hydroelectric power generation. Droughts result in a decline of revenues and an increase in operational costs for water agencies. The former occurs due to voluntary or mandatory reductions in water use and the later due to additional cost of purchasing water, deepening wells, or implementing water education and conservation campaigns.

The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM categories show experts' assessments of conditions related to drought. These experts check variables including temperature, soil moisture, stream flow, water levels in reservoirs and lakes, snow cover, and meltwater runoff. They also check whether areas are showing drought impacts such as water shortages and business interruptions. Associated statistics show what proportion of various geographic areas are in each category of dryness or drought, and how many people are affected. U.S. Drought Monitor data go back to 2000.

The jurisdiction is located in the portion of Sonoma County that experiencing severe (D3) drought as shown in Figure 4. However, drought does not directly affect any Sonoma Water infrastructures; therefore, we have this hazard in the low-risk section of the LHMP.

B1b. Locations of Natural Hazards That Can Affect the Jurisdiction

Please refer to the General Description of All Hazards That Can Affect the Jurisdiction (B1a) as well as the hazard maps in Appendix E for each hazard's geographical range.

B1c. Extent of Natural Hazards That Can Affect the Jurisdiction

Please refer to the General Description of All Natural Hazards That Can Affect the Jurisdiction (B1a) for each hazard's range of anticipated intensities.

B1d. Previous Occurrences of Hazard Events

Previous Earthquake Events

The Bay Area has experienced at least nineteen earthquakes greater than Magnitude 6.0 during the last 150 years. The largest of these was the April 21, 1906 Great San Francisco earthquake [26,27]. The Magnitude 7.8 earthquake caused extensive damage in the San Francisco Bay Area, including Sonoma County. Other significant historic earthquakes that caused substantial damage in the Bay Area include the 1838 San Andreas earthquake, the 1868 earthquake on the Hayward Fault, and the Loma Prieta earthquake in 1989.

The most recent Bay Area earthquake to cause major damage was the Magnitude 6.0 South Napa Earthquake that occurred on August 24, 2014. This earthquake, located on the West Napa Fault, was centered in American Canyon. Eight miles of surface rupture and strong shaking caused extensive damage to Napa County structures, including more than 100 water pipe failures, or a failure of about .5 repairs per km of water pipe for the City of Napa. The afterslip amounted to as much as 14 inches of displacement on top of the 18 inches of surface slip that occurred during the event, causing ongoing damage to foundations and underground utilities. [28]

For the Bay Area, a plot of moderate to large earthquakes on a time scale (Figure 2) shows that the seismic activity in the region prior to the 1906 earthquake was significantly higher than activity following it. Most likely, this is because the 1906 earthquake created a stress shadow by substantially relaxing stress on all of the Bay Area faults that form the San Andreas Fault system [29]. As shown in Figure 2, there appears to be an increase in earthquake activity in the last three decades suggesting that the Bay Area might be emerging from the 1906-induced stress shadow, and that faults that have been quiescent during the past century may now once again become more seismically active.

The most recent earthquakes on the Rodgers Creek fault occurred on September 13, 2022 near Santa Rosa. Earthquakes on the fault also occurred on October 1, 1969 near Santa Rosa, as two Magnitude 5.6 and 5.7 events located within a kilometer of each other [30,31,32, 33]. The earthquakes struck within a span of about 1.5 hours and resulted in considerable damage to the Santa Rosa water distribution system, including cracks in the Lake Ralphine Dam. Prior to the 1969 events, the other known earthquake on the fault was the 1898 Mare Island event with a magnitude in the 6.2 to 6.7 range.

Previous Flood Events

Table 7 shows the highest recorded historic crests of the Russian River at Guerneville between 1940 and 2023. [34,35] The measurements in this table since 1995 are from the Johnson's Beach USGS Gage (#11467002). [36] As a reference point for the recorded historic crests, National Weather Service (NWS) of the National Oceanic and Atmospheric Administration's (NOAA) definitions for flood stages at Guerneville [37] are defined as follows:

- 29 ft: Monitor stage.
- 32 ft: Flood stage. Minor flooding. Lower Mill Street in Guerneville and Old Bohemian Highway in Monte Rio are expected to flood.
- 32.5 ft: In Guerneville the intersection of HWY 116 and Neeley Rd is closed. Mays Canyon Rd by the old rodeo grounds is closed.
- 33 ft: In Guerneville the intersection of HWY 116 and Drake Rd is closed.
- 35 ft: Moderate flooding is forecast along the lower Russian River. Numerous businesses and residences in the lowest sections of towns within the reach are expected to flood.
- 36 ft: In Forestville Mirabel Park Resort and Mirabel trailer park flood. In Guerneville Fern Rd at HWY 116 floods.
- 37 ft: In Forestville Mirabel Rd at River Rd floods.
- 40 ft: Major flooding is expected along the Russian River. In Guerneville travel on River Rd becomes very difficult.
- 41.5 ft: In Guerneville, River Rd closed. In Monte Rio the main intersections flood.
- 44 ft: In Guerneville HWY 116 west of town closed. Travel in most areas is impossible.
- 45 ft: Disastrous flooding along the lower Russian River. Much of downtown Guerneville will become inundated.
- 49.5 ft: Flood of record. 2/18/1986 (102,000 cfs).

Note that the datum for the elevations listed in Table 7 and the NWS flood stage list above is 8.79 ft above NGVD29.

Table 7: Historic Crests for the Russian River at Guerneville [38,39]

Date	Historic Crests for Russian River at Guerneville (ft)
2/18/1986	49.50
1/10/1995	48.00
12/23/1955	47.62
12/23/1964	47.35
2/28/1940	46.87
2/27/2019	45.38
1/1/1997	44.99
1/2/1997	44.25
1/5/1966	42.50
1/1/2006	41.81
3/10/1995	41.45
1/24/1970	41.30
2/1/1963	41.10

1/17/1974	40.70
1/27/1983	40.40
2/25/1958	40.20
1/17/1978	39.50
1/14/1969	39.50
1/22/1943	39.50
1/21/1967	39.30
12/20/1981	39.00
2/6/1942	39.00
1/17/1954	38.35
1/8/1960	38.10
1/12/1973	37.90
1/11/2017	37.80
2/4/1998	36.60
2/13/1975	36.60
12/4/1970	36.50
1/21/1993	36.30
2/7/1998	36.04
1/14/1980	36.00
2/13/1962	35.80
12/28/1945	35.22
12/4/1950	34.70
12/25/1983	34.20
1/10/1953	34.15
12/12/2014	33.42
2/20/1998	33.06
2/16/1959	32.50
1/10/2023	31.83
4/5/1941	31.80
12/24/2012	30.36

Significant historic floods occurred on the Russian River in 1955, 1964, 1986, 1995, 1997, 2006, 2017, 2019, and 2023. The earliest major flood recorded on the Russian River occurred in 1862. This flood predated gauge measurements of river flow but is estimated to have had a discharge of about 100,000 cubic feet per second. The largest flood in recent history occurred between February 14 and 18, 1986, when a peak discharge of 102,000 cubic feet per second was recorded and the flood reached a gage height of 49.5 feet at Guerneville. [40]

In February 2019, the Russian River crested at a historic height of 45.5 feet, or 13 feet above flood level. Governor Gavin Newsom declared a state of emergency in Sonoma County and four other Northern California counties due to flooding caused by severe storms. In January and February 2017, Sonoma

Water and significant portions of the State of California, experienced extensive flooding and associated landslides, mudslides, and riverine erosion. Locally, the Board of Supervisors of the County of Sonoma adopted Resolution 17-0025 on January 13, 2017, and Resolution 17-0079 on February 21, 2017, ratifying disaster proclamations of local emergencies. The Governor issued State Emergency Proclamations on January 23, 2017 and March 7, 2017, declaring states of emergency and requesting Federal Disaster Declarations. Federally, FEMA issued three Major Disaster Declarations in 2017 for severe winter storms, flooding, and mudslides in California between January 3, 2017 and February 23, 2017 (DR-4301, DR-4305, and DR-4308). Sonoma Water infrastructure was damaged during the storms covered by these declarations.

Sonoma County was included in the DR-4301 and DR-4308 disasters, and Sonoma Water applied for Public Assistance funding under these events to repair damage to the Mirabel-Wohler facilities, and for the emergency debris removal project at Green Valley Creek. Sonoma Water also incurred damage at the Russian River County Sanitation District (Russian River CSD), and emergency response costs throughout the sanitation systems. The extensive flooding from these storms caused sanitary sewer overflows in the Penngrove Sanitation Zone, Sonoma Valley County Sanitation District, and Russian River CSD; power failures and loss of auxiliary power at Russian River CSD; damage to roads, electrical equipment, and the infiltration ponds at Mirabel-Wohler facilities, as well as extensive debris accumulation within the Mirabel fish gallery and on the inflatable dam; and damage to engineered features within Riverfront Park. During these events the Russian River rose approximately 40 feet in portions of the Mirabel-Wohler facilities, as described on the DR-4301 FEMA Public Assistance Project Worksheets for Mirabel-Wohler.

State and Federal disaster proclamations and declarations are issued when flood stages or damage thresholds are reached. Table 8 shows the flood-related Federal and State disaster declarations that include Sonoma County.

Table 8: Sonoma County Flood-Related Federal and State Disaster Declarations [41]

Disaster #	Year	Disaster Name	Disaster Type	Disaster Cause	Counties & Cities Declared	Federal or State Declaration Date
DR-4683	2022	California Severe Winter Storms, Flooding, and Mudslides	Flood	Storms	Alameda (County) Amador (County) Calaveras (County) Contra Costa (County) Mendocino (County) Merced (County) Monterey (County) Sacramento (County) San Joaquin (County) San Luis Obispo (County)	January 14, 2023

					San Mateo (County) Santa Barbara (County) Santa Cruz (County) Ventura (County)	
DR-4434	2019	California Severe Winter Storms, Flooding, and Mudslides	Flood	Storms	Marin, Mendocino, Napa, Humboldt, Lake, Sonoma	5/18/2019 (Federal)
DR-4308	2017	California Severe Winter Storms, Flooding, and Mudslides	Flood	Storms	Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Kings, Lake, Lassen, Marin, Mariposa, Merced, Modoc, Mono, Monterey, Napa, Nevada, Plumas, Sacramento, San Benito, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tule River Indian Reservation, Tuolumne, Yolo, Yuba	4/1/2017 (Federal)
DR-4301	2017	California Severe Winter Storms, Flooding, and Mudslides	Flood	Storms	Alameda, Amador, Butte, Calaveras, Contra Costa, El Dorado, Humboldt, Inyo, Lake, Lassen, Marin, Mendocino, Merced, Mono, Monterey, Napa, Nevada, Placer, Plumas, Sacramento, San Benito, San Luis Obispo, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Sutter, Trinity, Tuolumne, Yolo, Yuba	2/14/2017 (Federal)
DR-1646	2006	2006 June Storms	Flood	Storms	Alameda, Amador, Calaveras, El Dorado, Lake, Madera, Marin, Merced, Napa, Nevada, Placer, San Joaquin, San Mateo, Santa Cruz, Sonoma, Stanislaus, Tuolumne counties + statewide HM	6/5/2006 (Federal)
DR-1628	2005 2006	2005/06 Winter Storms	Flood	Storms	Alameda, Alpine, Amador, Butte, Colusa, Contra Costa, Del Norte, El Dorado, Humboldt, Lake, Lassen, Marin, Mendocino, Napa, Nevada,	2/3/2006 (Federal)

					Placer, Plumas, Sacramento, San Joaquin, San Luis Obispo, San Mateo, Santa Cruz, Sierra, Siskiyou, Solano, Sonoma, Sutter, Trinity, Yolo, Yuba counties + statewide HM	
GP 2003	2003	State Road Damage	Road damage	Flood	Alameda, Colusa, Contra Costa, Del Norte, Humboldt, Lake, Marin, Mendocino, Napa, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, Trinity	1/1/2003 (State)
GP 99-03	1999	Sonoma Road Failure	Road damage	Flood	Sonoma	3/29/1999 (State)
DR-1203	1998	1998 El Nino Floods	Flood	Storms	Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Fresno, Glenn, Humboldt, Kern, Kings, Lake, Los Angeles, Marin, Mendocino, Merced, Monterey, Napa, Orange, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Ventura, Yolo, Yuba, Del Norte	2/9/1998 (Federal)
DR-1155	1997	1997 January Floods	Flood	Storms	Alpine, Amador, Butte, Colusa, Del Norte, El Dorado, Glenn, Humboldt, Lake, Lassen, Modoc, Napa, Nevada, Plumas, Sacramento, San Joaquin, Sierra, Siskiyou, Solano, Sonoma, Sutter, Tehama, Trinity, Yuba, Calaveras, Madera, Mono, Monterey, Placer, San Benito, San Luis Obispo, San Mateo, Santa Cruz, Shasta, Stanislaus, Tuolumne, Yolo, Contra Costa, Fresno, Marin, Tulare, Mariposa, Merced, Santa Clara, Alameda, San Francisco, Kings, Mendocino	1/4/1997 (Federal)
DR-1044	1995	1995 Severe Winter Storms	Flood	Storms	Los Angeles, Orange, Humboldt, Lake, Sonoma, Butte, Colusa, Contra Costa, Del Norte, Glenn, Kern, Lassen, Mendocino, Modoc, Monterey, Napa, Placer, Plumas, San Luis Obispo,	1/13/1995 (Federal)

					Santa Barbara, Santa Clara, Santa Cruz, Tehama, Ventura, Yolo, Yuba, Alpine, Amador, Nevada, Riverside, Sacramento, San Bernardino, San Mateo, Shasta, Sutter, Trinity, San Diego, Alameda, Marin, Fresno, Kings, El Dorado, Madera, Solano, Siskiyou	
DR-979	1992	1992 Late Winter Storms	Flood	Storms	Alpine, Los Angeles, Humboldt, Napa, Santa Barbara, Culver City (Los Angeles County), City of Los Angeles (Los Angeles County), Contra Costa, Mendocino, Sonoma, Fresno, Imperial, Madera, Monterey, San Bernardino, Sierra, Tehama, Trinity, Tulare, Modoc, Orange, Riverside, Lassen, Siskiyou, Plumas, San Diego	1/15/1993 (Federal)
DR-758	1986	1986 Storms	Flood	Storms	Humboldt, Napa, Sonoma, Glenn, Lake, Marin, Modoc, Sacramento, Santa Clara, Santa Cruz, Solano, Yuba, Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Lassen, Mendocino, Nevada, Placer, Plumas, San Joaquin, Sierra, Sutter, Tehama, Tuolumne, Yolo, Fresno, Madera, San Mateo, Alameda, Contra Costa, Del Norte, Trinity, Mono, San Benito, Shasta	2/18/1986 (Federal)
DR-677	1982 1983	Winter Storms	Flood	Flood	Contra Costa, San Joaquin, Sacramento, Marin, San Mateo, Los Angeles, San Diego, Alameda, Orange, San Benito, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sonoma, Ventura, Trinity, Colusa, Lake, Mendocino, Monterey, San Luis Obispo, Solano, Yolo, Butte, Glenn, Kern, Kings, San Bernardino, Sutter, Tehama, Merced, Del Norte, Fresno, Madera, Napa, Placer, Riverside, Stanislaus, Tulare, Humboldt, Mariposa, Nevada, Yuba	2/9/1983 (Federal)
DR-651	1982	1982 Winter Storms	Flood	Storms	Alameda, Santa Clara, Solano, San Joaquin, Contra Costa, Humboldt, Marin, San Mateo, Santa Cruz, Sonoma	1/7/1982 (Federal)

DC-78-06-11	1978	Heavy rains excluded	Flood	Storms	Santa Clara, Solano, Sonoma, Tuolumne, Colusa	2/13/1978 (State)
DR-253	1969	1969 Storms	Flood	Storms	Los Angeles, San Luis Obispo, Fresno, Inyo, Riverside, San Bernardino, Santa Barbara, Tulare, Ventura, Amador, El Dorado, Kern, Kings, Madera, Modoc, Mono, Monterey, Orange, Placer, Sacramento, San Joaquin, Shasta, Solano, Stanislaus, Tuolumne, Mariposa, Merced, Calaveras, San Benito, Sierra, Contra Costa, Humboldt, Mendocino, Sonoma, Plumas, Tehama, Yuba, Butte, Marin, Yolo	1/26/1969 (Federal)
DR-183	1964	1964 Late Winter Storms	Flood	Storms	Del Norte, Humboldt, Shasta, Mendocino, Colusa, Glenn, Lassen, Plumas, Sierra, Siskiyou, Sonoma, Sutter, Tehama, Trinity, Amador, Butte, El Dorado, Modoc, Nevada, Placer, Yuba, Alpine, Lake, Sacramento, Yolo, Marin	12/29/1964 (Federal)

Data obtained from NOAA [42] and presented in Table 9 shows major flood-related events in Sonoma County with additional impact information.

Table 9: Major Flood-Related Events in Sonoma County

Hazard	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
Flash Flood	January 20, 1993	7:15 AM	N/A	0	0	$500K	0
	March 9, 1995	10:34AM	N/A	0	0	$3.5M	$0.5M
	February 2, 1998	6:50 PM	N/A	0	0	$2.0M	0
	February 3, 1998	4:00 AM	N/A	0	0	$5.0M	0
	February 3, 1998	9:30 AM	N/A	0	1	$200K	$159K
	February 4, 1996	10:00 AM	N/A	0	0	0	0
	December 31, 1996	7:00 PM	N/A	1	0	0	0
	January 3, 1997	8:00 PM	N/A	1	0	0	0

Hazard	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
	February 5, 1998	6:00 PM	N/A	0	0	0	0
	February 6, 1998	12:22 PM	N/A	0	0	0	0
	February 7, 1998	1:18 PM	N/A	0	0	0	0
	February 13, 2000	10:00 AM	N/A	0	0	0	0
	February 13, 2000	9:00 PM	N/A	0	0	0	0
	January 11, 2001	10:00 AM	N/A	0	0	$7.0M	0
	December 16, 2002	2:00 AM	N/A	0	0	0	0
	January 25, 2008	8:00 PM	N/A	0	0	$800K	0
	November 30, 2012	1:00 PM	N/A	0	0	0	0
	November 30, 2012	3:00 PM	N/A	0	0	0	0
	December 2, 2012	9:00 AM	N/A	0	0	$0.5K	0
	December 2, 2012	10:00 AM	N/A	0	0	$0.5K	0
	December 23, 2012	8:31 AM	N/A	0	0	$0.5K	0
	December 23, 2012	11:16 AM	N/A	0	0	$1.0K	0
	December 23, 2012	2:46 PM	N/A	0	0	$0.5K	0
	February 8, 2014	2:31 PM	N/A	0	0	$5K	0
	December 11, 2014	10:20 AM	N/A	0	0	$5K	0
	December 15, 2016	12:03 PM	N/A	0	0	0	0

Hazard	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
	December 15, 2016	1:42 PM	N/A	0	0	0	0
	December 15, 2016	2:00 PM	N/A	0	0	0	0
	January 4, 2017	2:00 AM	N/A	0	0	$5.0K	$5.0K
	January 8, 2017	3:30 AM	N/A	0	0	0	0
	January 8, 2017	7:00 AM	N/A	0	0	0	0
	January 8, 2017	8:15 AM	N/A	0	0	0	0
	January 10, 2017	12:18 PM	N/A	0	0	0	0
	January 10, 2017	1:20 PM	N/A	0	0	0	0
	January 18, 2017	7:30 PM	N/A	0	0	0	0
	January 18, 2017	7:45 PM	N/A	0	0	0	0
	January 20, 2017	4:45 AM	N/A	0	0	0	0
	January 22, 2017	4:15 AM	N/A	0	0	0	0
	February 9, 2017	12:00 PM	N/A	0	0	0	0
	February 9, 2017	2:42 PM	N/A	0	0	0	0
	March 22, 2018	4:30 AM	N/A	0	0	0	0
	January 16, 2019	1:45 PM	N/A	0	0	0	0
	January 16, 2019	4:30 PM	N/A	0	0	0	0
	January 16, 2019	7:24 PM	N/A	0	0	0	0
Heavy Rain	December 12, 1995	2:45 AM	N/A	0	0	0	0
	December 29, 1996	12:00 AM	N/A	0	0	0	0
	January 2, 1998	4:00 AM	N/A	0	1	0	0
	January 1, 2002	3:00 AM	N/A	0	0	$200K	0
	December 15, 2002	8:00 PM	N/A	0	0	0	0

Hazard	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
	December 16, 2008	7:00 AM	N/A	0	0	$25K	0
	May 5, 2009	6:30 AM	N/A	1	1	$50K	0
	October 24, 2010	11:00 AM	N/A	0	0	0	0
	February 16, 2011	-	N/A	0	0	0	0
	March 24, 2011	5:00 AM	N/A	0	0	$28.5K	0
	June 4, 2011	1:00 AM	N/A	0	0	0	$20M
	November 30, 2012	5:46 AM	0	0	0	0	0
	December 22, 2012	2:25 PM	0	0	0	$30K	0
	February 8, 2014	10:30 AM	0	0	0	0	0
	September 26, 2014	5:25 PM	0	0	0	0	0
	December 11, 2014	3:20 AM	0	0	0	0	0
	December 11, 2014	8:09 AM	1	0	0	0	0
	December 11, 2014	11:18 AM	0	0	0	0	0
	December 11, 2014	1:22 PM	0	0	0	0	0
	February 8, 2015	8:30 AM	0	0	0	$25K	0
	February 9, 2015	4:02 AM	0	0	0	0	0
	January 16, 2019	2:50 PM	N/A	0	0	0	0
Winter Storm	November 21, 2013	9:40 PM	N/A	0	0	$5.0K	0

Hazard	Date	Time	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
	February 16, 1994	8:00 PM	N/A	0	0	$500K	0
	December 9, 1995	10:00 AM	N/A	1	15	$60M	$5.0M
	March 10, 1995	5:09 AM	N/A	0	0	0	0

Previous Fire Events

Historically, fire has been a hazard factor in Sonoma County due to the local climate and geography. Figures 11, 22 and 32 show historical fires that have occurred near Sonoma Water's water supply and transmission, sanitation system, and flood protection infrastructure respectively. In recent history, fire events have increased in both frequency and intensity.

2020

The 2020 California wildfire season, part of the 2020 Western United States wildfire season, was a record-setting year of wildfires in California. By the end of the year, 9,639 fires had burned 4,397,809 acres (1,779,730 ha), more than 4% of the state's roughly 100 million acres of land, making 2020 the largest wildfire season recorded in California's modern history (CAL FIRE, 2020), though roughly equivalent to the pre-1800 levels, which averaged around 4.4 million acres yearly and up to 12 million in peak years. California's August Complex fire has been described as the first "gigafire," burning over 1 million acres across seven counties—an area larger than the state of Rhode Island. The fires destroyed over 10,000 structures and cost over $12.079 billion (2020 USD) in damages, including over $10 billion in property damage and $2.079 billion in fire suppression costs. The intensity of the fire season has been attributed in part to over a century of poor forest management as well as increased warming due to climate change.

The LNU Lightning Complex fires were a large complex of wildfires that burned during the 2020 California wildfire season across much of the Wine Country area of Northern California – Lake, Napa, Sonoma, Solano, and Yolo Counties, from August 17 to October 2, 2020. The complex was composed of numerous lightning-sparked fires, most of which were small. However, while they initially started separate from each other, the Hennessey Fire eventually grew to merge with the Gamble, Green, Markley, Spanish, and Morgan Fires, scorching 192,000 acres (777 km^2) by itself, for a total burn area of 363,220 acres (1,470 km^2) in the complex. The fire, which burned in the hills surrounding several large cities, such as Fairfield, Napa, and Vacaville, destroyed 1,491 structures and damaged an additional 232. In all, six people were killed and another five injured. The LNU Lighting Complex is currently the fourth-largest wildfire in California's recorded history.

The 2020 Glass fire burned over 67,000 acres, destroying 1,555 structures and damaging 282 structures. A state of emergency was declared for Napa, Sonoma, and Shasta counties due to the Glass and Zogg fires.

2019

The 2019 Kincade fire burned roughly 77,758 acres and was the largest of the 2019 California wildfire season and the largest wildfire recorded in Sonoma County at the time before being surpassed by the LNU Lightning Complex fires in 2020.

2017

In 2017, there were a series of destructive fires throughout the region (Tubbs, Nuns, Atlas, Redwood Valley, Pocket, and Sulphur). The Tubbs Fire burned approximately 36,807 acres in Sonoma and Napa counties, destroyed 5,636 structures and killed 22 people. The Nuns Fire burned approximately 54,000 acres (34,398 in Sonoma County and 20,025 in Napa County), destroyed 1,355 structures and killed 3 people. The Atlas Fire burned approximately 51,624 acres in Napa and Solano Counties, destroyed 120 structures and killed 6 people. The Redwood Valley Fire burned approximately 36,523 acres in Mendocino County, destroyed 546 structures and killed 9 people. The Pocket Fire burned approximately 14,225 acres in Sonoma County, destroyed 6 structures. The Sulphur Fire burned approximately 2,207 acres in Lake County, destroyed 162 structures. In total, 2017 North Bay fires burned roughly 195,768 acres throughout the region.

2015 and Prior

Other historic fires include the Valley fire, which destroyed 76,067 acres in Sonoma, Lake, and Napa counties in 2015; the North Pass fire, which destroyed 41,983 acres in Mendocino County in 2012; and the Rumsey fire, which destroyed 39,138 acres in Napa and Yolo counties in 2004.

Table 10 shows some of the major fires in Sonoma County that burned over 1,000 acres, and Table 11 shows the federal and state disaster declarations resulting from fire in Sonoma County.

Table 10: Major Historic Fires in Sonoma County

Date	Location	Acres Burned
September - 1964	Wildfire Series: Hanley, Mt. George, Nuns Canyon in Napa and Sonoma County	71,500
	Hanley (Sonoma County)	52,700
	Nuns Canyon (Sonoma County)	10,400
1965	Wildfire Series: Glenn, Napa, and Sonoma County	113,766
	Knight's Valley (Sonoma County)	6,000

	Pocket Ranch (Sonoma County)	4,000
	Arrowhead (Sonoma County)	4,000
	Chileno Valley (Sonoma County)	5,000
	Pressley (Sonoma County)	5,500
	Coleman Valley (Sonoma County)	1,500
	Austin Creek (Sonoma County)	7,000
1972	Bradford	1,760
August - 1978	Creighton Ridge	11,405
August - 1988	Cloverdale	1,833
September - 1988	Geysers	9,000
August - 1996	Cavedale	2,100
October - 1999	Geyser Road	1,300
June - 2000	Berryessa (Napa and Sonoma)	5,731
September - 2004	Geysers (Sonoma and Lake)	12,525
November – 2013[43]	McCabe Fire (The Geysers)	3,505
September - 2015	Valley Fire (Lake, Napa, and Sonoma Counties)	76,067
September - 2016	Sawmill Fire	1,547
October – 2017	Tubbs Fire	36,807
October – 2017	Pocket Fire	17,345
October – 2017	Nuns Fire (Oakmont, Norrbom, Adobe, Pressley, and Patrick Fires merged)	56,556
October - 2019	Kincade Fire	78,758
August - 2020	LNU Lightning Complex (Walbridge) Fires	57,569
September - 2020	Glass Fire	67,000

Table 11: Sonoma County Fire-Related Federal and State Disaster Declarations

Disaster #	Year	Disaster Name	Disaster Type	Disaster Cause	Counties & Cities Declared	Federal Declaration Date
FM-5376	2020	Glass Fire	Fire	Fire	Napa, Shasta, Sonoma	9/27/2020
FM-5331	2020	LNU Lightning Fire Complex	Fire	Fire	Lake, Napa, San Mateo, Santa Cruz, Solano, Sonoma, Yolo	8/18/2020 (Federal)
DR-5295	2019	Kincade Fire	Fire	Fire	Sonoma	10/24/2019 (Federal)
DR-4344	2017	California Wildfires	Fire	Fire	Butte, Lake, Mendocino, Napa, Nevada, Orange, Sonoma, Yuba	10/10/2017 (Federal)
FM-2554	2004	Geysers Fire	Fire	Fire	Sonoma	9/4/2004

						(Federal)
-	1965	1965 Fires	Fire	Fire	Marin, Napa, Placer, Solano, Sonoma	9/18/1965 (State)
-	1964	Fires and High Winds	Fire	Fire	Napa, Sonoma, Santa Barbara	9/22 – 9/25/1964 (State)
-	1961	1961 Widespread Fires	Fire	Fire	Amador, Butte, El Dorado, Napa, Nevada, Placer, San Diego, Sonoma, Tehama	9/8/1961 (State)

B1e. Probability of Future Hazard Events and Effects of Future Conditions on Anticipated Intensities of Hazards

Probability of Earthquake Events

Recent work by the Working Group on California Earthquake Probabilities (WGCEP), a group of leading scientists, practitioners, and academics, has estimated very high probabilities (72%) of a major earthquake in the Bay Area in the next 30 years (Figure 3) [44]. The most significant contributor to this probability is the Rodgers Creek fault zone. The WGCEP has estimated a 33% probability for a major earthquake on the Rodgers Creek fault zone within the next 30 years. This value has been increased from WGCEP's 2012 estimate of 31%. The probability of earthquake on the Rodgers Creek fault zone is also higher than any other fault in the Bay Area, including the San Andreas Fault. Research studies show an average earthquake recurrence interval of 131-370 years for the portion of the fault located in Sonoma Water's service area [45, 46,47].

Ground Shaking Hazard

The distance of Sonoma Water's water supply and administration facilities from the nearest major Bay Area faults is shown in Table 12. The scenario PGA values include median and median plus one standard deviation estimates of PGA from a Magnitude 7.0 earthquake on the Rodgers Creek fault and were computed using the latest ground motion prediction equations [48, 49, 50, 51]. The probabilistic PGA values are those estimated by the United States Geological Survey (USGS) for a 10% probability of exceedance in 50 years (mean return period of 475 years) and a 2% probability of exceedance in 50 years (mean return period of 2,475 years) and are based on a detailed treatment of uncertainty [52]. These probability levels are typically used in seismic design of structures and form the basis of the seismic design codes such as the International Building Code [53] and the California Building Code [54]. The 2,475-year return period is considered as an acceptable upper bound for design against collapse.

The estimated median PGA values at the Agency's water supply and administration facilities from a Magnitude 7.0 earthquake on the Rodgers Creek fault range between 0.2g to 0.5g and the median plus one standard deviation values range from approximately 0.4g to 0.9g. Similarly, the probabilistic estimates for 475 year and 2,475-year return period range from approximately 0.4g to 0.6g and 0.6g to

1.1g, respectively. The highest predicted PGA values are at the Kawana and Ralphine tanks, Sonoma Booster station and at the Agency's administration facilities due to their proximity to the Rodgers Creek fault. Figure 8 shows the Agency's water supply system together with a plot of USGS estimates of PGA contours in Sonoma County.

The 475-year PGA values at Sonoma Water's sanitation facilities range from 0.3g for the Russian River County Sanitation District, Occidental County Sanitation District and portions of Sonoma Valley Sanitation District to 0.6g for portions of the Airport/Larkfield/Wikiup Sanitation Zone and South Park County Sanitation District (Figure 19).

Table 12: Peak Ground Acceleration (g) at Water Transmission Facilities

Facilities	Name	Distance to Fault (km)	Deterministic (M=7)		Probabilistic 10% in 50 Years	Probabilistic 2% in 50 Years
			Median	Median + □		
Diversion Facilities	Wohler Collector No 1	10.00	0.25	0.42	0.42	0.71
	Wohler Collector No 2	10.00	0.25	0.42	0.42	0.71
	Wohler Collector No 3	12.00	0.22	0.37	0.38	0.63
	Wohler Collector No 4	11.90	0.22	0.37	0.38	0.63
	Wohler Collector No 5	11.60	0.22	0.38	0.38	0.63
	Wohler Collector No 6	9.50	0.25	0.43	0.42	0.71
	River Diversion Structure (RDS)/Inflatable Dam	10.90	0.23	0.40	0.39	0.65
	Occidental Road Well	9.80	0.25	0.43	0.39	0.65
	Sebastopol Road Well	9.80	0.25	0.43	0.41	0.70
	Todd Road Well	9.10	0.26	0.45	0.40	0.67
Storage Facilities	Ralphine Tanks	3.30	0.41	0.71	0.49	0.88
	Cotati Tanks	8.80	0.27	0.45	0.41	0.70
	Forestville Tank	11.40	0.23	0.38	0.38	0.64
	Annadel No. 1 Tank	6.40	0.32	0.54	0.45	0.78
	Annadel No. 2 Tank	8.30	0.28	0.47	0.42	0.72
	Eldridge Tanks	8.50	0.27	0.46	0.40	0.67
	Sonoma Tanks	7.00	0.30	0.52	0.38	0.62
	Kastania Tank	7.80	0.29	0.49	0.49	0.87
	Kawana Springs Tank	1.00	0.50	0.86	0.55	1.01
Pump Stations	Forestville Booster Station	11.40	0.23	0.38	0.38	0.64
	Sonoma Booster Station	4.10	0.39	0.66	0.50	0.91
	Ely Booster Station	6.80	0.31	0.53	0.42	0.72
	Eldridge Booster Station	8.50	0.27	0.46	0.40	0.67
	Wilfred Booster Station	5.50	0.34	0.58	0.46	0.80
	Kastania Booster Station	7.80	0.29	0.49	0.49	0.86
	Kawana Booster Station	6.90	0.31	0.52	0.44	0.76
	River Road Chlorination Facility	11.40	0.23	0.38	0.38	0.64

Treatment Facilities	Mirabel Chlorination Facility	12.00	0.22	0.37	0.39	0.65
	Wohler Chlorination and Corrosion Control Facility	10.00	0.25	0.42	0.42	0.71
Administration Facilities	404 Aviation Blvd, Santa Rosa	2.40	0.45	0.76	0.59	1.07
	800 Aviation Blvd , Santa Rosa	2.40	0.45	0.76	0.59	1.07
	204 Concourse Blvd, Santa Rosa	2.40	0.45	0.76	0.59	1.07

Note: The peak ground acceleration values for rock/dense soil conditions with average shear wave velocity of 760m/s for top 30m. Deterministic ground motions were computer using the NGA relationships [40-43].

Among the historically active regional faults, those anticipated to significantly affect the performance of Sonoma Water's facilities include the following:

- San Andreas Fault
- Rodgers Creek - Healdsburg Fault
- Maacama Fault
- Hayward Fault

Discussions of ground shaking probability for each of these faults are presented in the following paragraphs. Unless otherwise noted, magnitude (M) refers to moment magnitude.

San Andreas Fault. The Working Group on California Earthquake Probabilities (Working Group 2003) has estimated that during the 30-year time period between 1990 and 2020, there is a 23 percent probability of an M 7 or larger earthquake occurring on the San Francisco Peninsula segment of the San Andreas fault, which extends northward from the Loma Prieta rupture segment, and a less than 5 percent probability of an M 8 earthquake along the north coast segments of the fault. More recent work (Working Group 2008) by the U.S. Geological Survey (USGS) has confirmed that these probabilities are still considered suitable. The maximum earthquake for the San Andreas Fault is judged to be in the range of M 7.75 to M 8 (moment magnitude); recent work (Niemi and Hall, 1992) indicates that on the average, an event of such magnitude can be expected to occur approximately every 200 to 300 years.

There are no traces of the San Andreas Fault that traverse or bisect any of the Sonoma Water's pipelines. The north coast segment of the San Andreas fault is located about 10 miles southwest of Guerneville. This report assumes an M 8 event on the north coast segment of the San Andreas Fault is the controlling event for the purposes of planning.

Rodgers Creek - Healdsburg Fault. The Working Group on California Earthquake Probabilities (Working Group 2014) has estimated that during a 30- year time period following 2014, there is a 32 percent probability of an M 6.7 or larger earthquake occurring along the Rodgers Creek Healdsburg Fault. For preliminary planning purposes, a Rodgers Creek M 7 might be assumed to occur within the next 100 to 300 years. Even higher magnitude events are considered possible, especially if the Rodgers Creek - Healdsburg and Hayward faults break in the same event, although the return period for such events is likely in excess of 1,000 years. Any earthquake on the Rodgers Creek – Healdsburg Fault with M 6.25 or larger is likely to produce surface rupture in Sonoma County.

Maacama Fault. This fault has been interpreted as a right stepping extension of the Rodgers Creek - Healdsburg Fault. Fault creep has been measured near Ukiah and Willits at about 5.6 to 7.6 mm per year. The most recent event is prehistoric and occurred between 1520 AD and 1650 AD. Trenches suggest a long-term slip rate of between 11 and 14 mm per year.

The southern section of the fault that is closest to Sonoma Water's facilities is about 33 miles long and could produce M 7 earthquakes. If the Maacama Fault breaks along both its southern, central and northern segments, magnitude could be M 7.7. No specific return period has been provided for earthquakes on the Maacama fault system. The seismic hazard in Table 12 includes contribution from the Maacama Fault.

Hayward Fault. The Working Group (2008) has estimated that during the 30-year time period from 2006 to 2036, there is a 31 percent probability of a M 6.7 (or larger) earthquake occurring on the Hayward fault. The maximum earthquake for the Hayward Fault is judged to be in the range of M 7 to M 7.25; the average recurrence of such events is estimated to be approximately 150 to 250 years.

Other Potentially Active Faults. There are a number of potentially active faults that are close to Sonoma County. The activity rates for these faults are relatively low, with the last large rupture over M 5, thought to be between 11,000 and 1,600,000 years ago.

For completeness, some of the known mapped faults are listed below:

- Joy Woods. About 6 miles south of the WWTP. Could produce M 5 to M 6 events.
- Bloomfield. About 9 miles south - southeast of the WWTP. Could produce M 5 to M 6.5 events.
- Americano. About 16 miles south - southeast of the WWTP. Could produce M 5 to M 6.5 events.
- Tolay. About 19 miles southeast of the WWTP. Could produce M 5 to M 6.5 events.
- Point Reyes. Under the Pacific Ocean, about 19 miles southwest of the WWTP. Could produce M 5 to M 7.5 events.
- Alexander. About 15 miles northeast of the WWTP. Could produce M 5 to M 6.8 events.
- Unnamed. Several unnamed faults, about 5 to 7 miles northeast of the WWTP. Could produce M 5 to M 6.5 events.

Probability of Flood Events

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a one-percent chance of being equaled or exceeded in any given year. The "annual flood" is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only. It is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period, and the same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a one-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

The intensity, distribution, and duration of rainfall are the most important factors in determining the magnitude of floods. If a storm event extends many hours or days, flooding can be exacerbated as soils become saturated, reservoirs fill, and runoff from the upland and upstream areas accumulates downstream. Table 13 indicates the rainfall levels that are expected to fall in the low and high rainfall areas of the county during a 24-hour period based on the NOAA NWS Precipitation Frequency Data Server. For detailed discussions of how climate change may impact the probability of flood events at each of Sonoma Water's facilities, see the "Climate Sensitivity" sections under "Russian River System" in Element B2a.

Table 13: Precipitation Frequency Intervals Associated with 24-Hour Storm Event in Sonoma County

Recurrence Interval	Southeast County, Sonoma (inches)
2-year	3.2
10-year	4.6
25-year	5.5
50-year	6.2
100-year	7.0

Probability of Fire Events

The wildfire season in Sonoma County generally begins in June and ends in mid-October; however, wildfires have occurred in every month of the year. Drought and local weather conditions can expand or shorten the length of the fire season. The early and late shoulders of the fire season are usually associated with human-caused fires. The peak months of July, August, and September are usually related to thunderstorms and lightning strikes.

Wildfire frequency and severity are projected to increase in Northern California as a result of climate change, resulting in hotter, drier weather with longer summers and expanded fire seasons for the region. In a study for northern California, future climate scenarios including warmer and windier conditions resulted in projected wildfire that burned more intensely and spread faster in most locations (Fried et al., 2004), although local coastal influence may dampen this effect.

For detailed discussions of how climate change may impact the probability of fire events at each of Sonoma Water's facilities, see the "Climate Sensitivity" sections under "Russian River System" in Element B2a.

B2. Hazard Impacts and Community Vulnerability

Risk assessments have been conducted to determine the potential impacts of hazards to customers, the economy, and the environment. Risk assessments provides a base for the rest of the mitigation planning process and helps to identify and prioritize actions that reduce the risk from hazards.

B2a. and B2b. Summary of the Jurisdiction's Vulnerability to Identified Hazards and Potential Impacts of Hazards on the Jurisdiction

The purpose of completing the vulnerability analysis is to assess the extent to which Sonoma Water facilities can withstand the applicable hazards discussed in Element B. Mitigations and future emergency operations plans will serve as a guide for planning and developing a response to natural hazards; effects of hazards on the Sonoma Water system will be based on the identified vulnerabilities of the system.

The vulnerability assessment included a review of data collected, as-built drawings of the system, and a field review of the system. Potholing as well as underground and in-pipe investigations were not included in the assessment.

The following sections describe the significant vulnerabilities of the Sonoma Water facilities. This vulnerability assessment emphasizes the geologic and seismic hazards (including earthquake and creek hazards) discussed in Element B, because earthquakes pose the highest risk. Additionally, the vulnerabilities associated with the lower risk hazards would be similar to those identified and associated with earthquakes.

Water Supply System and Risk Assessment

Sonoma Water's water supply system is shown in Figure 5. The primary source of water for the system is a ground water aquifer located in the Mirabel Park area just north of the town of Forestville. The aquifer is adjacent to the Russian River and charged by the river by natural filtration through an approximately 60-foot-thick sand and gravel riverbed. Water from the aquifer is pumped by six Ranney-type collector wells and released into 88.6 miles of large diameter pipelines (aqueducts) that transmit water throughout Sonoma Water's service area. Three of the six collectors are located along the eastern bank of the river in the Wohler area and are referred to as the Wohler collectors, and the remaining three are located along the western bank of the river in the Mirabel area and are known as the Mirabel collectors. On average, the Mirabel and Wohler collectors can each provide a sustained flow of approximately 15 million gallons daily (mgd). In addition to the collector wells, the water supply system has ten conventional wells that can supplement the water supply provided by the collectors. Seven of these wells are located along the Russian River in the general vicinity of the collectors, while the remaining three are located in the Santa Rosa Plain near Sebastopol.

The water transmission system has eight booster pump stations that provide the necessary head to move the water through the system. Water storage is provided by 18 steel storage tanks with a collective storage capacity of 122.1 million gallons. Sonoma Water maintains two major reservoirs: Lake Mendocino, impounded by the 164-foot-tall Coyote Valley Dam, and Lake Sonoma, impounded by the 319-foot-tall Warm Springs Dam. Other facilities include an inflatable rubber dam on the Russian River, river water intake screens, two fish ladders and a fish viewing gallery, a river diversion structure, a system of ditches, sedimentation pond, infiltration ponds and a levee, three water treatment facilities, an electric power substation, a hydroelectric plant, and several emergency power generators.

The key facilities that constitute the water supply system are summarized below:

- **Russian River system**– includes Dry Creek, the Russian River, the Russian River aquifer, and the Warm Springs (319 feet tall) and Coyote Valley (164 feet tall) earth-fill embankment dams.
- **Diversion facilities**– includes collector wells, inflatable dam, intake screen and brushes, River Diversion Structure (RDS), Mirabel well field, levees and diversion channels in the Wohler-Mirabel area, infiltration ponds, fish ladders, and the fish viewing gallery.
- **Aqueducts**– includes all of the aqueducts that transport water from the diversion system facilities to storage tanks and to Sonoma Water's contractors through tie-ins throughout the system.
- **Storage facilities**– includes 18 storage tanks at eight locations (Annadel, Cotati, Eldridge, Forestville, Kastania, Kawana, Ralphine, and Sonoma) that provide 128.8 million gallons of storage.
- **Pumping facilities** – includes 8 booster stations (Eldridge, Ely, Forestville, Kastania, Kawana, Sonoma Booster No. 1, Sonoma Booster No. 2, and Wilfred). Note that Kastania is largely decommissioned, aside from telemetry equipment.
- **Treatment facilities**– includes three chlorination and corrosion control facilities.
- **Power system for Water Supply**– includes the electric substation at the Wohler corporation yard, fixed and portable emergency generators, and the 12kV power line.
- **Supplementary facilities**– includes the ten conventional wells that supplement the water supply provided by the collectors.

The primary vulnerability assessment of Sonoma Water's water supply facilities, known as the Natural Hazard Reliability Assessment (NHRA), was performed in 2004 to 2007 and formed the basis for Sonoma Water's first LHMP in 2008.This comprehensive effort reviewed drawings, conducted site reconnaissance and as-needed engineering calculations (ranging from simplified to detailed) to analyze water supply system vulnerabilities. The NHRA showed that portions of the system lack redundancy and a single pipe break or loss of a single component, such as a key pump station, can result in significant disruption. The NHRA assessed the impact of these vulnerabilities on system response through a detailed hydraulic model of the system. A range of damage scenarios were postulated and the system response in terms of loss of pressure at the contractor turnout and loss of storage in the tanks was studied. The analyses showed that within a matter of hours, one or more such failures can deplete water storage and cause significant pressure loss at turnouts serving the contractors.

In addition to the NHRA's vulnerability assessment of Sonoma Water's water supply infrastructure, the NHRA performed an overview of the water distribution systems of Sonoma Water's contractors and a qualitative assessment of their potential seismic vulnerabilities. The purpose of this work was to assess the potential for major breaks in the distribution systems and their likely impact on Sonoma Water's water transmission aqueducts. A major break or multiple leaks within the contractor's system could impose significant additional demands on the aqueducts during and after an emergency. This assessment showed that the contractor systems are subject to similar hazards and are vulnerable to significant damage. An uncontrolled release of water from the contractor system will impose excessive demands on Sonoma Water's water system and means to monitor contractor system response through flow measuring devices at turnouts was recommended. The NHRA was updated in 2022 to incorporate recent seismic hazard data and evaluate direct service disruption impacts to the water system in a major earthquake.

The 2008, 2013, and 2018 LHMPs' vulnerability information for the water supply infrastructure was based on the 2008 NHRA's assessment because the water supply system vulnerabilities have not changed significantly since the NHRA was completed. That being said, water supply vulnerability information was updated for the present LHMP based on the recent 2022 NHRA to include specific new or reassessed conditions--particularly to reflect reductions in vulnerability as a result of progress on past mitigation actions. Figures 5 through 15 show the water supply system overlain on maps of Sonoma Water's identified primary hazards from Element B. The sections below describe the key vulnerabilities to the water supply infrastructure associated with the identified primary hazards.

Russian River System

The primary source of water for Sonoma Water's water system is the Russian River, which recharges an aquifer beneath and adjacent to the river through the overlying gravel layer by natural filtration. The most significant vulnerabilities to this water source consist of possible contamination and increased turbidity resulting from major floods, wildfires, debris flow, landslides, and drought, exacerbated by climate change. A hazardous material spill from an accident can also result in possible contamination. The effect of such contamination can be minimized, depending upon its extent, by releasing water from the upstream dams to flush contaminants. The Sonoma County Sonoma Water's Emergency Operations Plan addresses such events. During a major earthquake, permeability of the aquifer could be lost due to liquefaction or dynamic densification of the gravel resulting in compression or dilation of the aquifer. Significant loss of production capacity during a short time following a major earthquake can occur, but generally the aquifers tend to recover after a period of time. Such changes have been observed in past earthquakes.

Lake Mendocino is located on the East Fork Russian River three miles northeast of Ukiah. It was formed by the construction of the Coyote Valley Dam by the United States Army Corps of Engineers (USACE) in 1959. The dam is a 164-foot rolled earth embankment used for water storage and flood control purposes. Sonoma Water and the Mendocino County Russian River Flood Control and Water Conservation Improvement District share permits from the State for rights to store up to 111,000 acre-feet of water from May 11 – September 30 in the reservoir. Sonoma Water has the exclusive right to control the releases of water from the water supply pool in Lake Mendocino because it was the local sponsor for the dam project. When the water level rises above the top of the water supply pool and into the flood control pool, the USACE assumes control of releases.

Lake Sonoma is located approximately 14 miles northwest of Healdsburg at the confluence of Warm Springs Creek and Dry Creek. The reservoir was formed in 1982 by the construction of Warm Springs Dam, a 319-foot-high rolled earth dam, constructed by the USACE. Similar to Lake Mendocino, Sonoma Water has exclusive rights to control the rate of release of water from the water supply pool in Lake Sonoma. When the water level in the lake rises above elevation 451 feet and goes into the flood control pool, the USACE assumes control of the water release. The Warm Springs Dam includes a hydroelectric turbine, discussed below.

The Warm Springs and Coyote Valley dams are located within close proximity of major active faults. The Warm Springs dam is located 4 kilometers from the Healdsburg fault, a northward extension of the Rodgers Creek fault, and 10 kilometers from the Maacama, 23 kilometers from the Hayward, and 29 kilometers from the San Andreas Fault. The Coyote Valley dam is located 1.4 kilometers from the Maacama fault, and more than 50 kilometers from the San Andreas, Rodgers Creek, and Healdsburg faults. The USACE is responsible for dam safety. Sonoma Water will work with the Corps to develop a plan to address the identified vulnerabilities at Lake Sonoma and Lake Mendocino, to include the Warm Springs and Coyote Valley dams, in future LHMP updates.

A wildfire in the Russian River system could set off a series of events that would significantly alter Sonoma Water's ability to provide drinking water to its service area. Figure 12 shows the fire threat hazard overlaid on Sonoma Water's water supply systems and shows that the water supply and flood control reservoirs at Lake Sonoma and Lake Mendocino have moderate to very high fire vulnerability. The intense heat of a wildfire would likely modify the soil structure resulting in hydrophobic soil. Since hydrophobic soils do not allow rainfall to infiltrate into the ground, increased runoff will result. [55] These soils, accompanied by the lack of tree canopy and the relative slope steepness around Lake Sonoma, Lake Mendocino, and throughout the Russian River watershed, would increase runoff and erosion into the water supply system. Increased erosion would result in property loss, mobilize nutrients, create turbidity, reduce storage within the reservoirs, and could potentially deposit debris in the riverbed, causing flooding. This vulnerability could be exacerbated by increased frequency of drought and flooding as a result of climate change. Additionally, a flood event following a wildfire would create even more erosion. Post-October 2017 wildfire analysis of the water quality impacts to the Russian River System from fire ash leachate is currently underway.

Drought and water supply variability are also vulnerabilities of Sonoma Water's water supply. Towards this end, two of Sonoma Water's highest priority projects are advancing the understanding and use of

Forecast-Informed Reservoir Operations (FIRO) for Lake Mendocino and modifying the hydrologic index. See the description of FIRO under Programs in C1a.

Climate Sensitivity: Lake Sonoma
Rating: Medium

- A majority of Sonoma Water's customers receive their drinking water from Lake Sonoma. The lake is about two and a half times larger than Lake Mendocino and relies entirely on runoff from precipitation to fill. Releases from Lake Sonoma support a fragile ecosystem in Dry Creek that contains endangered coho salmon and threatened steelhead trout. Changes in hydrology may affect Lake Sonoma operations and shift the quantity and timing of releases that support the Dry Creek ecosystem and Sonoma Water's service area.
- Sonoma Water must make higher releases during periods of insufficient unimpaired flow to ensure that required minimum instream flow requirements are met at downstream compliance points all along the Russian River and Dry Creek. Future decreases in precipitation will increase stress on already-tenuous system operation during drought years. Increased variability in dry season compliance flows is directly tied to more variable reservoir storage levels.
- Increased summer temperatures and a longer dry season, as predicted by climate models, could result in increased agricultural diversions along the Russian River and Dry Creek. This would require an increase in dry season reservoir releases in order to meet downstream minimum flow requirements.
- Climate change is generally expected to increase the wildfire risk in the Lake Sonoma region through increased incidence of dry conditions (drought) and higher temperatures over a longer fire season. Fire frequencies are projected to increase regionally on the order of 20% to 30%. Potential of fire hazard exists in the Lake Sonoma watershed that will impact drinking water quality.

Climate Sensitivity: Lake Mendocino
Rating: High

- Changes in hydrology may impact Lake Mendocino operations and release of water to Russian River Project.
- Increase temporal variability of precipitation events, causing more severe and frequent floods and droughts.
- Reductions in the volume of overall snowpack under changing climate in the Eel River Watershed may impact release of water from the PVP and hence less inflow into Lake Mendocino.
- There is potential for atmospheric rivers, the storms that are associated with most flood events in Russian River, to increase in intensity. Increases in flood risk may cause changes to flood control operations by US ACE in Lake Mendocino, further exacerbating the current flood operation impacts on water supply.
- Lake Mendocino's water supply reliability has decreased in recent years due to amendments to the Potter Valley Project FERC license in 2006 that caused a change in PVP operations.

Uncertainty on the PVP diversions would have significant impacts to downstream water users, ecosystems, and groundwater aquifers.

- Climate change is generally expected to increase the wildfire risk in the Lake Mendocino region through increased incidence of dry conditions (drought) and higher temperatures over a longer fire season. Fire frequencies are projected to increase regionally on the order of 20% to 30%. Potential of fire hazard exists in the Lake Mendocino watershed that will impact drinking water quality.

Diversion Facilities

The components of Sonoma Water's system that facilitate the diversion of water from the source (the Russian River aquifer) to the water transmission aqueducts are referred to as the diversion facilities. The diversion facilities can be grouped by those that draw water from the aquifer and those that help recharge it. The former include the six radial collector wells and the Mirabel well field, while the latter include the inflatable dam, the River Diversion System (RDS) caisson, infiltration ponds, diversion channels, the main levee, and appurtenant power, communications, treatment, and piping infrastructure - all located in the Wohler-Mirabel area.

The earliest of the six collector wells were constructed in 1959 and the latest in 2006. The general construction of the collector well includes a large diameter (ranging from 13 to 18 feet inside diameter and 18- to 33-inch-thick walls) concrete caisson that extends from the ground surface into the aquifer. The caissons range in length from about 108 feet to 123 feet. At the bottom of each caisson are perforated pipes (referred to as laterals) that extend radially into the alluvial aquifer. Each lateral ranges in length from approximately 70 feet to over 175 feet, and ranges in size from 8- to 10-inch diameter for the older five collectors and 12 to 18 inches for the newest sixth collector. Each caisson supports a pump house with two pumps to draw water through the laterals. All of the supporting electrical and communication systems to operate the pumps remotely are located within each caisson's pump house.

Areas of moderate, high, and very high liquefaction potential exist at the water supply facilities that include the six collector wells and the Mirabel well-field. Additionally, because of the proximity to a free face of the river bank the collectors are also subject to a very high lateral spread hazard. Structural assessment of the collector wells and the RDS, performed as part of the NHRA, shows that three of the six collectors and the RDS have a high likelihood of sustaining irreparable damage due to liquefaction and lateral spread. Strong earthquake shaking can also cause damage to electrical and communication equipment that is not adequately anchored. Other diversion system facilities such as the inflatable dam, the RDS levee, ditches, and the infiltration ponds are also located in the same high liquefaction hazard area.

The pump houses of each collector well are located within the FEMA floodway, but elevated above hazardous flood heights, and thus have a low likelihood of direct damage from flood or debris impact. Other elements of the diversion facilities are vulnerable to flooding however, including erosion damage to the levee and maintenance roads caused by overtopping of the levee, siltation of the infiltration ponds, damage to electrical power poles due to ground saturation during flooding, and significant debris deposits on the inflatable dam, maintenance roads and in the fish ladders and fish viewing gallery. In 2005, portions of the levee were severely damaged due to overtopping of flood waters. In January and February of 2017, the levee was again overtopped due to the DR-4301 and DR-4308 floods, causing the entire Mirabel facility to become flooded with turbid river water, which left a layer of soil-clogging silt in the aquifer recharge basins that required removal. Additionally, electrical power poles were compromised, all maintenance roads required debris removal and repair from erosion damage, and significant debris was deposited on the inflatable dam and in the fish viewing gallery, resulting in over $800,000 in necessary repairs throughout the Wohler-Mirabel area. A flood event could also significantly damage the levee itself. As flood waters breach the levee the back side could begin to erode, limiting access to the site and removing the facility's barrier to flood risk.

Wildfire in the Russian River system is also a significant vulnerability of concern, as it could greatly exacerbate the diversion system's flood vulnerabilities by leading to increased runoff and greater debris deposits during flooding. Secondly, increased turbidity in the Russian River as a result of a wildfire would decrease overall water quality, potentially impacting the diversion system and collector well performance, and influence aquifer recharge abilities. Figure 12 shows that most of Sonoma Water's water supply system is in an area of low fire hazard, except for the facilities in the Wohler and Mirabel area, and the water supply and flood control reservoirs at Lake Sonoma and Lake Mendocino. However, a more detailed examination during site reconnaissance at the Wohler and Mirabel area confirmed a low fire hazard because of a clearing zone around the facilities. Sonoma Water has an active maintenance program to address such issues.

<u>Climate Sensitivity</u>: Mirabel Collectors, Mirabel River Diversion, Mirabel Emergency Diversion, Infiltration Ponds, Inflatable Dam, Fish Screen and Fish Ladder, and Wohler Diversion Facility
Rating: High

- Increased flooding potential may cause an increase in direct risk to Russian River collector system infrastructure due to inundation risk. Future flooding vulnerability is expected to grow in the face of extreme precipitation events due to climate change. The base elevation of the existing 100-year flood is 78.12 feet according to the FEMA flood map, which is only about 2-3 feet above the critical elevation at these collectors. Climate change will likely increase the 100-year flood by 25-30% at these locations. Mirabel ponds, road, wells, and collectors themselves are expected to be inundated by 5-10 feet during the projected future 100-year flood event.
- Increased flooding conditions potentially will impact the operation of Collector Well 5, as it is already being operated under the direct influence of surface water.
- Fire frequencies are projected to increase on the order of 20% to 30%. Water quality issues may arise due to increased wildfire in the contributing watershed; riverbank filtration has been shown to be sensitive to increases in certain species of dissolved organic carbon/natural organic matter in the river water.

- Flood presents a significant risk at the Wohler Diversion facility. The Wohler collectors and Wohler station are right at existing flood levels, and these facilities will very likely be inundated during future floods. The road to collector #6 is essentially at grade in the floodway, which presents a large access problem during flood events.
- Increased flooding potential may increase risk to the Russian River collector system infrastructure at Wohler due to inundation impacts.

Aqueducts

The water transmission aqueducts consist of approximately 89 miles of pipelines ranging in size from 14 inches to 54 inches. The system transports water from the Russian River diversion facilities located in the Wohler-Mirabel area, southwards and eastwards to the water supply service area. The aqueduct facilities consist of 11 pipeline segments that include the Russian River-Cotati Intertie, the Santa Rosa Aqueduct, the Sonoma Aqueduct, the Petaluma Aqueduct, the Oakmont Pipeline, the Wohler-Forestville Pipeline, the Wohler-Mirabel Intertie, the Kawana Pipeline, the North Marin Aqueduct, the Collector 6 Pipeline and the Eldridge-Madrone Pipeline. The configuration of the aqueduct facilities is shown in Figure 5.

The aqueducts are distributed over a large geographical area, traverse zones of varying geology and topography, and are subject to a range of natural hazards. The facilities were built incrementally over a period of several decades (ranging from 1957 to 2006) and under a range of evolving design standards and construction techniques. Pipeline construction consists of predominantly bar-wrapped concrete cylinder pipe (75%) and welded steel pipe (25%). Typical joint types consist of gasket joints, welded bell-and-spigot joints, and welded butt-strap joints. Most river and stream crossings include concrete encasement over some or most of the pipeline between the banks of the river or stream.

Major hazards to the pipeline system include earthquakes, floods, and landslides. The earthquakes and earthquake induced hazards such as liquefaction, surface fault rupture, lateral spread, and strong ground shaking are the most significant.

In general, buried pipelines, such as the aqueducts, are designed for internal pressure with limited consideration to large relative displacements of ground along their length. Such pipelines are typically designed with bell-and-spigot type connections (also known as segmented pipelines) and do not perform well when subjected to ground failure resulting from earthquakes, floods, and landslides. In the 1964 Anchorage, Alaska earthquake more than 100 water pipe breaks were reported. In the 1971 San Fernando earthquake, the City of San Fernando temporarily lost water, gas, and sewage services due to liquefaction induced lateral spread along the eastern and western shores of the Upper Van Norman reservoir. For relatively small ground displacements associated with earthquake ground shaking, the pipelines perform reasonably well, incurring only random damage that can usually be handled as part of emergency repairs following an earthquake.

Sonoma Water's aqueduct facilities cross many locations where they may be subjected to ground deformation, and thus a high vulnerability to liquefaction exists throughout the system. The most obvious locations are where pipelines cross active faults and creeks, as river and stream crossings have a very high potential for lateral spread. Vulnerable locations include the Wohler-Mirabel Intertie, significant portions of Petaluma Aqueduct, and localized areas of the Russian River-Cotati Intertie and Sonoma Aqueduct.

The Rodgers Creek fault crossing of the Santa Rosa Aqueduct was formerly identified as the single most vulnerable site for the aqueduct facilities. The Sonoma Aqueduct and Oakmont Pipelines cross the Spring Valley segment of the Bennett Valley fault zone have an increased likelihood of failure in a surface rupturing event on this fault.

Other significant locations subject to ground deformation are at river and stream crossings where the aqueducts are vulnerable to earthquake induced liquefaction and lateral spread. Vulnerabilities exist across aqueducts and at multiple stream crossings within the system. Depending upon the geometry of the stream bank and the potential for liquefaction, these locations could have large lateral spread displacements and, consequently, the pipelines could fail.

Figure 10 shows Sonoma Water's water supply system overlaid on the FEMA flood maps. There are four locations where a pipeline is suspended over a stream crossing. In general, it is these stream crossing locations in combination with areas of high flood hazard that are at the highest risk of flood damage due to channel scour and direct impact from floating flood debris. As shown in Figure 10, the water supply aqueducts with the highest risk of flood include sections of the Russian River-Cotati Intertie, Forestville Aqueduct and Wohler-Mirabel Intertie, Sonoma Aqueduct, and some portions of the Santa Rosa Aqueduct.

There is minimal vulnerability to the aqueducts from fire because the piping is buried and constructed of fire-resistant materials, mostly steel and concrete.

Storage Facilities

Sonoma Water has a total of 18 flat bottom steel tanks located at nine independent sites. Out of the 18 tanks, 8 are anchored while the other 10 are unanchored. The tanks range in size from 0.3 million gallons (mg) to 18 mg. Almost half of the tanks have over-constrained piping, which consists of a pipe that is rigidly attached to the tank shell and restrained by burial near the tank or connection to an adjacent nearby tank. Such connections are vulnerable to damage in an earthquake because the piping is unable to accommodate uplift movement of the tank caused by earthquake induced overturning moments. Eight tanks require modification to piping to address over-constrained conditions.

Most of the water tanks also have bottom penetrating inlet/outlet and drain piping. Typically, the steel tank base plate is relatively thin (typical thickness of ¼ inch) and is vulnerable to tearing if tank uplift occurs at the bottom penetrating piping connection and within 15 inches of the tank wall. In this case all but 2 tanks have bottom penetrations greater than 3-feet from the tank wall, which results in a lower risk of tearing from uplift. The two tanks requiring modification to bottom penetrations are Ralphine 1 and Ralphine 3 which both have vulnerable drainpipes that exit the tank bottom within the area of concern for uplift.

Tensile hoop overstress in tanks is a vulnerability as water sloshes against the tank walls during an earthquake. A review of the tank shells revealed that 6 of the tanks require reinforcement or replacement of the bottom course of the tank shell.

Water tanks, which are often located on ridge tops, are susceptible to fire with south facing slopes being more susceptible because they receive higher solar radiation. Steeper uphill slopes tend to increase the rate of fire spread, whereas downhill slopes tend to slow down the rate of fire spread.

Sonoma Water's storage tanks are located in open space above their service area and are surrounded by vegetation. Vegetation surrounding the tanks provides fuel for spreading wildfire and can limit access to the tanks. In the event of a fire surrounding the tanks Sonoma Water would have to rely primarily on remote communication systems to monitor tank levels for providing drinking water and fighting fire because physically accessing the tanks is too dangerous, as was the case during the October 2017 wildfires. However, the communication systems and electrical power systems such as for pumping are vulnerable to wildfire because power supply could be severed if overhead power lines and supporting poles feeding the site are burned. Monitoring tank levels helps Sonoma Water understand if the tank fill valves are working and also helps indicate when there is a break in the system. Figure 12 shows a high fire threat near the Los Guilicos tank, which could impact the power supply and communications systems to this tank.

Climate Sensitivity: Water Storage Facilities
Rating: Medium
Unprecedented warm conditions during the summer and winter are expected due to rising temperatures across the region. Rainfall variability is expected to increase, with more extreme annual lows and highs. Runoff may be flashier than observed historically, as rates of groundwater recharge will become less variable over time. Agricultural water demand may increase by up to 10%. Increased variability in supply and likely increases in demand due to climate change may stress existing conveyance, pumping, and storage systems.

Pumping Facilities

Sonoma Water has eight booster pumping stations. Out of the eight stations, the Sonoma Booster Station is the most critical and is essential for water supply to a significant segment of Sonoma Water's customers. The remaining stations are an important part of the system but not necessary for providing continuous supply of water.

Five booster stations consist of single-story buildings while the other three are open to air. The most significant vulnerabilities include potential damage to the booster station building and electrical control cabinets due to earthquake, wildfire, or flood. Minor to moderate damage to the building may not necessarily be a significant hazard since the stations are not manned. However, major damage or collapse of the building can result in associated damage to the pump motor or motor control centers by falling debris. A building that is significantly damaged may also prevent or delay any required manual reset of pump controls thereby impeding system operations. In terms of the potential for major collapse due to earthquake, the most vulnerable is the Sonoma Booster Station because it is situated in close proximity to the Spring Valley segment of the Bennett Valley fault zone.

Wildfires can impact power, control, and communication systems to the booster pump stations. This occurred during the October 2017 wildfires, when operation of the Sonoma Booster Station was impacted due to burned power and communication lines, and Sonoma Water was unable to remotely monitor storage tank levels.

Treatment Facilities

The Russian River aquifer water is naturally filtered and typically tests absent for coliform without disinfection. To maintain regulatory levels of residual chlorine in water supplied to the contractors, the water system has three chlorination facilities. Two of the three chlorination facilities are also corrosion control facilities to chemically treat the water's pH to minimize the potential for corrosion. The three facilities include the Wohler chlorination and corrosion control facility located at Sonoma Water's corporation yard on Wohler Road, the Mirabel chlorination facility located near the Mirabel collectors, and the River Road chlorination and corrosion control facility located on River Road. The River Road facility is currently used only for corrosion control.

The Mirabel and Wohler facilities are single story reinforced masonry buildings that generally perform adequately in an earthquake provided the buildings have adequate roof to wall connections. The River Road facility is a two-story masonry building with a soft first story and has been retrofitted by the addition of braces at some of the open bays at the first floor. Typically, buildings with a soft first story perform poorly in earthquakes with excessive damage. The extent of potential damage to this building will depend upon the adequacy of the retrofit scheme. The most significant hazard at the treatment facilities is the potential for a chlorine release or damage to the contents and non-structural elements. These treatment facilities are also vulnerable to a chlorine release resulting from a wildfire. All three facilities are in a moderate fire hazard area. Should a wildfire break out in the vicinity of the treatment buildings causing their structures to catch fire the potential for a chlorine release would be high.
The River Road facility is also at moderate risk of damage from flooding. During the DR-4301 and DR-4308 floods in January and February 2017 this building was surrounded by flood waters, and the electrical gate actuator required replacement due to damage from inundation.

Power System for Water Supply

Sonoma Water's water supply facilities receive power from the Power and Water Resources Pooling Authority (PWRPA) and Pacific Gas & Electric Company (PG&E). This includes Sonoma Water-owned substation at the diversion facilities, which provides the power for the Wohler and Mirabel collector wells. Power from the substation is delivered to the collectors at Wohler and Mirabel through a 12-kV power-line that runs along the river and infiltration ponds as shown in Figure 6. The 12-kV power runs on an overhead line that is vulnerable to flooding of the Russian River. As floodwaters rise, they will inundate the power poles where scouring of their foundation may occur and moving water could be the cause for debris impact and pole failure. The 12-kV line is also in an area of very high liquefaction potential making it vulnerable during an earthquake.

Emergency backup power is available to the diversion facilities in the Wohler-Mirabel area through five fixed-place generators. Three of these generators power all feeders to the substation and are 2,000 kW diesel generators located near the Wohler Chlorination Building. These generators require a manual start and can run for approximately 2.5 days before re-fueling. Fuel for the substation generators is provided by a 25,000-gallon diesel tank located onsite. Each substation generator can run up to six pumps at either of the Mirabel and Wohler collector wells. In addition to the substation generators, there are two fixed place 1,250 kW diesel generators located near the Mirabel Chlorination Building, which can operate two of the main pumps at the Mirabel collectors. Fuel to these generators is provided by a 25,000-gallon fuel tank located onsite. These generators can run for approximately 5 days without refueling. When all five generators are run at full power, nine out of ten pumps at the collectors (excluding Collector #6) can be operated simultaneously.

The treatment facilities also have emergency generators for operating the chlorine sensors and scrubber systems. Emergency power to two of the eight booster pumping stations is provided by generators located at the Sonoma Booster Station and the Ely Booster Station site. Sonoma Water has a series of uninterruptible power supply (UPS) units located at nearly all of their facilities to operate the communication and Supervisor Control and Data Acquisition (SCADA) systems for a period of three to four hours after a major power loss.

Additionally, Sonoma Water operates a hydroelectric facility at the Warm Springs Dam in Lake Sonoma, in collaboration with the USACE. After the Warm Springs Dam was completed in 1982 Sonoma Water installed a hydroelectric turbine, which has been producing electricity since 1988. This hydroelectric facility has a capacity of 2.79 megawatts (MW), however since power production is influenced by the flow of water through the dam, the output is usually 1.3 MW which generates 12 million kWh of energy annually. The energy produced by the Warm Springs Dam hydroelectric turbine is provided to Sonoma Water system through PWRPA, providing nearly 25% of Sonoma Water's annual energy needs, including those needed for water supply. The dam and hydroelectric turbine are both operated in collaboration with the USACE.

<u>Climate Sensitivity</u>: Lake Sonoma Hydroelectric Facility

Rating: Medium
Climate change is expected to increase temporal variability of precipitation events, causing more severe and frequent floods and droughts. A large impact of this shift will be decreased hydroelectric power generation at Warm Springs Dam. More large precipitation events in the winter and less precipitation events in the summer will cause more variable reservoir storage levels, decreasing reliability of reservoir releases and power generation.

Supplementary Facilities

In addition to the main water source, the Russian River aquifer via the six radial collector wells, the water supply system has ten conventional wells as supplementary water sources: seven located in the Mirabel well field known as the Russian River Wells, and three located in the Santa Rosa Plain area, known as the Production Wells. The seven Russian River Wells are not in active use and are only for emergency purposes.

All seven Russian River Wells are located in the FEMA floodway, making them extremely susceptible to flood related debris impacts, although they are not in active use. The three Production Wells are known as the Occidental Road Well, the Sebastopol Road Well, and the Todd Road Well, and they collectively provide a sustained flow of about 7 mgd. The Production Wells are located outside the FEMA 100-year flood zone but are close to the boundary of this zone. Flooding at these locations can significantly impact water quality and cause damage to the well infrastructure in terms of electric short circuiting due to inundation and direct physical damage due to debris impact.

All of the wells are located in medium to low liquefaction hazard areas and are in non-fuel Fire Threat areas but are adjacent to moderate Fire Threat. The most significant hazard from an earthquake viewpoint is the damage to above ground infrastructure, and communication and electrical control systems from strong ground shaking. Additionally, prolonged drought could dry up these supplementary water sources.

Sanitation System and Risk Assessment

Sonoma Water's sanitation system includes a combination of systems owned by the Agency, known as Sanitation Zones (SZs), and independent special districts fully operated by the Agency, known as County Sanitation Districts (CSDs). The system has four SZs and four CSDs: Airport/Larkfield/Wikiup (ALW) SZ, Geyserville SZ, Penngrove SZ, and Sea Ranch SZ; and the Occidental CSD, Russian River CSD, Sonoma Valley CSD, and South Park CSD. Figures 16 and 17 show the location of the sanitation districts and zones.

Sonoma Water assumed management responsibilities for the County of Sonoma Sanitation Districts and Zones on January 1, 1995, from the former Sonoma County Department of Public Works. The assets of the SZs are owned by Sonoma Water. The County Board of Supervisors acts as the Board of Directors for the SZs.

The CSDs are separate legal entities from Sonoma Water, with separate Boards that own the assets of their respective districts. For detailed information on the Sonoma Valley County Sanitation District's natural hazards, vulnerabilities, and mitigation actions, please see its 2022 Local Hazard Mitigation Plan.

The staff decided to include the Russian River County Sanitation District in this 2023 Sonoma Water Local Hazard Mitigation Plan Update in addition to the Occidental and South Park CSDs that had always been part of Sonoma Water LHMP. For this reason, the sanitation portion of the Sonoma Water LHMP focuses on the sanitation zones that are owned directly by Sonoma Water, but still includes the Russian River, Occidental and South Park CSDs.

The plan is to eventually include Sonoma Valley County Sanitation District Local Hazard Mitigation Plan in Sonoma Water Local Hazard Mitigation Plan and have one consolidated local hazard mitigation plan for the whole agency. Figures 18 through Figure 26 show the sanitation facilities overlain on maps of the identified primary hazards.

Geyserville Sanitation Zone

The Geyserville Sanitation Zone (Geyserville SZ) service area covers approximately 177 acres, serving approximately 370 Equivalent Single Family Dwelling Units (ESDs) using a gravity collection system. The Geyserville SZ has one lift station and the Geyserville SZ wastewater treatment plant. The treatment plant currently provides secondary treatment for an average of 77,000 gpd. The plant includes 5 ponds for aeration, settling, and percolation, headworks, treatment infrastructure, PV panels, a wind turbine, and a single pump station. The treated wastewater is disposed of through percolation ponds and evaporation. The wind turbine was installed in 2013, generates 5 kW at full capacity, and provides 2% of the annual energy consumption for Geyserville SZ.

The Geyserville SZ is primarily vulnerable to flooding and liquefaction. The Russian River is northeast of the Geyserville SZ, placing the east side of the zone in the 100-year FEMA flood boundary (Figure 21). The treatment plant and pump station at Hamilton Lane are also directly within the 100-year FEMA flood boundary. Access to the treatment plant is a primary concern during a flooding event, along with the effects that flooding can have on reducing performance of the percolation ponds. Portions of the collection system located within areas of flooding are vulnerable to increased inflow into the collection system, which can lead to sanitary sewer overflows and related public and environmental health risks.

Geyserville SZ is mostly in an area of high and very high liquefaction risk, with the entire treatment plant classified as very high risk, including the pump station on Hamilton Lane. Pipelines, especially those connected to fixed facilities such as the pump station, are vulnerable to damage within zones of potential liquefaction hazard. The northwest section of the sanitation zone surrounding Wood Creek is considered high risk for lateral spread, making this collection infrastructure, especially the pipeline crossing Wood Creek, vulnerable during an earthquake.

No Geyserville SZ facilities are traversed by a mapped fault system; however, the zone is parallel to and within relatively close proximity to the Maacama Fault and directly southeast of the Alexander Fault. As such, zone facilities could still be subject to significant ground shaking, being in an area of .4g Predicted Ground Acceleration (PGA).

Fire, steel corrosion, and concrete corrosion are not primary hazards for the Geyserville SZ. This zone is located in moderate or non-fuel Fire Threat areas, including the treatment plant which is considered non-fuel. The zone is moderate to low risk for both steel and concrete corrosion hazards, including the treatment plant which is at low risk for both. The lift station is slightly higher risk for steel and concrete corrosion, located in a moderate risk area for both.

Climate Sensitivity
Rating: Medium
The Geyserville SZ lift station and wastewater treatment plant are both located within the Russian River 100-year floodplain. The Geyserville SZ is vulnerable to increased precipitation that leads to river flooding and elevated groundwater levels. The river flooding limits access to the treatment plant and lift station. The treatment plant is elevated, and direct flooding does not appear to be a significant hazard at the plant itself. The elevated groundwater tables limit the percolation capacity of the treatment plant and increased precipitation could worsen this situation. These hazards to not appear to significantly limit wastewater conveyance or treatment capacity beyond current hazards, so the climate sensitivity rating is moderate.

Airport/Larkfield/Wikiup Sanitation Zone

The Airport/Larkfield/Wikiup Sanitation Zone (ALW SZ) covers approximately 2,100 acres, serving approximately 4,163 ESDs. The ALW SZ includes one lift station and a tertiary treatment plant that currently treats 750,000 gallons per day (gpd) on average. All recycled water produced from this plant is used for irrigation. The treatment plant infrastructure includes ponds, building structures, treatment facilities, generators, and one of Sonoma Water's four photovoltaic (PV) systems. The recycled water infrastructure includes pipes, valves, meters and pumps. The PV system at ALW SZ is a fixed ground mount system located on the south pond embankments, with 3,312 panels providing 498 kW capacity and an average annual output of 730,000 kWh.

The wastewater treatment ponds at ALW SZ have high embankments and could be subjected to liquefaction and ground shaking hazard. Therefore, a detailed vulnerability assessment of these is recommended. The recycled water network within ALW SZ contains portions of recycled water pipes in High or Very High Liquefaction risk area. Pipelines, especially the pipeline connections to fixed facilities, are most vulnerable to damage within zones of potential liquefaction hazard. ALW SZ contains areas at-risk of lateral spread as well, and these are generally in the same location as the High and Very High Liquefaction risk areas, particularly along Mark West Creek. Otherwise, this sanitation zone is mostly located in a low to moderate liquefaction vulnerability area.

The northeast corner of the ALW SZ intersects the Hayward-Rodger's Creek Fault, making a significant portion of the collection system vulnerable to damage due to fault rupture. Additionally, the lift station is also located in relatively close proximity to the fault. While the treatment plant is farther away from the Hayward-Rodger's Creek Fault, the entire plant is within the .4g PGA zone, leaving its above-ground components moderately vulnerable to damage or collapse by ground shaking. Closer to the fault, the east side of the ALW SZ is within the .6g PGA zone, making the lift station and collection system infrastructure in this area subject to strong ground shaking hazard. Figure 18 shows fault proximity, and Figure 19 shows PGA hazard.

For flood vulnerability, the ALW SZ contains infrastructure within the 100-year flood boundary (Figure 21). ALW SZ sanitation lines cross streams in 11 locations, with numerous manholes located in the 100-year flood zones. Significant portions of the treatment plant are also shown within the 100-year mapped floodplain. However, the most significant flood impacts at the treatment plant are the access issues to the north pond, inundation of essential pipe valves that are needed to divert treated effluent between storage and treatment locations, and inundation of manholes.

The recycled water network has 26 valves in the 100-year flood zone. However, because these facilities are minimally used during the winter flood season, the vulnerability created by lack of access to recycled water valves is low.

ALW SZ is exposed to several high and moderate steel corrosion areas, including the majority of the treatment plant. There are less features in concrete corrosion hazard zones, but still a large amount of potentially vulnerable infrastructure at risk of concrete corrosion. Corrosion has not been reported to be a significant issue for the zone facilities but may warrant a more detailed assessment.

For fire vulnerability, the majority of ALW SZ falls under the category of non-fuel or moderate Fire Threat, with the exception of the neighborhood in the north-east corner, which is exposed to high and very high Fire Threat conditions (Figure 23). The north-east corner of ALW SZ is also along the boundary of historic fire zones, and experienced catastrophic fire in the October 2017 Tubbs Fire (Figure 22).

The lift station is located in this portion of the ALW SZ. Because the collection system is underground, this infrastructure is at little risk of damage by fire. However, power to the lift station is vulnerable, as was demonstrated during the 2017 Tubbs Fire. The treatment plant is not considered at-risk for fire. The 2017 Tubbs Fire also showed that after a catastrophic fire in a sanitation system Sonoma Water must incur costs to cap sewer laterals, in order to prevent damaging debris from entering the collection system. Sonoma Water in conjunction with FEMA completed this effort and capped sewer laterals remaining from the 2017 Tubb Fire for over 300 private structures.

The northeast corner of ALW SZ is also subjected to potential landslide hazard and predicted debris flow sources, which includes the lift station and collection system network, and excludes the treatment plant, as shown in Figure 24.

<u>Climate Sensitivity</u>
Rating: Medium

- The ALW SZ is subject to creek flooding at the treatment plant. Creek flooding inundates the road to North Pond, limiting access to the pond and to several valves. Increased precipitation events could make this situation worse. However, access to the plant is not limited.
- The Northeast portion of the zone is vulnerable to high fire hazard. Drought conditions could further exacerbate the fire hazard.

Penngrove Sanitation Zone

The Penngrove Sanitation Zone (Penngrove SZ) service area covers approximately 475 acres, providing wastewater collection services for approximately 556 ESDs. The Penngrove SZ does not include a treatment plant, but it does include the Penngrove Lift Station at the south end of the zone. The lift station routes collected influent from Penngrove SZ to the City of Petaluma’s collection system for treatment via the sanitation line force main, a 16,224 foot long, 6-inch PVC pipe that runs along the railroad line and ends at the City’s Wilmington lift station.

A primary hazard for Penngrove SZ is flooding. Penngrove SZ is subjected to flooding via Willow Brook and Lichau Creek, which converge in the south end of the zone near the Penngrove lift station. There are 9 instances where sanitation pipes cross a stream. The Penngrove lift station is located in the FEMA 100-year flood boundary and experiences flooding with regularity. The Penngrove lift station used to routinely flood causing floodwaters to inundate the facility’s electrical equipment forcing operators to shut off power resulting in Sanitary Sewer Overflows (SSOs) throughout the collection system in the Penngrove SZ. In 2017 Sonoma Water was awarded a FEMA HMGP grant to mitigate the serious flood risks at this lift station and implemented a project to raise the facility’s electrical equipment above the 100-year floodplain. However, flood risk and inflow and infiltration (I&I) within the collection system still pose problems for SSOs at the lift station due to pumping capacity limitations.

Very high and moderate liquefaction risk exists in Penngrove SZ for the infrastructure adjacent to Willow Brook and Lichau Creek, which travel directly through the zone. The lift station and force main, which routes the collected sewage to the City of Petaluma’s treatment system, are at moderate liquefaction risk. Although, the south end of the sanitation line force main travels through an area of very high liquefaction risk as it crosses Lynch Creek. Pipelines, especially the pipeline connections to fixed facilities such as lift stations, are most vulnerable to damage within zones of potential liquefaction hazard. Figure 20 shows the liquefaction and lateral spread hazard for the sanitation facilities.

Penngrove SZ facilities are at moderate seismic risk from ground shaking, being in a .4g PGA zone. In addition, the sanitation line force main crosses the Tolay Fault, however this fault is not currently considered active, nor anticipated to pose significant risk of damage to Penngrove SZ facilities.

The entire Penngrove SZ, including Penngrove lift station and the full length of the force main are in an area of high steel corrosion hazard. The majority of Penngrove SZ is within zones of moderate to high risk of concrete corrosion hazard. Despite these findings, corrosion has not been reported to be a significant issue for the zone facilities. A more detailed assessment may be warranted.

There is no debris flow hazard within Penngrove SZ, and the majority of Penngrove SZ is classified as no fire risk, with the exception of the neighborhoods and collection system pipelines on the west and far eastern sides. Fire poses minimal risk to the buried Penngrove SZ facilities. However, there is some moderate landslide susceptibility within Penngrove SZ, with a few locations of high susceptibility along Lichau Creek.

Sea Ranch Sanitation Zone

The Sea Ranch North and Central Sanitation Zones (Sea Ranch North & Central SZs) service areas cover approximately 4,600 acres and are located directly on the coastline. Sea Ranch North & Central SZs provide service to approximately 622 ESDs, using a gravity collection system. There are five lift stations, and two treatment plants. The Sea Ranch North SZ wastewater treatment plant currently treats approximately 22,000 gallons per day. The treated wastewater is disposed of by transfer to Gualala County Sanitation District for tertiary treatment and recycled as irrigation water. There is a percolation pond for emergency disposal. Sea Ranch Central SZ treatment plant currently treats approximately 2,000 gallons per day. Infrastructure in the Sea Ranch North & Central SZs includes ponds and treatment facilities.

Facilities at the Sea Ranch SZs are located in areas of high and very high Fire Threat (Figure 23). This sanitation zone is primarily within a low liquefaction risk area, with the exception of the Gualala River which has a very high risk for liquefaction (Figure 20). Treatment facilities and lift stations within the Sea Ranch SZ are located in close proximity to the San Andreas Fault (Figure 18) and are subject to strong ground shaking hazard with PGA .4g (Figure 19). There is no flood data for these facilities on the current FEMA Flood Insurance Rate Maps. The majority of this sanitation zone is in low to moderate concrete and steel corrosion areas with some portions in high corrosion risk areas. The landslide risk throughout the Sea Ranch SZs is moderate to low, except along the Gualala River and the immediate coastline, which is highly susceptible to landslides.

Russian River County Sanitation District

The Russian River County Sanitation District service area covers approximately 2,700 acres. The sewer service area includes the unincorporated areas of Rio Nido, Guerneville, Guernewood Park, and Vacation Beach. There are approximately 3,217 equivalent single family dwelling units in the RRCSD service area.

Raw sewage is collected by a series of small diameter (typically 4" to 8" diameter) collection pipes. A single backbone sewer main (with 12", 15", 16", and 21" segments) transfers collected wastewater to the WWTP. The 16" pipeline is a force main that terminates at the Headworks Building at the WWTP. An 8" ductile iron pipeline takes effluent from the WWTP to a tank and delivers the treated effluent to the Northwood Golf Course.

Treated (tertiary treatment) sewage leaves the WWTP via an outfall to enter the Russian River when discharge is allowed between October 1 and May 14.

Collection System

Table 14 provides a breakdown of the pipe by diameter and material, and highlights that the most common pipe material is ABS (33.89 miles), representing nearly 87% of all pipes. There are small amounts of cast iron, ductile iron, PVC, and VCP.

The ABS pipe material was most likely chosen due to its light weight (ease of installation) and corrosion protection for raw sewage.

Table 14: RRCSD Pipe Collection System

Pipe Material*	Length (Miles)	Diameter (Inches)
	33.89	4, 6, 8, 10, 12, 15, 21, 24, 27, 30
	.05	6
	0.03	4
	1.98	8, 16
DIP	0.41	4, 6, 8
PVC	2.33	2, 4, 6, 8, 12
VCP	0.37	21, 24
Total	**39.06**	

* ABS: **Acrylonitrile Butadiene Styrene**
ACP Asbestos Cement Pipe
CIP: Cast Iron Pipe
CMLCS: Cement Mortar Lined and Coated Steel
DIP: Ductile Iron Pipe
PVC: Polyvinyl Chloride Pipe
VCP: Vitrified Clay Pipe

The soils at many creeks are Holocene age and prone to seismic-induced liquefaction. The potential for pipeline damage and the consequences of pipe failure are larger at creeks because pipe damage would entail release of raw sewage into the sensitive creek environment.

Collection System Vulnerabilities

The highest vulnerability to the collection system is due to the potential damage due to seismic events, which also translates to the highest potential cost to the RRCSD. Many pipes within the RRCSD collection system are located in areas of moderate to high liquefaction, which poses the potential for loss of use of a portion of the collection system or the potential for sewage spills. The potential for pipeline damage and the consequences of pipe failure are larger at creeks because pipe damage would entail release of raw sewage into the potentially sensitive creek environment.

In order to quantify the potential for the seismic hazard, the length of pipelines in the Very High, High, and Moderate liquefaction zones were estimated, using the maps provided in Appendix E. Within each of the zones, the pipelines were assumed to be installed in an open-cut trench adjacent to a stream or river, where significant lateral spreads can occur. An occurrence of an M 8 event on the San Andreas Fault was assumed, which on average produces PGA = 0.34g at the ground surface near each pipe. For the pipeline inventory, the typical style of pipe installation uses cemented joints (ABS pipes) or non-seismic push-on joints (CIP, DIP, PVC, VCP pipes).

The number of pipe failures was then estimated, given the level of shaking (PGA = 0.34g), and the pipe fragility models of ALA (2001). Given these assumptions, approximately 42 pipe repairs will be required, of which about nearly all will occur in the areas mapped as having high to very high liquefaction susceptibility. Of these repairs, approximately half can be assumed to be full breaks, and half will be leaking joints (ALA, 2001). These repairs exclude damages to customers' service laterals. Table 15 quantifies the extent of pipe damages to the RRCSD collection system, should an M 8.0 earthquake occur along the San Andreas Fault. Uncertainties in the ground motions and pipe performance suggest these median-based quantities may vary ±50%.

Table 15: Pipe Damage – San Andreas M 8.0 Earthquake

Liquefaction Zone	Total Pipe Length (miles)	Total Pipe Repairs	Pipe Breaks	Pipe Leaks
Very High		15	7	8
High		27	14	13
Moderate		< 1	<1	<1
Low, None		< 1	< 1	<1
Total		**42**	**21**	**21**

Equipment at the lift stations (pumps, motors, controls) is well anchored and therefore not subject to damage from seismic shaking. The lift stations themselves and the connected piping are, however, vulnerable to damage from liquefaction, typically due to flotation and/or rotation of the lift station.

Collection System Mitigations

The vulnerable areas of the collection system have the potential for a significant number of failures. If pipe breaks are identified after an earthquake, flooding, or due to high stream flow, full repair is required before the sewer can be re-used. In contrast, pipes with leaks can be kept in service while repairs are made.

The general approach to pipe repair will be as follows:

- Identify obvious damage at the surface (i.e., sewage backups, readily seen at the surface). Damage at the surface may happen infrequently, but it is important to investigate, and/or notify property owners to report sewage backups to the RRCSD.
- From the WWTP, trace back to find locations where there is no flow. Visual inspection under manholes can often identify no-flow conditions.
- Map out locations where manholes have floated. Manholes will float (rise up) when the pore pressure exceeds the weight of the manhole for a period of time. This will typically only occur at locations with Very High (or High) liquefaction susceptibility and a high groundwater table. At these locations, there will almost certainly be broken pipes attached to the manhole at depth. For a gravity flow system, floated manholes will need to be replaced. Given the available liquefaction maps, and assuming a high magnitude earthquake during ground saturated/high water table conditions, it would be prudent to plan for flotation of manholes. In order to provide a more precise/quantified value of floated manholes, additional assessments will need to be performed using precise manhole weights and geometries and local soil borings.)
- Use video cameras to perform a visual inspection of all pipes suspected to be damaged. Start video inspection on all pipes within the mapped High and Very High zones, then proceed to the moderate and low liquefaction zones, respectively.
- At key locations where there is a sewage blockage or broken pipe, isolate the manhole, then use pumps and flexible hose to move the sewage between usable manholes.
- Working radially from the WWTP, repair broken pipes and, where initially convenient, repair leaking pipes. Depending on site-specific conditions, leaking pipes might be left in service. Repair crews can be used to expeditiously repair broken pipes first (while leaving the street open) and then return to the leaking pipes to make permanent repairs.
- Jet-flush the repaired pipes to clean out accumulated silts, sands, and debris.

Pipe replacement might be the most effective solution in a few highly damaged locations. Where repairs are made, some common approaches are:

- Install a pipe repair clamp for a small leak or break.
- Replace a short section of damaged pipe (a few feet to one segment) and insert a new length of pipe with collars at each end to make leak-tight joints.
- Replace an entire length of sewer line if there are multiple damage points between two manholes.

Post-earthquake replacement of entire lengths of pipe between manholes can be the most cost-effective strategy where:

- Manholes or lift stations have floated.
- Multiple breaks between manholes have occurred.
- Hydraulic/flow issues are known to exist.

While pipe repairs will be satisfactory to return the pipe to service, it will not prevent further damage due to future earthquakes (or large aftershocks). Unless the replacement pipe is seismically designed, the replacement pipe will remain vulnerable to be damaged in aftershocks or future earthquakes. It is recommended that seismic resistant pipes be installed in the Very High and High liquefaction zones, in areas closest to creek crossings, or where the pipe runs parallel to creeks, such that the pipe will not leak or break under a one percent soil strain. All overhead pipes that are self-supporting or on bridges over creeks should be replaced or upgraded to sewers that can sustain PGA = 0.59g. Pipe replacements can be installed piecemeal post-earthquake or done prior to future earthquakes as part of a planned pipe replacement program. Furthermore, there are 11 lift stations in the collection system:

- Drake Estates (two pumps)
- Rio Nido (three pumps)
- Drake Road (two pumps)
- Laughlin Road (two pumps)
- Watson Road (two pumps)
- Guerneville Lift (three pumps)
- Beanwood (three pumps)
- Center Way (two pumps)
- Guernewood Park (two pumps)
- Main (three pumps)
- Vacation Beach (two pumps)

Lift Station Vulnerabilities

As part of this project, several lift stations were visited, but in-depth inspections were not completed, nor were the design drawings for the lift stations reviewed. Based on these limited inspections, the following assumptions have been made:

- The lift stations are located in areas not prone to liquefaction or were designed to resist buoyancy should liquefaction occur.
- The lift stations are not prone to lateral spreads due to liquefaction.
- As part of implementation of a seismic improvement plan, these assumptions should be validated.

Lift Station Mitigations

It is recommended that RRCSD make provisions to have on hand enough emergency generators to operate critical lift stations in the system for 48 hours following a San Andreas M 8 earthquake. Of particular concern is the Vacation Beach Lift Station, which is powered by the Russian River Treatment plant generator. Guernewood Park, Guerneville, and Beanwood Lift Stations are powered by the Main Lift Station, which contains an old generator. The generator at the Main Lift Station should be replaced, the system providing the distribution of power should be evaluated, and portable generators should be made available in accordance with the results of evaluation of the electrical distribution system. This presumes dry weather flows at the time of the earthquake. By "critical," it is meant that, under dry weather flows, a lift station is needed to operate within 48 hours of the earthquake, otherwise a sewage backup and spill will occur. This presumes there will generally be potable water flowing after the earthquake.

After 120 hours, it is reasonable to assume that PG&E power will be restored to the Main Lift station, but emergency generators may still be needed for a few of the lift stations. All lift stations should be outfitted with quick-connect couplings (sometimes called "pigtails") to allow rapid hook-up to an emergency generator (i.e., just plug in, use a manual transfer switch, and without need for an electrician to wire the emergency generator into the bus).

Wastewater Treatment Plant

The Russian River County Sanitation District WWTP is located at 18400 Neeley Road, Guerneville, CA and covers an area of approximately 12.5 acres.. The wastewater treatment process and the major facilities are described below:

- Preliminary Treatment
  - Preliminary treatment includes screening, grit removal, and flow measurement.
  - Headworks. Raw sewage from domestic and commercial sources enters at the Headworks through a 16" force main. At this point, large inorganic solids in the waste stream are removed.
- Secondary Treatment
  - Aeration basins. There are two rectangular reinforced concrete aeration basins, and one reinforced concrete equalization basin on the western side of the developed site. The wastewater undergoes biological treatment in the aeration basins. Air is injected into the wastewater to promote the growth of microorganisms that feed on organic materials in the sewage. The aeration basins are also configured to remove nutrients (nitrogen and phosphorus) from the waste stream.
  - Secondary clarifiers. There are three circular concrete tanks (two smaller and one larger) called the secondary clarifiers. The wastewater from the aeration basins is pumped into these clarifiers to separate the wastewater from the mixed liquor suspended solids. The suspended heavier materials settle to the bottom of the clarifiers as sludge, and the sludge is then returned to the aeration basins. The secondary-treated water flows over the weirs of the clarifiers and is then sent to the tertiary filters.
- Tertiary Treatment
  - Tertiary filters. The secondary-treated water from the clarifiers flows by gravity into the tertiary filter complex to produce the effluent (tertiary-treated water, also called recycled water). This filtering process removes the remaining suspended solids in the effluent. To prevent clogging, the solids that accumulate in the filters are occasionally flushed out during a backwash cycle and returned to the aeration basins.
- Disinfection. The clear effluent from the tertiary filters is disinfected using ultraviolet light.
- Solids Handling. The excess sludge in the wastewater after secondary treatment is mixed with polymer and dewatered in a press for disposal to landfill.
- Storage reservoirs. Two reservoirs with a combined capacity of 4.5 million gallons are used to store recycled water. The recycled water is transported directly from the 3.5 million

gallon holding pond to the seasonal discharge locations, including nearby forests and the Northwood Golf Course. Tertiary effluent that does not meet water quality standards is automatically diverted to a one-million-gallon emergency pond, where it is then pumped back to the headworks or to an aeration basin for retreatment.

- Control Buildings

The normally occupied buildings at the site include the operations building, generator building and maintenance building. There is a transformer pad to the north of the generator building.

The wastewater treatment plant is vulnerable to several hazards, including geologic and seismic hazards, and fire. Seismic hazards include ground shaking; water impulse and sloshing forces; differential ground displacements due to landslide or liquefaction; and debris flow. The plant has already been adversely affected by a debris flow circa 1992 that originated off-site on the slopes and travelled between the clarifier area of the plant and the mechanical building, into the downslope effluent storage reservoir. All of the slopes bordering the northern boundary of the site should be considered to have a high potential for landsliding, both statically (due to seasonal heavy rains) and seismically (due to intense shaking).

Vulnerability to wildfire includes limited access to RRCSD facilities for maintenance and fire suppression. This is particularly true at the RRCSD WWTP site. Alternate access is desirable to allow easier access for emergency vehicles, but availability of right-of-way is limited. Wildfires could also cause secondary natural hazards like landslides. For this reason, the mitigations discussed for geologic and seismic-induced landslides are similar to those planned for wildfires.

The following paragraphs discuss the WWTP structures and systems that are at risk primarily during earthquake hazards.

Aeration Basins: Vulnerabilities and Mitigations

The aeration basins are part of a reinforced concrete rectangular structure with three basins.

The two eastern-most basins are used for aeration. The western-most basin was empty at the time of inspection and contained no equipment (no baffles, no aeration).

Vulnerabilities

If the aeration basins are full at the time of the earthquake, the water impulse and sloshing forces will load the downcomers. If the downcomers are deteriorated, they may break. The header air-pipe above the water level might be impacted by sloshing forces.

Mitigations

None recommended.

Buried Piping: Vulnerabilities and Mitigations

The pipes installed at the WWTP are generally welded steel, with bolted connections for valves and dresser couplings used where pipes enter/exit concrete tanks. Due to a lack of available records and calculations for the original WWTP design, it cannot be ascertained that any of the buried piping was specifically designed to handle earthquake loads.

Vulnerabilities

Assuming ground shaking at the site of PGA = 0.34g and firm soil conditions without liquefaction or landslide, buried pipe will survive the shaking, except where the pipe has become distressed due to corrosion (internal or external) or if it has construction defects (like improper welds).

This being said, the northern part of the site appears to be exposed to ongoing slope movements, and the site might also be exposed to liquefaction. The primary locations where pipes are likely to be damaged are a) where pipes enter tanks/structures, and b) where tanks are founded on deep foundations but adjacent pipes are buried just a few feet underground.

There is a strong possibility that, given PGA = 0.34g, there will be differential displacements exceeding an inch between some of the concrete tanks/structures and the surrounding soil. Consequently, there might be multiple pipe failures at the WWTP site with PGA = 0.34g (San Andreas M 8), but there is insufficient information to highlight the specific location where this might occur. The pipe failure could manifest itself in imposed distortions on a valve such that the valve becomes inoperable.

Additionally, there are two geotechnical issues that can lead to differential soil movements at the site:

- In the northern part of the site, near the clarifiers, there are steep slopes. Long-term creep of the slopes can impose differential movements on the pipes, especially where the pipes connect to concrete structures (like the clarifiers) that are founded on deeper, more stable soils. Earthquake-triggered movements can be larger than the long-term soil movement.
- In the central and southern parts of the site, where the ground surface is flatter, there is potential for liquefaction-induced settlements; the potential of a lateral spread towards the river exists, especially for the southern part of the site.

The specifications and designs for the existing buried piping for this site were unavailable for review, but the drawings and specifications for several recent upgrades, including the 2003 Third Unit Process Project, the 2011 Disinfection Upgrade, and the 2013 Biological Nutrient Removal Project were reviewed. It is clear that these projects implemented current code requirements for seismic shaking, but there is no evidence that the piping, buried or above ground, was designed for differential displacement. It appears that most pipe installations include Dresser (or similar) couplings, which are usually able to absorb about an inch of movement, but in strong shaking there can be much more than an inch of movement, and the existing pipes would be challenged.

A few locations in the northern part of the site (high slope area) have above-ground piping. These pipes were not traced back to drawings/pipe-specific calculations, but it seems likely that the above-ground configuration was used to address ongoing movement of the steeper slopes. As installed, these installations are adequate for inertial shaking, but are still subject to failure should there be imposed PGDs or a debris flow.

Given these observations, it is therefore anticipated that there will be damage to buried piping during an earthquake. The probability of pipe breaks at the RRCSD WWTP as a result of a San Andreas event is high. These pipe breaks can occur nearly anywhere in site, concentrated in areas where the pipes enter structures.

Mitigations

Given the significant chance of pipeline damage at the plant and current uncertainty in assessing which portions are the most vulnerable, pre-earthquake mitigation to the buried large bore conveyance pipes at the plant is not recommended at this time. Any such mitigation improvements would likely still remain vulnerable to damage following a significant San Andreas event, and thus not likely prove to be cost effective without a more detailed analysis of the piping systems. However, a prudent approach would be to have an emergency response plan that factors in that there might be the need to mobilize a pipe repair crew that could make pipe repair(s) within 24 hours. Assuming the causative earthquake is a San Andreas M ~8 earthquake, there will be extensive pipe damage in Sonoma County (as well as other parts of the greater Bay Area); thus, having a pre-set agreement to mobilize pipe repair crews will be useful. Receiving aid from other lesser-impacted agencies in the Bay Area might also be another option. (In the Bay Area, only EBMUD has a large in-house crew capable of repairing 24" to 48" steel pipe; in Southern California, the Metropolitan Water District of Southern California has the ability to roll spare pipe to any size diameter.) Although steel pipe will not likely need to be replaced, the ability to roll steel shapes will likely be needed for repairs. Larger pipe contractors might have this capability, but from a planning perspective, RRCSD should assume that there will be a larger demand for their services than usual.

Going forward, when RRCSD makes modifications at the WWTP, unless otherwise recommended by site-specific geotechnical assessment, it is recommended that all pipes (including chemical pipes and water conveyance pipes) be designed to accommodate three inches of knife-edge settlements when entering concrete vaults. This can usually be accommodated using a combination of bellows, ball-joints with slip joints, dresser-like couplings (at least two per pipe, generally restrained), expansion loops in vaults, etc.

In order to mitigate the geotechnical vulnerabilities, and until geotechnical investigations can be done, it is recommended that for future water (including wastewater / sludge) pipe installations:

- All pipe-structure connection points be designed to accommodate three inches of differential “knife-edge” type movements at soil-structure connection points (where ground slope is more than five degrees).
- All buried pipe throughout the plant be designed to handle liquefaction and slope movement (resulting in a one percent strain on the pipe). All buried chemical pipes should be similarly designed. Above-ground pipe installations can be used, but such pipe should be checked for inertial loads per ASME B31 provisions, assuming elastic limits (no pipe stress over yield) for PGA = 0.34g / firm soil spectra in each of the two horizontal directions, and a corresponding vertical spectra.

By following these recommendations, future pipe installations will be much more likely to withstand future earthquakes.

This still leaves open the question of how vulnerable the pipe network is at the existing WWTP, and what to do to lessen the impacts. The choices include:

- Do nothing.
- Improve emergency response capability, including the ability to quickly repair broken pipes, or to use above ground temporary hose to bypass damaged pipe.
- Do modest level of mitigation, where the costs are lowest and the existing vulnerability the highest.

- First priority: From influent/grit chamber to aeration to discharge to the river. This reinforces the primary treatment process.
- Second priority: From influent to secondary clarifier (at least clarifier 3, 60-foot) to disinfection to discharge to the river. This reinforces secondary treatment process. Included are the sludge pipes from the secondary clarifier.
- Third priority: From secondary clarifiers to tertiary treatment to the disinfection of discharge to the river or to tertiary water users (golf course).
- Fourth priority: Pipeline from the WWTP to the tank serving the tertiary water user (golf course).
- Fifth priority: Ensure tank at Northwood Golf Course is seismically robust.

Structures: Vulnerabilities and Mitigations

There are several buildings at the WWTP, and most date to the original plant construction. The style of construction is reinforced masonry.

There are three building structures on the north side of the plant:

- The westernmost building includes control, administration, and water quality lab. This is a two-story building with a gable roof and is labeled the Operations Building.
- The central building contains the emergency generator and is labeled the Generator Building. It is a single story building with a flat roof. The fuel tank for the emergency generator is currently located uphill of the building and is anchored. The fuel pipe from the fuel tank to the emergency generator building is supported by the fuel tank that sits on two small concrete blocks on fill.
- The easternmost building contains chemical-mixing equipment and is labeled the Mechanical Building. This is a tall single-story building with a gable roof.

To accommodate the slope of the site, each of these three buildings is partially buried on the north site. The solid waste handling building is a rectangular two-story building made of reinforced masonry. Pipes and conduits between the solid waste building and the adjacent control building should be able to sustain at least one inch of differential movement between the buildings.

The blower building is a single-story reinforced masonry structure.

Vulnerabilities

All of these buildings were apparently designed for seismic forces consistent with 1979 UBC, or about $V = 0.18W$. For inertial loading, this should be sufficient to provide reasonably good performance at PGA = 0.34g for long-duration shaking.

It is suspected that there is ongoing slope movement in this area of the site, and this has led to partial separation between the solid waste building and the adjacent control building (Figure 12).

Mitigations

Upgrading the fuel pipe that provides fuel from the fuel tank to the emergency generator to accommodate up to three inches of differential movement is recommended.

Flocculation Tank: Vulnerabilities and Mitigations

There is a flocculation tank in a rectangular concrete vault. From an inertial point of view, the concrete vault is adequate to handle ground-shaking hazards.

Vulnerabilities

Adjacent to the flocculation tank is a vertical chemical tank (plastic). The plastic tank is tied down with steel cables to prevent rocking (and sliding to a lesser extent) under seismic motions. Although the steel cables are adequate for inertial loads, the attached pipes may be damaged if there are PGDs.

Mitigations

None recommended

Ultraviolet Treatment and Filters: Vulnerabilities and Mitigations

Vulnerabilities

The UV system is composed of several arrays of vertically-oriented glass tubes that are inserted into the water. It is unknown if such a system has undergone strong earthquake shaking in the past, and it is possible that rattling of the glass tubes within or above the water will result in occasional glass breakage.

The UV treatment system is located under a steel frame, which is adequate for inertial loading.

Adjacent to the UV system are two steel water-holding tanks for the tertiary filters resting on a concrete pad that do not appear to be anchored. Assuming the tanks are full of water during an earthquake, the tanks could slide sideways a few inches; this would lead to damage to several of the attached pipes.

Mitigations

For purposes of this report, it is suitable to allow for UV System damage under an earthquake and to have plans to make repairs within two weeks (for sporadic damage of tubes) or 12 weeks (for major damage).

It is recommended that the water-holding tanks be anchored and all attached pipes be upgraded to accommodate up to three inches of differential movement.

Ponds: Vulnerabilities and Mitigations

Vulnerabilities

The ponds are cut into the site, possibly with fill at the southern embankments. The slopes are lined with asphalt-type material. Under strong shaking, sloshing of water out of the ponds (if full) will occur; this is considered acceptable.

Mitigations

None recommended.

Housekeeping: Vulnerabilities and Mitigations

The term "housekeeping" refers to two types of seismic issues:

- Equipment with inadequate anchorage/restraint and whose failure would impact plant operations. For example: switchgear.
- Items with inadequate anchorage/restraint and whose failure might result in some losses but are unlikely to impact plant operations. For example: storage cabinets and suspended ceilings over office areas.

Vulnerabilities

The following housekeeping items were assessed:

- The emergency generator uses manufacture-supplied isolation mounts. The start-up battery for the emergency generator is adequately installed.
- Air blowers and blowers were adequate.
- A chemical mixing tank is anchored.
- A water heater tank is not anchored.
- Electric switchgear cabinets in the control building (nine bays) and the blower building have unknown anchorage.
- Two vertical air tanks are unanchored.
- House transformers were anchored.
- The suspended ceiling over an office room (containing SCADA equipment) is likely non-seismic. There are no fire sprinkler heads through the tiles.
- A six-bay switchgear cabinet is located in the control building in the SCADA room; anchorage was not confirmed.
- A SCADA cabinet is marginally anchored.
- There is a loose computer in the SCADA room.
- There are several unanchored storage shelves in the water quality lab.
- There are counter-top ovens (and similar) devices in the water quality lab. These devices have small counter-top lips to prevent slippage to the floor below. There are several floor-mounted storage shelves and refrigerators that are unanchored / on wheels in the water quality lab.
- There is a counter-top oven / device in the water quality lab. This has no counter-top lip to prevent slippage to the floor below.
- The SCADA cabinets in the blower building are anchored.
- There is an unanchored cabinet in the blower building.

Mitigations

All cabinets that are unanchored/marginally anchored should have anchors/restraints based on PGA = 0.34g with I_p = 1.5, where anchor bolts have a factor of safety of at least two for these loads (R = 1). All shelves and racks are recommended to be anchored and the shelves should be modified to have restraints to prevent items from sliding onto the floor. Adding low-cost restraint devices to lab equipment would prevent the equipment from rocking during ground shaking.

For very strong shaking, it is recommended to install supplemental snubbers to the emergency generator.

A seismic-rated ceiling could be installed, but this is considered low priority because falling tiles can be readily addressed post-earthquake, and there is little life safety risk.

Slopes: Vulnerabilities and Mitigations

There are series of geologic and seismic conditions that could adversely affect the improvements and operations of the plant, both in a static and seismic situation. The plant has already been adversely affected by a debris flow circa 1992 that originated off-site on the slopes and traveled between the clarifier area of the plant and the mechanical building, into the downslope effluent storage reservoir.

Vulnerabilities

There is little to no protection from slope movements to protect the facility at this site. The slopes immediately adjacent and upslope of the site are prone to landsliding, including relatively fast-moving and laterally extensive debris flows. Giblin Associates (2002) performed an evaluation of the site in preparation for the 2003 Third Unit Process Project and reported that debris from earlier flows were approximately six feet deep at the site of the 60-foot clarifier. Additionally, a large debris flow in 1992 was triggered by heavy rains when debris extended into the effluent reservoir.

Mitigations

All of the slopes bordering the northern boundary of the site are at high risk for landslides, both statically (due to seasonal heavy rains) and seismically (due to intense shaking). Giblin recommended improvement in upslope drainage to reduce the risk of future rain-initiated debris flows. Debris slides can be initiated by seismic shaking, and although improved drainage will reduce the risk, the risk remains substantial.

A comprehensive geologic and geotechnical assessment should be performed on these slopes (and offsite properties) to refine the areas of existing and potential landslides and develop impact mitigation alternatives in the case of a landslide. Design mitigation scheme could include construction of debris diversion/catchment walls or impact fences to protect the essential operations of the treatment plant. These could be deep-founded structures (possibly soldier-pile walls) intended to deflect the debris away from the primary operational areas or catchment-type fences that prevent the debris from crossing the site or impacting improvements.

Occidental County Sanitation District

The Occidental County Sanitation District (Occidental CSD) service area covers approximately 55 acres and provides service to approximately 273 ESDs using a gravity collection system. There is one lift station in the Occidental CSD that supports truck filling for transport of wastewater to ALW SZ for treatment.

The lift station also functions to pump wastewater up to the Occidental wastewater treatment plant for equalization storage, when needed. The Occidental CSD treatment plant, which formerly provided secondary treatment of approximately 20,000 gpd, includes ponds, treatment facilities, and one off-site holding pond. With treatment now occurring at the ALW SZ facilities, the off-site pond will no longer serve as part of the Occidental CSD system, and portions of the Occidental CSD treatment facilities will be decommissioned.

A general overview of these sanitation system vulnerabilities is as follows:

- Lift station and treatment plant for Occidental CSD are located in areas of potential landslide hazard.
- The Occidental CSD is located in an area of high fire threat.

South Park County Sanitation District

The South Park County Sanitation District (South Park CSD) service area covers approximately 1,460 acres within the City of Santa Rosa. South Park CSD provides wastewater collection service to approximately 4,426 ESDs using a gravity collection system. The collected influent is routed to the City of Santa Rosa's collection system for treatment.

A general overview of these sanitation system vulnerabilities is as follows:

- The eastern most portion of South Park CSD is in close proximity to high and very high fire threat, as well as the Hayward-Rodgers Creek Fault.
- The South Park CSD collection system components adjacent to Santa Rosa Creek are in a very high liquefaction risk area.

Flood Protection Infrastructure and Risk Assessment

Sonoma Water, in cooperation with the United States Army Corps of Engineers (USACE) and the Natural Resources Conservation Services (NRCS), is responsible for maintaining specific federal and non-federal flood protection projects within the Russian River watershed. Some of these projects include Lake Mendocino, Lake Sonoma, the Central Sonoma Watershed Project, and the Russian River Channel.

The Coyote Valley Dam at Lake Mendocino and Warm Springs Dam at Lake Sonoma are operated in collaboration with the USACE. Sonoma Water has the exclusive right to control the releases of water from both reservoirs when the water level is within the water supply pool. However, when the water level rises above the top of the water supply pool and into the flood control pool, the USACE assumes control of releases. For this reason, Lake Sonoma and Lake Mendocino are considered part of Sonoma Water's water supply system and are discussed in more detail in Element B2.

In 1958 under the authority of Sonoma Water's enabling legislation, nine geographical zones were proposed as a means of financing the construction and maintenance of flood protection infrastructure within Sonoma County. Each zone would encompass a major watershed. The county is now divided into nine flood control zones, which include: 1A Laguna-Mark West Watershed, 2A Petaluma Creek Watershed, 3A Valley of the Moon Watershed, 4A Upper Russian River Watershed, 5A Lower Russian

River Watershed, 6A Dry Creek Watershed, 7A North Coastal Watershed, 8A South Coastal Watershed, and 9A Bay Watershed. In subsequent years, the following zones became active voter-approved zones: 1A, 2A, 3A, 5A, 7A, and 8A, while 4A, 6A, and 9A are still unformed zones. Zones 1A, 2A, and 3A have Zone Advisory Committees that annually prioritize and approve capital improvement projects for their respective zones. These three zones have financed the construction of flood protection and drainage infrastructure, maintenance of natural waterways, preparation of master drainage plans for areas subject to flooding, and erosion and sediment control activities. Zones 1A, 2A, and 3A have also financed a majority of the flood protection operation and maintenance activities of Sonoma Water. The vast majority of flood protection infrastructure is located in Flood Zones 1A, 2A, and 3A. For this reason, the LHMP focuses the natural hazard vulnerability assessment on these three flood zones but includes all flood zones.

In Zone 1A, the Central Sonoma Watershed Project has four flood control reservoirs that include the Spring Lake Reservoir (Santa Rosa Creek), Matanzas Creek Reservoir, Piner Creek Reservoir, and Brush Creek Reservoir. Each of these reservoirs are equipped with appurtenant structures including at grade and underground conveyance channels and conduits. Unlike the Warm Springs and Coyote Valley dams however, these flood control reservoirs are not equipped with flood gates. Instead, they operate passively either as detention basins or bypass systems. In cooperation with the NRCS, several waterways have also been shaped and stabilized as part of the Central Sonoma Watershed Project. Some stabilization measures include use of concrete and riprap, while other channels are trapezoidal earthen structures with limited use of riprap.

Throughout the Russian River watershed, Sonoma Water provides funding and works in collaboration with several partners to provide, maintain, and improve flood forecasting systems. Within the Russian River Basin Sonoma Water works with the United States Geological Survey to maintain several stream gaging stations and provides funding under an agreement with the California Department of Water Resources to maintain several rain gages. These stations provide information on rainfall intensity, stream height, and stream discharge that are essential for flood forecasting. Other stations also exist, located on the Laguna de Santa Rosa at Guerneville and at the mouth of the Russian River near Jenner, and these aid in monitoring flood conditions as well. After the October 2017 wildfires, Sonoma Water undertook a project to install additional rain and stream gages in priority areas at risk of flash floods or debris flows from the burn areas. The new gage system is integrated with the National Weather Service to provide data transmission for issuance of hazard watches to protect life safety and property.

Additionally, Sonoma Water’s San Francisco Bay Area Advanced Quantitative Precipitation Information (AQPI) System project will significantly improve rainfall and atmospheric river forecasting abilities for Sonoma Water’s service area. The installation of X-Band Radars through the AQPI project will give flood control managers, including Sonoma Water, more accurate information on the location, timing, and intensity of expected rainfall, with an emphasis on improving short-term (48-hour) monitoring and prediction of high-impact rainfall events.

Sonoma Water provides maintenance services for over 150 miles of engineered and natural channels (creeks) primarily in zones 1A, 2A, and 3A. The maintenance activities include debris removal, bank stabilization and protection, maintenance of inlet/outlet structures, silt removal, vegetation management, levee repair, service road maintenance, and dam and reservoir structure maintenance.

Sonoma Water holds fee title on some channels, and access easements on many others. Easements allow the Agency to access creeks and channels to perform maintenance to reduce the risk of flooding, but in no way obligate Sonoma Water to perform such maintenance. Sonoma Water's Stream Maintenance Program (SMP) uses the SMP Manual and programmatic permits as the guiding framework for implementing flood protection work in the areas maintained by the Agency. In general, Sonoma Water performs maintenance on three types of channels: engineered, modified, and natural. Engineered flood control channels are waterways which have been significantly altered to provide an estimated level of flood protection. In contrast, Natural and Modified channels are channels that do not meet Sonoma Water's design criteria for flood control channels.

Such channels may be in a natural state but in many cases have been straightened, deepened, or hardened by landowners. Natural and modified channels do not have a defined engineered hydraulic capacity to be maintained.

In addition to the reservoirs and engineered flood protection channels, Sonoma Water also owns and maintains numerous storm drain and/or creek by-pass conduits and related appurtenant facilities. Most of these facilities are 72-inch diameter and larger concrete conduits distributed throughout various locations of Flood Control Zone 1A, although Flood Zones 2A and 3A also have some of these facilities.

The following sections detail known vulnerabilities from the current LHMP vulnerability assessment and recent flood events. It is worth noting that, unlike Sonoma Water's role as a continuous, year-round provider of water supply and sanitation services, many flood protection facilities are not required to function continuously and, depending on the timing of a hazard event, might remain out of service for several months without significant impact. The uncertainty of this timing in the case of these flood protection facilities does offer an inherent degree of mitigative protection against some of the vulnerabilities identified below.

Figures 27 through 36 show the flood protection infrastructure overlain on maps of the identified primary hazards.

Flood Zone 1A – Laguna-Mark West Watershed

Flood Zone 1A encompasses the Laguna de Santa Rosa and the Mark West Creek Watershed. It contains all four detention reservoir structures from the Central Sonoma Watershed Project, as well as all conduits and engineered streams from Windsor to Cotati. The Agency is responsible for the operation of reservoirs associated with the Central Sonoma Watershed Project, as well as flood protection channels maintained by the Stream Maintenance Program (SMP). Sonoma Water infrastructure in Flood Zone 1A is vulnerable to several hazards.

Fault rupture within Flood Zone 1A is a primary vulnerability for Sonoma Water flood protection infrastructure. The Spring Lake Detention Reservoir, Santa Rosa Creek Diversion, and Spring Creek Diversion Structure are all traversed by the Bennett Valley Fault Zone. The Piner Creek Detention Reservoir is traversed by the Rodger's Creek Fault parallel to the dam structure, and the Brush Creek Reservoir is in close proximity to an unnamed fault. Multiple storm drain conduits are also in close proximity to mapped faults within Flood Zone 1A. The mostly earthen flood control channels managed by Sonoma Water are anticipated to be significantly less vulnerable to irreparable damage due to fault rupture than the detention reservoirs or other fixed improvements such as conduits or concrete control structures. The Piner Creek Detention Reservoir, Brookhill School, and Brigham Avenue conduits are at risk of very strong ground shaking due to being in a .6g PGA ground shaking risk zone. The rest of the detention reservoirs and conduit structures in Zone 1A are within the .4g PGA zone.

Liquefaction is another earthquake-related hazard to which the flood protection infrastructure is vulnerable. All of the reservoirs, except Matanzas Creek Reservoir, are within zones of moderate liquefaction potential, and numerous conduits are within liquefaction zones ranging from moderate to very high hazard. Typically, open channels are vulnerable to liquefaction hazard. Engineered channels in high to very high liquefaction hazard zones are also subject to high risk for lateral spread. Nearby facilities located within a zone of lateral spread are at high risk for damage.

Brush Creek, Piner Creek, Spring Lake, and Matanzas Creek Detention Reservoirs all include areas rated high for landslide risk. Landslides that are located within the watershed but outside the boundaries of Sonoma Water's owned facilities also pose a risk by providing a source of sediment that can migrate into Sonoma Water's flood protection infrastructure and reduce capacity. The engineered flood protection channels are certainly vulnerable to this hazard, as well as reservoirs and conduits. The Cook Creek landslide is one such example. Erosive conditions in the upper reaches of the Matanzas Creek are also long known to contribute to excessive sedimentation in the Matanzas Creek Reservoir. Secondary erosion/landslide effects within a post-fire watershed or from floods could also cause sedimentation that will adversely impact flood protection infrastructure managed by Sonoma Water.

The Matanzas Creek and Brush Creek Detention Reservoirs are subject to high fire threats, while the Piner Creek and Spring Lake Detention Reservoirs are subject to moderate fire threat. The erosive effects of fire can lead to landslides and significant sedimentation that can reduce the capacity of flood protection infrastructure. The Spring Creek Diversion Structure is also located in a high fire threat location but is not assessed to be highly vulnerable to significant damage. Neither are any of the buried concrete conduits expected to incur significant damage due to fire. Engineered channels are susceptible to fire damage in that the desired vegetation in these channels can burn, which would increase erosion and reduce the flood protection capacity of the channels, as well as fire damage to the channel's tree canopy can increase vegetative growth of undesirable channel-clogging plants that also decrease flood protection capabilities.

Most of Sonoma Water's fixed (non-earthen or hardened) improvements within Flood Zone 1A are constructed out of reinforced concrete, or at least have elements made from concrete and steel. They are considered somewhat vulnerable to corrosion, and those in highly corrosive environments should be evaluated for evidence of weakening. All of the reservoirs are in an area of moderate to high corrosion potential. There are five conduits in highly steel-corrosive soils, potentially affecting either reinforced concrete pipes or corrugated metal pipes. There are six concrete conduits that are located in highly concrete-corrosive soils. It is recommended that the conduits be evaluated for evidence of corrosion.

Sonoma Water's flood protection infrastructure is even vulnerable to flooding itself. Many of the facilities are earthen improvements that are vulnerable to large storm events and large stream flows, specifically the erosive effects of those events that can cause embankments to fail, transport large quantities of channel-clogging sediment that reduces flood protection capacity and scour engineered facilities. Even hardened features (e.g., concrete, etc.) are vulnerable to the erosive scouring effects of high stream flows and/or sediment transport that occurs during storm events. Examples of this vulnerability are evident in both the Santa Rosa Creek Tunnel and the Vortex Tube facilities; the Santa Rosa Creek Tunnel was damaged from flood scour in the January and February 2017 floods. These same flood events also caused excessive sedimentation in many engineered channels in Zone 1A (Cook Creek, Copeland Creek, Gossage Creek, Laguna Creek, Santa Rosa Creek). The Matanzas Creek reservoir has recently been assessed to have insufficient principal spillway capacity for an extreme flood event. This could result in premature use of the emergency spillway, which is unlined and susceptible to erosion damage if used.

In addition to the five detention reservoir structures and flood protection channels, Zone 1A includes the Laguna de Santa Rosa. This natural feature serves as an overflow basin covering 254 square miles and connecting the Mark West creek and other smaller creeks to the Russian River. The Laguna de Santa Rosa attenuates flooding on the Lower Russian River and is the largest watershed tributary to the Russian River. Sonoma Water does not have operational, maintenance, or flood protection obligations related to the Laguna de Santa Rosa, but does recognize its valuable role in flood attenuation and has partnered with other entities in looking to preserve its function in the watershed.

<u>Climate Sensitivity</u>: Detention Basins on Brush Creek, Paulin Creek, and Matanzas Creek
Rating: High

- The main vulnerability of these three facilities is to increased precipitation intensity. While the facilities were originally designed to a 100-year precipitation event, recent hydrologic analysis has indicated the potential for vulnerabilities associated with extremely intense rainfall events. Increased precipitation intensity under future climate scenarios will lead to an increase in the use of the auxiliary spillway and a decrease in the attenuation capacity of the reservoirs as larger outflows occur when the auxiliary spillway is engaged. This will have impacts on downstream flood conveyance through the City of Santa Rosa. Hydraulic model investigations with alternative future climate precipitation events should be used to provide a clear picture of expected future outflows under more intense rainfall conditions.

- Of the three reservoirs, Matanzas Creek Reservoir is likely the most vulnerable because of its earthen embankment that serves as the emergency spillway. Predicted flow rates over this emergency spillway in the 72-hour PMP were over 18,000 cfs, with the water level ten feet above the spillway crest. While the PMP used to generate this event is likely above a 1000-year return period event, lesser storm under future climate conditions could result in significant flows down the earthen embankment. Given recent concern over earthen embankments because of conditions at Lake Oroville, it would be prudent to model smaller storm events to determine the return period storm that would first engage the auxiliary spillway.

Climate Sensitivity: Zone 1A Flood Conveyance System
Rating: High
Flood conveyance in Zone 1A is considered sensitive to climate induced increases in streamflow, as the system has current flood vulnerabilities that will occur more frequently under expected future climate scenarios. The nonlinear nature between flood flow and sediment transport could exacerbate future flood control channel maintenance, as expected increases in precipitation intensity drive increases in runoff and increases in sediment transport.

Climate Sensitivity: Santa Rosa Creek and Matanzas Creek Triple Box Culverts
Rating: High

- The primary sensitivity of the flood conveyance infrastructure on the Santa Rosa Plain to climate change is the projected increase in precipitation intensity and associated runoff. While increased sediment transport is expected to be a significant concern for other creeks draining into the Santa Rosa Plain, it is not expected to be as significant on Santa Rosa Creek because of the upstream detention basins.
- Predicted stream flows will have successively larger return period events in Santa Rosa Creek. Predictions indicate that the 50-year event on Santa Rosa Creek is only 17% larger than the peak flow for the 25-year event, and that the 100-year event is only 12% larger than the 50-year event. For Matanzas Creek, the 50-year event is 31% larger than the 25-year event, and the 100-year event is only 12% larger than the 50-year event. The relatively small increases in the 100-year events over the 50-year events are indicative of how potential future climate scenarios could lead to increased frequency of significant flooding events, as projected rainfall and runoff increases with climate change are on the order of 10 to 20 % or more. Based on these factors, this asset is considered HIGHLY sensitive to climate changes.

Climate Sensitivity: Spring Lake, Santa Rosa Creek Diversion, Spring Creek Diversion
Rating: Medium

- The diversion structure on Santa Rosa Creek is vulnerable to sedimentation and blockage. The vortex drain structure under Montgomery Drive is vulnerable to blockage from sediment and woody debris. This could be exacerbated under future climate conditions with increased precipitation.

- The diversion structure on Spring Creek is vulnerable to sedimentation reducing flow through the box culvert. Sedimentation is expected to increase under future climate scenarios.
- The channel leading from the Spring Creek Diversion Structure to Spring Lake is vulnerable to slump failures of the channel banks that would impede flow. There is need to remove sediment from historic localized bank failures in this diversion channel.

Flood Zone 2A – Petaluma Creek Watershed

Flood Zone 2A encompasses the Petaluma River Watershed – a watershed that experiences frequent significant flooding events and which covers the area from Penngrove to Petaluma. Within Zone 2A Sonoma Water owns/manages several engineered flood protection channels and two conduits (Thompson and Cherry–Magnolia) that are vulnerable to many of the same hazards described above for Flood Zone 1A.

Zone 2A contains moderate to high-risk liquefaction zones, leaving flood protection infrastructure vulnerable in the event of an earthquake. Where there is a liquefaction risk there is also a potential for lateral spread. The downstream portion of the Cherry-Magnolia conduit may be at risk of lateral spread and contains a portion in the high-risk liquefaction area.

The Tolay fault runs through the middle of Flood Zone 2A, intersecting many engineered channels. However, this fault is assessed to be inactive and poses minimal risk of fault rupture or significant damage to the engineered flood protection channels.

Flood Zone 2A contains areas with .3g, .4g, and .6g PGA. However, all Sonoma Water's flood protection infrastructure falls into the .4g PGA zone, exposing it to moderate ground shaking hazard that is assessed to pose minimal risk to these facilities.

Most of this zone is comprised of highly corrosive soil. The Cherry-Magnolia and Thompson Conduits are located within areas of high risk for steel corrosion, and the Cherry-Magnolia Conduit is in a moderate concrete corrosion risk area.

Flooding and high stream flows arising from large storm events pose many of the same hazards and risks for the Zone 2A flood protection infrastructure as described above for the Zone 1A infrastructure. The erosive and sediment-inducing effects of flood events, as well as landslides, threaten the flood protection capacity of this infrastructure. Adobe Creek, for example, is well recognized for the sediment producing characteristics of its upper watershed that threatens capacity of downstream flood protection infrastructure. The January and February 2017 floods caused excessive sedimentation that impacted engineered channels, including Adobe Creek.

The majority of this flood zone is located within areas mapped as having moderate or no wildfire hazard. However, the western and eastern edges are in areas of very high fire hazard, but direct fire risk to flood protection infrastructure is assessed to be low, as none of these facilities are located in the high fire risk areas. The greatest fire related vulnerability of Sonoma Water's flood protection infrastructure can be attributed to secondary post-fire erosion from the upper watersheds that could reduce the flow carrying capacity of downstream flood protection infrastructure.

Climate Sensitivity

Rating: Medium to High

- Medium to High sensitivity to future climate induced flooding from a combination of sea level rise and increased precipitation. Increased runoff volumes associated with increased precipitation rates and intensities could exceed channel conveyance capacity in the Petaluma River and its tributaries. Localized flooding already occurs for return interval events on the order of 10 years, increased rainfall intensity will further reduce this interval between flooding events.
- Flood conveyance in Adobe Creek is vulnerable to increased flows and associated sediment transport. Future climate may provide multiple storms per year capable of delivering sufficient quantities of sediment to Adobe Creek to limit conveyance and cause localized flooding. Deposition could be shifted upstream due to a decreased gradient in the creek because of sea level rise.

Flood Zone 3A – Valley of the Moon Watershed

Flood Zone 3A encompasses the Valley of the Moon Watershed, including Upper Sonoma Creek. It sits to the east of flood zones 1A and 2A and extends south from Kenwood to Highway 121. Compared to infrastructure in Flood Zone 1A, or even Zone 2A, Sonoma Water has a very limited amount of engineered flood protection infrastructure within Flood Zone 3A. Zone 3A flood protection infrastructure consists of the Kenwood Creek Bypass Conduit and engineered flood protection channels along portions of Sonoma Creek, Fryer Creek, Nathanson Creek, Rodgers Creek, as well as the Lawndale Channel.

Similar to Flood Zones 1A and 2A, the erosive and sediment-inducing effects of flooding and storm events, landslides in the upper tributary sub-basins, as well as wildfire events within the watershed, pose capacity-reducing vulnerabilities to Sonoma Water's flood protection infrastructure in Zone 3A.

Sonoma Water channel improvements along Sonoma Creek, Rodgers Creek, and Nathanson Creek are located within zones of moderate to very high liquefaction potential, where the associated risk for damage caused by lateral spread may be increased. The Kenwood Creek Bypass and Happy Court conduits are both substantially located within zones of moderate liquefaction potential and terminate in Sonoma Creek where liquefaction potential is very high.

There are several mapped faults that run through this area. The Hayward-Rodgers Creek Fault is located within the southwestern portion of the watershed. However, none of Sonoma Water's flood protection infrastructure is traversed by these faults, such that the ground deformation effects of fault rupture are not anticipated to affect the Zone 3A facilities.

Flood Zone 3A is located within areas of .4g PGA hazard or less. For the type of flood protection infrastructure that Sonoma Water has within Zone 3A, .4g PGA is not anticipated to pose a significant risk of damage from strong ground shaking.

Corrosion is assessed to pose minimal risk to Zone 3A infrastructure. Only the Kenwood Creek Bypass Conduit would be potentially vulnerable to corrosion, but this concrete pipe is located in an area of low concrete corrosion hazard.

Climate Sensitivity

Rating: Medium - High

- Sonoma Creek is a flashy creek subject to rapid increases in water level immediately following periods of intense precipitation. The system is therefore vulnerable to increases in precipitation intensity projected under future climate scenarios. While the majority of the channel can contain the current 100-year flood event, elevated runoff rates associated with more intense rainfall events may exceed the conveyance capacity of the creek. Furthermore, steep sided creeks may be more likely to see bank failures under more frequent or higher intensity runoff events. Such failures would reduce conveyance capacity and could lead to localized flooding.
- Climate sensitivity for flood conveyance on Sonoma Creek is considered MEDIUM. Current out of bank floods along the lower reaches of Sonoma Creek occur at 100-year events, expected to be exacerbated by climate induced precipitation variability. Climate sensitivity for flood conveyance on tributaries to Sonoma Creek, namely Nathanson Creek and Fowler is considered HIGH.

Other Flood Zones – 4A, 5A, 6A, 7A, 8A, 9A

Unlike 1A, 2A, and 3A, the remaining flood zones do not contain large, engineered infrastructure. However, there are a small number of engineered, modified and natural channels in these zones under Sonoma Water's purview. Sonoma Water holds fee title on some channels in these zones, and access easements on others. Easements allow the Agency to access the creeks and channels to perform maintenance to reduce the risk of flooding, but in no way obligate Sonoma Water to perform such maintenance.

The January and February 2017 DR-4301 and DR-4308 flooding events highlighted some of the infrastructure vulnerabilities in these zones. Bank slumping occurred along creeks in Zone 6A due to flood waters and fallen trees in banks, in-stream fish monitoring equipment was destroyed in Zone 8A and 6A, excessive sedimentation accumulated in multiple engineered and modified channels, damage to engineered features occurred at Riverfront Park in Zone 5A, and significant road flooding occurred due to Green Valley Creek in Zone 5A causing property damage, public safety risk, and damage to listed species. While Sonoma Water was not obligated to address the DR-4301/4308 damage to creek banks in Zone 6A and along Green Valley Creek, Sonoma Water chose to respond and incur associated costs.

Climate Sensitivity: Russian River Zone 4A
Rating: Medium
The 100-year floodplain will be enlarged under future climate scenarios with higher intensity rainfall events. Climate Sensitivity is considered MEDIUM. Based on tabulated percent chance of flood events, an increase of 26% in the peak flow value for the 10% flood event would equal the current 2% flood event, and an increase of 26% in the peak flow value for the current 2% event would equal the 1% event. Thus, under potential future climate scenarios, there will be a significant shift in the recurrence intervals for given events.

Climate Sensitivity: Russian River Zone 5A
Rating: Medium

- Flood conveyance in Zone 5A is considered moderately sensitive to climate induced increases in river flow, as the system has current flood vulnerabilities that will occur more frequently under expected future climate scenarios.
- The management of flood risk and habitat in the Russian River Estuary is sensitive to climate change as sea level rise will increase wave energy at the beach and increase water surface elevations in the Estuary, requiring modifications to the management plan.

Administrative and Operational Support Facilities and Risks

Sonoma Water occupies three administrative facilities located at 404 Aviation Boulevard, 204 Concourse Boulevard, and 800 Aviation Boulevard in Santa Rosa, and an educational facility at 9703 Wohler Road. The 404 Aviation Boulevard facility, known as the Administration Building, houses a majority of the engineering, administration, accounting, environmental, public affairs, and executive management staff. The Administration Building is powered by 2,752 solar photovoltaic (PV) panels that have been installed on the building roof and on ground-mounted power canopy creating a solar carport. This PV infrastructure has a capacity of 465 kW and provides an average annual output of 550,000 kWh.

The 204 Concourse Avenue facility, known as the Operations and Maintenance Building, is located close to the Administration Building and houses much of the Operations and Maintenance division staff. It also houses the Supervisor Control and Data Acquisition (SCADA) control room, emergency operations center, office and cubicle space, locker rooms, dispatch area, tool room, water, electrical, and industrial waste labs, wood, metal, welding, and repair shops, central supply, additional parking, secure parking for motor vehicles (as well as bicycles inside and outside the building).

The 800 Aviation Boulevard facility, known as the Service Center, houses additional Maintenance division staff and is where Sonoma Water vehicles and equipment are maintained and managed. The

Service Center is within the Airport-Larkfield Wikiup Sanitation Zone (ALW SZ) treatment plant facility, and thus the same PV panels discussed in 4.2.2 are located here as well.

The 9703 Wohler Road facility, known as the Westside Facility, is the site of Sonoma Water's Water Education Program, and is located near the unincorporated town of Forestville and the Mirabel and Wohler water collection facilities. The Westside Facility consists of two classroom buildings, is surrounded by a demonstration Water Wise native plant garden, and frequently hosts school children as part of the Water Education Program.

The Administration Building, Operations and Maintenance Building, Service Center, and Westside Facility are located less than 2.5 kilometers from the Hayward-Rodgers Creek fault. Very strong ground shaking is expected at these facilities. An independent vulnerability assessment of Sonoma Water's administrative and operational support facilities is to be addressed in the future. That being said, the Administration Building, Operations and Maintenance Building, and Service Center are all located within the (ALW SZ) boundary, and thus many of the same vulnerabilities discussed above in Element B2 are anticipated to apply to these locations as well.

Summary of Impacts and Vulnerability By Hazard Type

Earthquake Impact and Community Vulnerability

Damage to water supply, sanitation, and flood protection infrastructure following a major disaster can lead to significant disruption. Observations from several disasters demonstrate this, including earthquakes in California, such as the 2014 South Napa Earthquake, the 1994 Northridge earthquake, and the 1989 Loma Prieta earthquake. In addition, observations from the catastrophic damages that occurred during the September 2010, February 2011, June 2011 and December 2011 Christchurch, New Zealand earthquakes should also be taken into consideration.

In 2014, a 6.0 magnitude earthquake occurred in the southern Napa Valley California area, centered less than 40 miles from Santa Rosa, CA. The South Napa Earthquake is one of the first damaging earthquakes to strike a major metropolitan area in the State of California in over two decades. During this earthquake electricity and water services disruptions occurred, and minor damage occurred to the water and wastewater treatment facilities. A draft report prepared by the Alfred E. Alquist Seismic Safety Commission and the Pacific Earthquake Engineering Research Center [56] concluded that the main causes of physical damage to infrastructure systems were surface fault rupture and ground shaking effects on older and less ductile system components. For example, all of the 11 sewer main breaks in the Napa Sanitation District system occurred in brittle asbestos cement pipe and most were near the fault. The City of Napa's water system was one of the most damaged infrastructure systems, with 241 water leaks reported in the six months following the earthquake. A seismically unanchored 67-foot diameter steel tank located near the fault rupture—one of 12 holding tanks in the city's water distribution network—also sustained significant damage and drained until empty due to a nearby pipe break.

Approximately three-quarters of the water main breaks were in old cast iron pipe. Roads, highways, and two natural gas transmission pipelines serving the northern Bay Area were also impacted by surface rupture and afterslip in the West Napa fault zone.

While the Napa Sanitation District's wastewater treatment operations performed quite well in the earthquake, the system was subsequently disrupted for two days due to an inflow of considerable quantities of wine spilled from damaged barrels. The wine's acidity disrupted normal anaerobic bacterial processes in the treatment plant's digester; remediation that involved blowing air into the digester took 24 hours to complete. No untreated water or solids were released. The 2014 South Napa earthquake highlighted the vulnerability of water and wastewater systems to earthquake related ground failures, the additional fire hazards that earthquake-related water system failures can pose, and the fiscal challenges that public agencies face in improving the seismic resiliency of these systems, both pre- and post-earthquake. The City of Napa's water system sustained more than $6.4 million in damage from the August 24, 2014 earthquake, subsequent aftershocks and ground settlement. In the immediate response period, the City of Napa continued pushing water through the damaged system to maintain fire-fighting and other critical functionality. This resulted in an estimated total loss of 100 acre-feet of water (about 7% of monthly water usage) but water was available for firefighting at all but one of the nine post-event earthquakes. The city spent $860,000 making emergency water system repairs in the first week following the earthquake. Assistance was provided through CalWARN by crews from other local water and wastewater agencies in the San Francisco Bay Area.

Ongoing afterslip and ground settlement have caused multiple ruptures in certain areas. The city appealed to FEMA to fund full replacement rather than repairs at 17 sites since the system is not in the same condition as it was before. As of January 2016, FEMA has obligated nearly $19.33 million in Public Assistance grants to qualifying public agencies and organizations. Of this, $4.74 million has been awarded for emergency related work, such as time and expenses for mutual aid and costs of emergency repairs to the damaged water system. Additionally, nearly $13.72 million has been awarded for permanent repairs to public buildings and infrastructure. [57]

There was significant disruption of water service following the 1994 Northridge earthquake in California. There was damage at 15 locations in the three transmission system pipelines that transmit water to the south from Northern California and at 74 locations in large diameter trunk lines and 1,013 locations in the Los Angeles Department of Water and Power's (LADWP) distribution pipeline network including damage to tanks and other facilities. Water system damage was distributed over approximately 1,200 square kilometers [58]. During the 1989 Loma Prieta earthquake 20 million gallons of raw sewage were reportedly dumped into the Oakland Estuary in a six-hour period following the earthquake.

During the 2010-2011 Christchurch, New Zealand earthquakes more than 78 km of water pipelines were damaged with majority of damage occurring in areas of high liquefaction [59] requiring hundreds of pipeline repairs. Most of the downtown Christchurch area became uninhabitable due to widespread liquefaction-related damage [60].

Flood Impact and Community Vulnerability

Flooding is the most frequent hazard that impacts Sonoma County. The January and February 2017 floods directly impacted Sonoma Water, causing damage to the water supply, sanitation, and flood protection infrastructure.

As a more extreme example, the Oroville Dam crisis showed how widespread rainfall during the January 2017 floods can cause significant damage to infrastructure and an imminent threat to public safety. As storms brought significant precipitation on the area, the Lake Oroville level rose until it flowed over a concrete weir at the top of the dam's emergency spillway, despite the reopening of the damaged main spillway. As water flowed uncontrolled over the weir, headward erosion of the emergency spillway threatened to undermine and collapse the concrete weir; had this occurred, a 30-foot (9 m) wall of water would have descended into the Feather River below and flooded communities downstream. A collapse never occurred, but over 150,000 people were issued an emergency evacuation, the main spillway suffered significant damage, and the bare slope of the emergency spillway was significantly eroded. [61]

Fire Impact and Community Vulnerability

Fire is another natural disaster that has devastated the region in recent years. The Valley Fire in 2015 spread through Lake, Sonoma, and Napa counties, and destroyed 1,955 structures and caused four fatalities. The fire caused an estimated $1.5 billion in losses, and FEMA provided an estimated $7 million in aid for housing and food.

In October 2017, a series of catastrophic fires spread through Sonoma County. In total, the Tubbs, Nuns, and Pocket Fires damaged more than 110,000 acres, destroyed 8,400 structures, and caused 42 fatalities. More than $3 billion in covered losses have been reported at the time this LHMP was being updated. While Sonoma Water's infrastructure was not damaged during the fires, fire-related vulnerabilities remain which would impact Sonoma Water's critical infrastructure. Sonoma Water's primary fire-related concern is that a fire near Lake Mendocino, Lake Sonoma, or the Russian River could cause catastrophic damages to the water supply. [62] Lake Sonoma is the main water supply for the Russian River, which serves the 600,000 people in Sonoma and northern Marin counties that receive drinking water from Sonoma Water. A wildfire could result in catastrophic post-fire sedimentation or landslides into Lake Sonoma that would threaten the water supply function, infrastructure, water quality, and forest health of this critical watershed. Wildfires often degrade water quality due to increased delivery of sediment, dissolved organic carbon, metals, and nutrients to waterways. These impacts could significantly impair Lake Sonoma's water quality for drinking water and the endangered and threatened fish species in Dry Creek, which flows downstream of Lake Sonoma.

B2c. NFIP-Insured Structures Repetitively Damaged by Floods

Sonoma Water does not have NFIP-insured structures, and therefore does not have NFIP properties that have been repetitively damaged by floods.

Element C. Mitigation Strategy

C1. Existing Authorities, Policies, Programs, and Resources, and Ability to Expand On and Improve Them

C1a. Sonoma Water's Existing Authorities, Policies, Plans, Programs, and Resources; Existing Building Codes, Land Use and Development Ordinations or Regulations

Sonoma Water has certain authorities, guidelines, and practices that enable and allow the Agency to implement the goals, objectives, and actions in Element C. These resources help guide Sonoma Water's hazard mitigation efforts. Of the plans identified below, most are reviewed or updated annually to address a wide range of operational needs, including support of hazard mitigation efforts.

Authorities

Sonoma Water's enabling legislation is Chapter 994 of the California Statutes of 1949. This legislation gives Sonoma Water the authority to produce, store, distribute, and sell surface water and groundwater for beneficial uses. Sonoma Water may also control flood waters, generate electricity, and provide recreational facilities in connection with flood control and water conservation works. Additionally, the legislation provides Sonoma Water with the power to levy property taxes separately from the County, collect benefit assessments for flood control purposes, charge for sanitation services, and charge for water delivered from the transmission system. This existing legislation supports Sonoma Water's natural hazard mitigation strategies described in Element C, providing the opportunities to pursue mitigation activities as needs arise.

Russian River County Sanitation District's enabling legislation is Health & Safety Code Section 4700 et seq. The RRCSD has the authority to construct and operate works of improvement for sanitation-related purposes; to execute related contracts, incur debt, and issue bonds for works of improvement; to fix rates, collect charges, and levy assessments for such purposes; and to acquire real property and related property rights such as easements and rights of way, including eminent domain authority if necessary.

Policies

Water Policy Statement

Sonoma Water's policies are represented in its Water Policy Statement. The statement sets forth standards for sustainably managing natural resources, protecting the environment, providing leadership for regional water resources issues, and partnering with stakeholders in order to benefit watersheds. In addition, the statement sets standards for communicating with the public, effectively managing regional water resources, and employing cost-effective methods and best management practices.

RRCSD's policies are predominantly represented in its Sanitation Codes and Standards. These codes and standards set forth uniform requirements for contributors to the wastewater collection and treatment systems of RRCSD and enable RRCSD to comply with all applicable State and Federal laws, including the Clean Water Act of 1977, as amended, and the General Pretreatment Regulations (40 CFR Part 403).

Energy Policy

Sonoma Water Energy Policy, adopted by the Board of Directors on March 22, 2011, guides the Agency's energy-related efforts. As one of the largest energy users in Sonoma County, Sonoma Water has used this policy as the framework to become a leader in energy and climate change activities. This policy provides two main goals: sustain carbon-free water and engage in energy and climate resiliency projects with regional benefit. Sonoma Water set the goal of providing carbon-free water by 2015, and successfully achieved this milestone through a combination of energy efficiency, and renewable energy purchase and development. The solar photovoltaic infrastructure owned and operated by Sonoma Water is described in Elements B2a and B2b. Sonoma Water reported 99% reduction in electricity emissions and 92% reduction in total emissions between 2006 and 2022. To achieve the goal of benefitting regional energy projects, Sonoma Water supported the development of our local community choice energy entity, Sonoma Clean Power, and continues to partner with them regularly.

Programs

The following programs support Sonoma Water's hazard mitigation efforts.

Stream Maintenance Program (SMP)

Sonoma Water's flood protection and stream maintenance policies were established in a series of resolutions adopted by the Board of Directors of Sonoma Water in the 1960s. Salmon listings in the late 1990s and early 2000s prompted Sonoma Water and the United States Army Corps of Engineers to engage in a Section 7 Consultation under the federal Endangered Species Act for operation of flood protection and stream maintenance responsibilities and the SMP is included in the Russian River Biological Opinion. Sonoma Water completed a Stream Maintenance Program (SMP) Environmental Impact Report (EIR) and a SMP Manual and obtained programmatic permits to continue routine flood control work. Through these resolutions, the Board of Directors' approval of the SMP EIR and SMP Manual, and guided by the current programmatic permits, Sonoma Water adopted standards and specifications for construction of flood protection channels, established flood protection design criteria, and has the ability to perform flood protection work within Sonoma Water flood protection maintenance areas.

Forecast Informed Reservoir Operations (FIRO)

Sonoma Water entered into a cooperative agreement with Scripps Institution of Oceanography and the Center for Western Weather and Water Extremes (CW3E) to advance research on the role of atmospheric rivers in filling Lake Mendocino and offer predictability to retain water without increasing flood risk to communities downstream of Coyote Valley Dam. The partnership also developed feasibility assessments for FIRO with the US Army Corps of Engineers. FIRO follows adaptive management principles for continual improvement of reservoir operations. In the case of Lake Mendocino, and much of the west coast, this approach hinges on opportunistically applying advances in monitoring and predicting atmospheric rivers, their associated precipitation and runoff. FIRO leverages current and improved forecasts of atmospheric rivers and their associated heavy precipitation and streamflow, through tools developed as part of the project. These data and tools inform reservoir operations, allowing more proactive and adaptive adjustments to variable weather conditions in decisions to retain or release water. FIRO does not require reservoir operators to employ information provided by FIRO; it merely provides additional information to inform operational decisions. The program represents an innovative use of science, technology, and observations for operators to adapt to variable conditions without costly reservoir infrastructure improvements.

Advanced Quantitative Precipitation Information System (AQPI)

Sonoma Water is the local sponsor for a regional project called the San Francisco Bay Area Advanced Quantitative Precipitation Information (AQPI) System project. The AQPI System will provide both improved observing capabilities and a suite of numerical forecast models to produce accurate and timely information for a variety of user needs, including improved precipitation and hydrologic information to assist the region in mitigating flood hazards, maximize water supply, and enhance ecosystem services. Precise rainfall forecasting for atmospheric rivers will give flood control managers, including Sonoma Water, emergency responders, transportation officials, and media outlets more accurate information on the location, timing, and intensity of expected rainfall. The primary emphasis will be to improve short-term (48 hour) monitoring and prediction of high-impact rainfall events. The secondary emphasis will focus on improved medium-range precipitation forecasts (out to 10 days) for water supply.

Sustainable Groundwater Management Act (SGMA) and Groundwater Sustainability Agencies (GSAs)

In September 2014, Governor Brown signed historic legislation requiring that California's critical groundwater resources be sustainably managed by local agencies. The first requirement of the Sustainable Groundwater Management Act (SGMA) was the creation of Groundwater Sustainability Agencies (GSAs), which are regulatory bodies responsible for developing and implementing plans to sustainably manage groundwater. SGMA requires that State-designated medium- and high-priority basins form a GSA(s) and develop a groundwater sustainability plan(s). Sonoma County has two medium priority basins (Petaluma Valley and Santa Rosa Plain) and one high priority basin (Sonoma Valley); these basins have to comply with SGMA.

On April 25, 2017 the Sonoma County Board of Supervisors and the Sonoma County Sonoma Water Board of Directors approved the formation of three joint powers agreements, resulting in the creation of three new GSAs for the Santa Rosa Plain, Petaluma Valley, and Sonoma Valley basins. These GSAs are tasked with ensuring the groundwater basins continue to have safe and reliable groundwater in the future. To bring a basin's groundwater into alignment with sustainable management practices, the GSAs can develop recharge projects, promote recycled water, and provide incentives for water conservation, along with regulating groundwater use. The Groundwater Sustainability Plans were approved by DWR on January 26, 2023, which now allow the GSA's to coordinate implementation projects with local partners, including Sonoma Water.

Sonoma Water's AQPI Systems project will support groundwater sustainability efforts by providing improved precipitation forecasting. The forecasting advancements made through AQPI will allow Sonoma Water to formulate detention projects that could alleviate groundwater depletion during drought conditions.

A website, www.sonomacountygroundwater.org, includes up-to-date information on SGMA and a place to sign up for more information.

Resources

Sonoma Water has a staff of over 260 professionals with a broad range of skills, all of whom work together to provide for the water supply, flood protection, and sanitation needs of Sonoma County residents, and to ensure Sonoma Water's compliance with environmental regulations. Sonoma Water is organized into eight divisions under the direction of the General Manager: General Management, Operations, Maintenance, Engineering and Resource Planning, Environmental Resources, Community and Governmental Affairs, Emergency Management and Security, and Administrative Services (see Appendix F for Sonoma Water Organizational Charts). Sonoma Water staff have successfully managed a wide range of projects and have an excellent relationship with the community they serve and the agencies they work with. Specifically, technical resources/staff who are involved with the development of mitigation projects include but are not limited to the following departments: Grants and Funded Projects, Design Engineering, CAD/GIS, Emergency Management and Security, and Public Affairs.

The Grants and Funded Projects department is responsible for all aspects related to grant management including proposals, awards, and compliance. In addition, the Grants and Funded Projects department is responsible for coordinating and facilitating the LHMP updates every five years.

Design Engineering provides design and project management services to implement capital construction projects associated with the Agency's water supply, flood management, and wastewater collection and treatment facilities. Principal functions revolve around the preparation of construction contract documents that depict and specify the work required to construct new or replacement infrastructure. Design Engineering also provides engineering support for long-range master planning, environmental compliance, and operations and maintenance. Additional functions include review of sanitation system improvements proposed as part of private development projects and establishing and maintaining design standards.

The primary mission of CAD staff is to support the Engineering Design Section with accurate and well-organized CAD documents for Capital Improvement Projects (CIP) including hazard mitigation projects, in addition to providing civil design support and analysis and clear mapping products for design and public communication. Staff also provide engineering record documentation management/research support and assist all Agency divisions and staff with similar services and products as needed. GIS staff provide project and program-based mapping and data analysis for all disciplines in the Agency, including assistance with providing the natural hazard data layer analyses for the 2023 SCWA LHMP.

In 2022, Sonoma Water established an Emergency Management and Security (EMS) Division. This EMS Division plans, develops, evaluates, and manages a comprehensive, Sonoma Water emergency management and security operations program; ensures appropriate systems, processes, protocols, and training are in place for the full scope of possible emergencies and disasters; coordinates continuity of operations programs; coordinates policy development, strategic planning, and operational response to security events; coordinates management, supervisory, and employee training in emergency and security measures; establishes and maintains procedures, emergency preparedness plans, and security protocols to ensure protection of system water quality, Sonoma Water facilities, assets, and employees; serves as the primary contact with and develops and coordinates Sonoma Water protocols for communications with local, state, and federal law enforcement and emergency response agencies regarding matters of security and emergency management; manages the response and oversees investigations relating to workplace violence incidents; manages and supports Sonoma Water's response and recovery to major emergencies and disasters. This division supports the LHMP by participating in the development, monitoring, and maintenance of the plan and overseeing certain projects.

Ensuring transparency and communications with our community is a priority for Sonoma Water. The Public Affairs Department manages the public outreach and information, governmental affairs, water education, and water conservation functions for Sonoma Water. Public Affairs staff are available to meet with our community to discuss Sonoma Water projects and initiatives and help provided education on all programs and projects that pertain to hazard mitigation. In addition, this team is responsible for public and stakeholder outreach using a variety of communication strategies, including but not limited to public/community meetings, press releases, social media and website postings.

Other resource groups within Sonoma Water that support implementation, include environmental/natural resources, survey and right-of-way, construction management, and operations and maintenance.

Sonoma Water has a public website at sonomawater.org which provides information on all departments, resources, programs. The website https://www.sonomawater.org/hazard-mitigation-projects is specifically designated to inform the public on hazard mitigation projects, and also provides a link to this LHMP, along with contact information to submit questions or comments at any time.

C1b. Sonoma Water's Ability to Expand On and Improve Existing Policies and Programs

Please refer to the Authorities, Policies, Plans, Programs, and Resources sections in section C1a of the LHMP. Table 4 contains plans, programs, and resources that have been thoroughly reviewed and integrated into the LHMP. The updated LHMP's mitigation goals, objectives, and actions will be reviewed by plan, policy, and program managers during their annual review to inform and improve future updates to policies, plans, and programs, as well as the County of Sonoma's General Plan, Strategic Plan, and Multi-Jurisdictional Hazard Mitigation Plan. The updated LHMP will be distributed to all plan, policy, and program managers during the public review comment period, along with the FEMA approved LHMP. The respective manager will be responsible for reviewing the updated LHMP and integrating relevant information into their updated documents.

C2. Participation in the NFIP and Compliance with NFIP Requirements

Special Districts are not eligible to participate in the NFIP. Sonoma County complies with the flood plain management requirements of the National Flood Insurance Program (NFIP) through the implementation of its Flood Damage Prevention Ordinance regulations set forth in Chapter 7B of the County Code. These procedures have been in place since January 1982, when the county elected to participate in the NFIP and first received flood insurance rate maps, floodway maps and the attendant certification requirements. The ordinance provisions, definitions, and requirements were modeled after language recommended by the NFIP and were reviewed and found fully compliant by the NFIP. The County's flood zones and mapping in the General Plan Safety Element and other documents are based on the 100-year flood zones and floodways shown in the FEMA Flood Insurance Rate Map.

Sonoma Water participates in the NFIP under the umbrella of Sonoma County. As the custodian of a sizeable portion of the flood control infrastructure in Sonoma County, Sonoma Water's role in flood protection and its impact on NFIP compliance is significant. All properties owned by Sonoma Water are insured under the County of Sonoma Self-Insured Property Insurance Program. Sonoma Water structures that have been damaged by floods are discussed in more detail in the Flood Protection Infrastructure and Vulnerability Assessment in Element B.

C2a. Description or Table/List of NFIP Participation Activities

C3. Goals to Reduce or Avoid Long-Term Vulnerabilities to Identified Hazards

C3a. Goals to Reduce the Risk from Identified Hazards

The goal of the 2023 SW LHMP is to maintain and enhance a disaster-resistant region by reducing the potential for loss of life, property damage, and environmental degradation from natural disasters, while accelerating economic recovery from those disasters. This goal is unchanged from the 2018 LHMP and continues to be the goal of Sonoma Water in developing its mitigation program. The specific goals of the LHMP are presented in Elements C3 and C4.

C4. Mitigation Actions and Projects

C4a. and C4b. Mitigation Actions and Projects to Reduce Impacts from Hazards Posing a Threat to the Jurisdiction

Water Supply System Mitigation Strategy

Based on the insights obtained from the comprehensive Natural Hazard Reliability Assessment of Sonoma Water's water supply system, and updated information obtained through the LHMP, Goal 1 and its associated objectives and mitigation actions form the current LHMP hazard mitigation strategy for the water supply system. For the full water supply system mitigation strategy see Appendix B.

Goal 1: Increase reliability of water supply to the public, including during and after a natural disaster, to reduce the vulnerability of people and property

Objective 1.1: *Implement system-wide improvements that reduce the overall system vulnerability by adding redundancy to the system and enhancing Agency's response through better monitoring of its system*

Mitigation Actions:

1.1.1 Continue to support Forecast Informed Reservoir Operations (FIRO) and its efforts to provide drought resilient planning.
1.1.2 Develop a modified hydrologic index to improve management of river flows and system storage.
1.1.3 Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.
1.1.4 Continue to research and pursue projects involved with aquifer storage and recovery.
1.1.5 Provide operational capability to minimize uncontrolled release by controlling flows out of Agency facilities with automated throttling valves on the Santa Rosa Aqueduct, Cotati intertie, and Wohler Forestville Intertie.

1.1.6 Develop a design or operational strategy to respond to unexpected pipeline damage within the Wohler-Mirabel area from liquefaction.
1.1.7 Continue to research and develop improved stormwater surface infiltration and recharge for water supply.
1.1.8 Improve secondary water quality in the Todd Road, Sebastopol, and Occidental Wells to provide additional water supply in the event that one of the Caissons is damaged by flood, drought, or earthquake.
1.1.9 Not used.
1.1.10 Work with the United States Geological Survey (USGS) to design and conduct a detailed geologic study of Bennett Valley and Rodgers Creek faults to accurately define the fault activity, paleoseismic history, rupture zone, and extent of surface rupture.
1.1.11 Provide seismic restraints to electrical and communication equipment at various facilities.
1.1.12 Plan, design and add redundant/emergency supply sources to minimize dependence on the Russian River aquifer as the main source of water supply. Install new emergency ground water wells located strategically throughout the system (assumed three locations).
1.1.13 Assess backwater culverts at Mirabel facility and consider remote operation of their valves.
1.1.14 Develop a GPS based system map with real-time monitoring at critical locations. For example, significant portions of the Agency's aqueducts run through large zones of undeveloped areas and pipe leaks in such areas are hard to precisely locate.
1.1.15 Install emergency manifolds at strategic locations to connect emergency hoses to Booster Stations. Use Capital Project planning process and planned Booster Station upgrades as a means to accomplish this.

Objective 1.2: *Perform diversion system improvements*

Mitigation Actions:

1.2.1 Develop and implement retrofit design for Collector 3 against liquefaction and lateral spread hazard.
1.2.2 Develop and implement retrofit design for Collector 5 against liquefaction and lateral spread hazard.
1.2.3 Develop and implement retrofit design for Collector 6 against liquefaction and lateral spread hazard.
1.2.4 Develop and implement design strategy to mitigate liquefaction and lateral spread hazard to the River Diversion Structure (RDS).
1.2.5 Develop a design strategy and operational plan to address flooding at the Mirabel facility.
1.2.6 Develop and implement an operational and design strategy to mitigate against potential fire damage to Mirabel and Wohler facilities. Include consideration of removing debris, trees, or other fire-hazard materials; installing fire resilient building materials; and modifying treatment processes to accommodate water quality changes.
1.2.7 Develop and implement an operational and design strategy to mitigate against turbid water at Collector 5 from burn area runoff due to this being the only collector under the influence of surface water during certain flow levels.

1.2.8 Develop and implement retrofit design for Collector 1 against liquefaction and lateral spread hazard.

1.2.9 Develop and implement retrofit design for Collector 2 against liquefaction and lateral spread hazard.

Objective 1.3: *Perform transmission system improvements*

Mitigation Actions:

1.3.1 Not used.

1.3.2 Not used.

1.3.3 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Santa Rosa Creek crossing.

1.3.4 Implement cathodic protection system improvements to the Santa Rosa and Russian River-Cotati Intertie aqueducts to mitigate corrosion hazard and extend the resilient life of those facilities.

1.3.5 Develop plans to relocate pipeline that crosses beneath the Spring Lake and the Spring Lake dam.

1.3.6 Develop and implement an operational or design strategy to mitigate fault rupture hazard to the aqueducts that cross the Bennett Valley fault.

1.3.7 Develop and implement an operational or design strategy to mitigate the liquefaction and lateral spread hazard at the Petaluma River crossing.

1.3.8 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Calabasas Creek crossing.

1.3.9 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Lawndale and Madrone Road crossings of Sonoma Creek.

1.3.10 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Verano Avenue crossing of Sonoma Creek.

1.3.11 Develop a long-term strategy to address lower probability damage to transmission system pipelines.

1.3.12 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Russian River crossing on the Wohler-Mirabel Intertie.

1.3.13 Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Willow Brook Creek crossing of the Petaluma Aqueduct.

1.3.14 Conduct site specific geotechnical assessment of the portions of the water transmission system that are within the mostly and many historic landslide occurrence zones.

Objective 1.4: *Perform pumping system improvements*

Mitigation Actions:

1.4.1 Not used.

1.4.2 Assess impact of Spring Creek Bennett Valley fault rupture on Sonoma Booster Station and develop and implement a design or operational solution to mitigate the fault rupture hazard.

1.4.3 Develop and implement seismic retrofit design or replacement of the Wilfred booster station building.

1.4.4 Develop and implement design or operational strategy to mitigate lateral spread damage to the Wohler-Mirabel Intertie.

__Objective 1.5__: *Perform storage system improvements*

__Mitigation Actions:__

1.5.1 Perform piping retrofit by replacing existing rigid piping with piping with flexible joints at the storage reservoirs.

1.5.2 Implement other retrofits such as removing over constrained conditions at storage reservoirs identified in the natural hazard reliability study.

1.5.3 Develop larger and more redundant storage facilities to minimize future water supply issues due to increased variability in supply and likely increased demand, which may stress existing conveyance, pumping, and storage systems.

__Objective 1.6__: *Improve Sonoma Water's emergency response capabilities*

__Mitigation Actions:__

1.6.1 Conduct first responder training of a broad pool of Agency's personnel to respond in an emergency.

1.6.2 Procure, or contract for, a mobile EOC and Communication trailer.

1.6.3 Not used.

1.6.4 Coordinate with PG&E to identify locations of buried electrical and high pressure gas lines overlap water transmission system.

__Objective 1.7__: *Provide reliable emergency power systems for water supply*

__Mitigation Actions:__

1.7.1 Develop and implement design and operations plans to mitigate liquefaction and/or fire related damage to electric power lines feeding collectors and pump stations.

1.7.2 Develop a design or operational strategy to maintain communications and auxiliary power at all Water Supply Tanks and booster stations in the event of fire damage. Develop a design for additional infrastructure for redundancy and reliability of communication system.

1.7.3 Not used.

1.7.4 Assess sufficiency of standby power at administrative buildings and Sonoma Water EOC and develop design strategy to ensure core functions are maintained in the event of a power failure.

1.7.5 Design and construct a new 12-kV electrical feeder for the Mirabel facilities which reduces risk due to seismic, fire and flood hazards.

__Objective 1.8__: *Reduce supply vulnerability and resilience of water supply watersheds*

__Mitigation Actions:__

1.8.1 Design and implement mitigation schemes for reducing the potential of flood damage to the well fields, collector wells, and caissons in the Mirabel, Wohler, and Laguna de Santa Rosa areas.

1.8.2 Conduct assessment of vegetation around Lake Sonoma and Lake Mendocino for potential vegetation management projects that will protect water quality and storage from fire.
1.8.3 Assess potential damage to Sonoma Water infrastructure in the event of Warm Springs and/or Coyote dam failure.
1.8.4 Assess vulnerability of Russian River supply upstream of Sonoma Water's diversion facilities to contamination from earthquake and non-earthquake induced landslides, wildland fire, and resulting post-fire erosion, especially to Lake Sonoma and Lake Mendocino water supply sources.
1.8.5 Coordinate with the USACE to support its efforts to address operational reliability of the outlet works at Warm Springs Dam.

Objective 1.9: *Minimize life safety risk and reduce operational vulnerability at water supply facilities*
Mitigation Actions:
1.9.1 Conduct a detailed seismic vulnerability assessment of structural and non-structural elements of the Agency's administrative facilities.
1.9.2 Not used.
1.9.3 Develop operational strategy to maintain water collection and pumping plant in the event that Wohler Bridge is damaged by earthquake, flood, or landslide.

Objective 1.10: *Minimize economic exposure to the Agency*
Mitigation Actions:
1.10.1 Work with the U.S. Army Corps of Engineers to expedite the earthquake safety assessment of Warm Springs and Coyote Valley dams; and reassessment of these under the revised Probable Maximum Flood conditions as impacted by the Probable Maximum Precipitation study.
1.10.2 Conduct a detailed seismic vulnerability assessment of electric power station at the Warm Springs dam.
1.10.3 Develop project design criteria document for new construction (water system, sanitary system and flood protection system).

Sanitation System Mitigation Strategy

Based on the insights obtained from the expanded vulnerability assessment of the sanitation system that was part of the present LHMP, Goal 2 and its associated objectives and mitigation actions form the LHMP hazard mitigation strategy for the sanitation system. For the full sanitation system mitigation strategy see Appendix B.

Goal 2: Increase reliability of wastewater collection, treatment and water reuse systems, including during and after a natural disaster, to reduce public safety risk and environmental damage

Objective 2.1: *Implement reliability measures for wastewater collection systems*
Mitigation Actions:
2.1.1 Update construction standards to address seismic resilient measures for the collection system.
2.1.2 Not used.

2.1.3 Develop and implement an operational or design strategy to mitigate the debris hazard effects of high stream flows and wind on the exposed pipeline crossing the drainage in the vicinity of the Sea Ranch SZ treatment plant.

2.1.4 Not used.

2.1.5 Develop and implement an operational or design strategy to mitigate the bank erosion effects of flooding and/or high stream flows near the overflow tanks at the Sea Ranch SZ main lift station.

2.1.6 Develop and implement an operational or design strategy to mitigate the erosive effects of high stream flows in Dutch Bill Creek adjacent to the Occidental CSD lift station.

2.1.7 Develop and implement an operational or design strategy to mitigate the effects of fire at the Occidental CSD lift station.

2.1.8 Develop and implement an operational or design strategy to mitigate the ground rupture effects of the Rodgers Creek Fault for portions of the Airport/Larkfield/Wikiup SZ collection system within the rupture zone.

2.1.9 Develop and implement an operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Airport/Larkfield/Wikiup SZ collection system crossing Mark West Creek.

2.1.10 Develop and implement operational or design strategy to mitigate the effects of flooding for portions of the Geyserville SZ collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of the Russian River.

2.1.11 Develop and implement operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for the Geyserville SZ collection system, particularly where it crosses and is adjacent to Wood Creek.

2.1.12 Develop and implement an operational or design strategy to mitigate damaging effects of fault rupture on the Airport/Larkfield/Wikiup SZ trunk main.

2.1.13 Develop and implement operational or design strategy to mitigate the effects of flooding at the Geyserville SZ lift station, including reliability of auxiliary power supply and erosion-induced exposure of manhole M10-1.

2.1.14 Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek.

2.1.15 Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ lift station.

2.1.16 Develop and implement an operational or design strategy to mitigate the effects of flooding for portions of the Airport/Larkfield/Wikiup SZ collection system subject to infiltration within areas of recurrent inundation or located within the 100-year floodplain.

2.1.17 Develop and implement an operational or design strategy to mitigate the effects of wildfire at the Airport/Larkfield/Wikiup SZ Lift Station.

2.1.18 Conduct corrosion assessment of Airport/Larkfield/Wikiup SZ, Penngrove SZ, and Occidental CSD facilities located within areas of moderate to high corrosive soil conditions.

2.1.19 Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek and Owens Creek.
2.1.20 Not used.
2.1.21 Develop and implement an operational or design strategy to mitigate the ground deformation effects of liquefaction for portions of the collection system (including lift stations and related force mains) subject to moderate liquefaction hazard.
2.1.22 Assess the potential for ground rupture effects of the Alexander Fault on Geyserville SZ facilities.
2.1.23 Develop and implement a design strategy to mitigate the effects of liquefaction on the Russian River CSD collection system (including lift stations and related force mains) in areas that have very high and high liquefaction potential.
2.1.24 Develop and implement a design strategy to mitigate the effects of liquefaction on the Russian River CSD tertiary recycled water system.
2.1.25 Conduct vulnerability assessment of critical pipelines located in Russian River CSD
2.1.26 Update construction standards to address liquefaction potential along the collection system.
2.1.27 Develop and implement a design strategy to mitigate the effects of embankment failure/landslides on portions of the Russian River CSD collection system that are in close proximity to creeks, drainage channels or steep slopes.
2.1.28 Develop and implement a design strategy to mitigate the effects of high stream flows (e.g., erosion and debris flows) on portions of the Russian River CSD collection system at creek crossings where the burial depth is unknown and assumed shallow.
2.1.29 Develop and implement a design strategy to elevate and/or protect pump stations located in Russian River CSD from flood related damage.
2.1.30 Replace power distribution system to lift stations located in Russian River CSD.
2.1.31 Develop and implement a design strategy to replace the existing emergency backup power system at the Main Lift Station.
2.1.32 Develop and Implement a design strategy to mitigate the effects of wild-land fire on Russian River CSD critical facilities.
2.1.33 Study potential for vacuum system in RRCSD collection system
2.1.34 Develop and implement operational or design strategy to mitigate the effects of flooding for portions of the RRCSD collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of the Russian River.
2.1.35 Update construction standards to address inflow and infiltration for the collection system.
2.1.36 Stablish sanitation level planning
2.1.37 Establish property partnerships and ordinances to reduce sanitary sewer overflows

***Objective 2.2*:** *Implement reliability measures for treatment plant and water reuse systems*
Mitigation Actions:

2.2.1 Develop and implement operational or design strategy to mitigate the effects of flooding on percolation at the Geyserville SZ wastewater treatment plant.

2.2.2 Develop and implement an operational or design strategy to mitigate the effects of flooding for Airport/Larkfield/Wikiup SZ treatment plant facilities that are subject to recurrent inundation or located within the 100-year floodplain.

2.2.3 Develop and implement an operational or design strategy to mitigate the effects of flooding on access to the Geyserville SZ wastewater treatment plant.

2.2.4 Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for the Geyserville SZ force main.

2.2.5 Not Used.

2.2.6 Not Used.

2.2.7 Develop and implement an operational or design strategy to ensure auxiliary power reliability at the Sea Ranch SZ main lift station during storm events.

2.2.8 Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ treatment plant.

2.2.9 Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard of portions of the Airport/Larkfield/Wikiup SZ recycled water system in the vicinity of the Mark West Creek and Woolsey Creek Crossing.

2.2.10 Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for portions of the Airport/Larkfield/Wikiup SZ recycled water system in the vicinity of Windsor Creek crossing.

2.2.11 Develop and implement an operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard at the Airport/Larkfield/Wikiup SZ treatment plant.

2.2.12 Develop and implement an operational or design strategy to mitigate the increased precipitation effects and fire risk from climate change in all sanitation areas.

2.2.13 Seismically restrain/anchor the steel tertiary filter tanks at the RRCSD treatment plant.

2.2.14 Seismically restrain/anchor miscellaneous equipment at the RRCSD treatment plant.

2.2.15 Seismically retrofit piping at the RRCSD treatment plant to allow for differential movement.

2.2.16 Seismically retrofit suspended ceiling over SCADA Control Room at RRCSD treatment plant.

2.2.17 Develop and implement a design strategy to provide additional storage capacity at the RRCSD treatment plant to enhance operational ability for storage during and after a natural disaster while repairs are made to restore treatment capabilities.

2.2.18 Conduct geotechnical assessment of the slopes bordering the Northern boundary of the RRCSD treatment plant.

2.2.19 Develop and implement a design strategy to mitigate the effects of landslides and debris flows at the RRCSD treatment plant.

2.2.20 Conduct site specific geotechnical assessment of the portions of the RRCSD treatment plant that are within the very high or high liquefaction zone.

2.2.21 Develop and implement a design strategy to upgrade the asphalt shingle/tar and gravel roofs at the RRCSD treatment plant to mitigate the effects of wild-land fire.

2.2.22 Establish long-term solution for Occidental CSD treatment plant.

***Objective 2.3**: Increase organizational efficiencies and effectiveness when responding to natural disasters*

Mitigation Actions:

2.3.1 Develop specific measures to include in an integrated Sonoma Water emergency response and recovery plan for sanitation operations.

2.3.2 Enhance the reliability of SCADA operations by upgrading network hardware, computer hardware, and radio hardware.

Flood Protection Infrastructure Mitigation Strategy

Based on the insights obtained from the expanded vulnerability assessment of the flood protection infrastructure that was part of the present LHMP, Goal 3 and its associated objectives and mitigation actions form the LHMP hazard mitigation strategy for the flood protection infrastructure. For the full flood protection infrastructure mitigation strategy see Appendix B.

Goal 3: Increase reliability of flood protection infrastructure to reduce the vulnerability of people and property to flood hazards

***Objective 3.1**: Improve the understanding of the vulnerability of Sonoma Water's flood protection infrastructure*

Mitigation Actions:

3.1.1 Determine risk and develop an operational or design strategy to mitigate the ground rupture/deformation effects of the Spring Valley Fault/Bennett Valley Fault Zone and moderate to very high liquefaction hazard at and around the Spring Lake detention reservoir and associated flood protection elements (Spring Creek diversion, Santa Rosa Creek diversion, Vortex Tube).

3.1.2 Assess concrete structures deteriorating from erosive effects of high storm flows, flooding, and sediment transport to ensure sustained integrity and flood protection reliability.

3.1.3 Assess conditions at Flood Detention Reservoirs to determine whether sediment removal is needed to preserve flood protection capacity.

3.1.4 Assess design strategy options for addressing capacity deficiencies of the primary spillway at the Matanzas Dam and improve the flood protection function of the spillway structure.

3.1.5 Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.

3.1.6 Assess the impacts of increased precipitation from climate change on engineered flood protection infrastructure.

3.1.7 Continue to research and develop improved stormwater surface infiltration and recharge opportunities to reduce flooding impacts.

3.1.8 Assess the potential ground deformation effects of fault rupture and moderate liquefaction hazard on the Brookhill School, Brigham Avenue, Colgan Avenue, Santa Rosa-Bellevue Avenue, Cook Creek, and Steel Creek Conduits.

3.1.9 Determine the highly vulnerable locations subject to ground deformation effects of liquefaction, where resulting lateral spread and/or sedimentation will decrease the level of flood protection provided by Sonoma Water's engineered flood protection infrastructure (e.g., channels, conduits, or reservoirs).

3.1.10 Conduct corrosion assessment of facilities located within areas of moderate to high corrosive soil conditions.

3.1.11 Identify critical watersheds or sub-watersheds that represent high fire risk and likely to represent high flood management impact (sediment) to agency's operations.

***Objective 3.2**: Implement reliability measures for reservoir facilities to maintain flood protection capabilities*

Mitigation Actions:

3.2.1 Develop and implement operational or design strategy to mitigate the fault rupture and strong ground shaking effects of the Rodgers Creek Fault at the Piner Reservoir Dam.

3.2.2 Develop and implement an operational or design strategy to mitigate the erosive effects of fire, landslides, and floods in watershed areas where resulting increases in sedimentation, storm flows, landslides, and embankment failures will decrease the level of flood protection provided by Sonoma Water's engineered flood protection infrastructure (e.g., channels, conduits, or reservoirs).

3.2.3 Develop and implement operational or design strategy to mitigate the ground deformation effects of landslides, where resulting ground deformation will damage Sonoma Water's flood protection infrastructure (e.g., channels, conduits, or reservoirs).

3.2.4 Develop and implement operational or design strategy to mitigate against potential loss of tree canopy in the event of a fire near reservoirs or engineered channels.

***Objective 3.3**: Implement reliability measures to maintain flood protection capability of engineered channels and conduits*

Mitigation Actions:

3.3.1 Restore flood protection capacity of SMP-managed channels by removing accumulated sediment and vegetation.

3.3.2 Participate with appropriate jurisdictional agencies and stakeholders to cooperatively develop operational or design strategies to mitigate the effects of flooding within the Petaluma River watershed resulting from alluvial fan avulsions of Copeland Creek and associated breakout flows.

3.3.3 Increase the designed flow conveyance capacity for portions of Santa Rosa Creek flood control channel to convey the 100-year flood event without overtopping.

3.3.4 Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Spring Creek Bypass Conduit.

3.3.5 Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Brigham Avenue Conduit.

3.3.6 Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Santa Rosa Creek Triple Box Culvert.

3.3.7 Develop and implement operational and/or design strategy to mitigate the seismic effects of strong to very strong ground shaking (PGA = 0.4 to 0.6g) on flood control conduits.

3.3.8 Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate to high liquefaction hazard on the Cherry-Magnolia and Thompson Conduits.

3.3.9 Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate liquefaction hazard on the Kenwood Creek Bypass Conduit.

3.3.10 Acquire flood easements from willing landowners in the Marin/Wilson/Wiggins Creek sub-watersheds of the Petaluma River watershed to preserve the benefits of existing downstream flood protection projects/improvements along the Petaluma River.

Emphasis of Mitigation Actions and Projects on New and Existing Buildings and Infrastructure

Sonoma Water is directly responsible for providing water to over 600,000 people in the developing and expanding North Bay Area. Sonoma Water is the primary wholesale provider of water to nine cities and water agencies who maintain their own distribution networks but very little redundant sources of supply. Sonoma Water's contractors, and in turn the public, rely on water supplied from Sonoma Water for domestic water supply and for both emergency and non-emergency use such as irrigation and other domestic and industrial needs.

Sonoma Water is also directly responsible for its Sanitation Zones and operates the independent Occidental and South Park County Sanitation Districts, as explained in Element B. The sanitation customers and the public rely on Sonoma Water to provide continued collection of wastewater and to minimize overflows within the system in order to protect public health and the environment.

Additionally, Sonoma Water maintains flood protection infrastructure, including flood control reservoirs, engineered and natural channels, stream and rain gauge systems, and storm drain and creek by-pass conduits as explained in Elements B2a and B2b. Communities throughout Sonoma County rely on this flood protection infrastructure to protect life and property from flood events.

Sonoma Water's water supply, sanitation, and flood protection infrastructure and systems stretch over an area of multiple natural hazards. The systems have a range of vulnerabilities to these hazards, which are assessed and explained in Element B. As an example, hydraulic analyses conducted as part of the original natural hazard reliability assessment of the water system show that damage to one or more water supply facilities could deplete water storage and cause significant pressure loss at turnouts serving the contractors within a matter of hours. Loss of water supply will leave the contractors vulnerable in their ability to provide fire flow and drinking water to the public.

Sonoma Water takes its water supply, sanitation, and flood protection responsibilities seriously and has developed mitigation goals to systematically address the vulnerabilities of these systems. Additionally, Sonoma Water's goals are integrated with the goals of the community laid out in the Sonoma County Local Hazard Mitigation Plan (County LHMP), as both the County LHMP Sonoma Water LHMP goals target reducing the vulnerability of people and property exposed to the relevant natural hazards for this area. Additionally, the goals have been aligned with the Sonoma Valley County Sanitation District LHMP. Keeping in view the desires of the community as expressed in the County LHMP, and the understanding of Sonoma Water system vulnerabilities, Sonoma Water has formulated the following three goals:

Goal 1: Increase reliability of water supply to the public, including during and after a natural disaster, to reduce the vulnerability of people and property

Goal 2: Increase reliability of wastewater collection, treatment and water reuse systems, including during and after a natural disaster, to reduce public safety risk and environmental damage

Goal 3: Increase reliability of flood protection infrastructure to reduce the vulnerability of people and property to flood hazards

Sonoma Water's current LHMP goals maintain the same intent and focus as those from the 2018 LHMP, with only minor modifications to syntax. However, significant enhancements have been made to the LHMP objectives and actions, due to the expansion of the vulnerability assessment for the sanitation and flood protection infrastructure in this LHMP. As a result, the Sonoma Water LHMP contains three mitigation action lists to represent each distinct infrastructure section (water supply, sanitation, and flood protection), and to align with the three mitigation goals.

The identified objectives and actions outlined below for the separate water supply, sanitation, and flood protection infrastructure and systems are intended to thoroughly address each Sonoma Water goal. In doing so, these mitigation strategies will enhance system reliability, emergency response, and overall operational resilience in the face of potential risks to people, property, and the environment from specific hazards and vulnerabilities associated with Sonoma Water's facilities. For each goal, objectives that frame particular areas of mitigation opportunity have been developed along with related specific mitigation actions.

A roadmap for implementing the below three mitigation strategies, including prioritization, cost-benefit considerations, and timeline, is explained in Element C and Appendix B.

A summary of Sonoma Water's progress towards the 2018 LHMP's mitigation actions is provided in Appendix A. The 2018 mitigation actions that were incomplete have been carried forward into the present LHMP's mitigation strategies, and information included in both Appendix A and Appendix B identifies the new actions versus those from the 2018 LHMP.

C5. Action Plan for Prioritization, Implementation, and Administration Including Cost-Benefit Review

Hazard mitigation actions are strategies and policies to reduce the impacts of hazard events on Sonoma Water's critical infrastructure. These actions are informed by the physical conditions of Sonoma Water's infrastructure and landscape, as well as the scope and severity of potential hazard events. These items serve as the long-term blueprint for reducing the potential losses identified in the risk assessment.

C5a. Prioritization of Mitigation Actions, Including Benefit-Cost Review

Prioritization of actions that support Sonoma Water's mitigation goals and objectives is based upon qualitative categorization of planning level benefit/cost (pro/con) assessments of the individual mitigation actions identified in Element C. The benefit-cost review that was performed is inspired by the qualitative method outlined in FEMA How-To Guide. The prioritization method did not change from the 2018 LHMP, and Sonoma Water's priorities are consistent with the 2018 LHMP as well. However, some actions moved to a higher or lower priority based on the risk assessment performed during this update.

Actions were organized into Tier 1 and Tier 2, based on the significance and likelihood of failure, and then subsequently into Priority A and B, based on the likelihood of implementation within the 5-year life of this LHMP.

Tier 1 or Tier 2

- **Tier 1.** Actions that provide the highest qualitative benefit/cost ratio, and once implemented will result in substantial improvement in the overall reliability of the system.
    - High significance of impact, AND
    - High likelihood of failure
- **Tier 2.** Actions that are considered desirable and will further enhance the system reliability once the first-tier objectives are achieved.
    - Mitigation actions with benefit/cost assessments below the Tier 1 threshold

Key factors that were considered in assigning Tier 1 or 2 of the benefit/cost assessment included:

- **Significance of impact**. For example, a break in the water supply system at Rodgers Creek fault will result in loss of flow to the entire Sonoma Valley, and therefore is considered a high priority. During benefit-cost review of the mitigation strategies for water supply, sanitation, and flood protection, factors such as time to significant loss of pressure, significant loss of storage, population impacted, amount of wastewater conveyance impacted, etc., were considered.
- **Likelihood of failure**. For example, more damage is likely to occur in areas of very high liquefaction potential near waterways than areas with moderate liquefaction potential far from waterways.

Mitigation actions that address vulnerabilities with a high significance of impact AND a high likelihood of failure will increase the action's overall qualitative benefit/cost and are considered Tier 1.

Priority A or Priority B

- **Priority A.** Actions that are estimated to have the potential or likelihood to be completed or initiated within the 5-year life of this LHMP based on current projections of available resources, opportunities, and cost to implement.
    - Low cost to implement
- **Priority B.** Actions for which the availability of dedicated resources or opportunities are not likely within the 5-year life of this LHMP, based on the estimated cost to implement and current projections of available resources.
    - High cost to implement

Key factors that were considered in assigning Priority A or B of the benefit/cost assessment included:

- **Cost to implement**. For example, anchorage of critical equipment is considered Priority A because of the relatively low cost to install.
- Opportunities to implement certain actions as part of other efforts or programmed work.
- Additional information still necessary to better define the scope, benefit, or schedule, especially for larger, long-term programmatic actions.
- Additional complexities or challenges to implementation.

Mitigation actions that are relatively low cost to implement are more easily initiated or accomplished within the 5-year life of this LHMP, and therefore are considered Priority A actions. However, additional considerations may also influence the benefit/cost assessment of Priority A or B considerations, including the factors listed above.

The prioritized mitigation action strategies for the water supply, sanitation, and flood protection systems are presented in Appendix B. Based on the considerations described above, the mitigation actions are grouped in the following priority sequence:

- **Tier 1, Priority A –** highest significance and likelihood of failure; high likelihood of implementation within 5 years
- **Tier 1, Priority B –** highest significance and likelihood of failure; low likelihood of implementation within 5 years
- **Tier 2, Priority A –** low significance and/or likelihood of failure; high likelihood of implementation within 5 years
- **Tier 2, Priority B –** low significance and/or likelihood of failure; low likelihood of implementation within 5 years

In summary, the Tier 1 actions are those that provide the highest qualitative benefit to cost, and once implemented will result in substantial improvement in the overall reliability of the system. Tier 2 actions are considered desirable and will further enhance system reliability once the first-tier objectives are achieved but are assessed below the Tier 1 threshold. With this approach, Tier 1 actions will generally be implemented ahead of Tier 2. However, some Tier 2, Priority A actions may be implemented ahead of more critical Tier 1 actions due to the availability of different resources or opportunities.

Sonoma Water has used and will continue to use a variety of project-specific mechanisms to ensure that the projects and mitigation strategies identified as existing or having relatively high priorities in this LHMP will be implemented in other Sonoma Water's plans, policies, and processes. See Appendix B for the water transmission, flood protection, and sanitation mitigation action tables.

C5b. Department or Agency Responsible for Implementing and Administering the Action; Funding Sources and Expected Time Frame

Responsible Departments or Agencies
See the *Responsible Entity* column in Appendix B.

Funding Sources
Mitigation actions that involve capital projects will be integrated into Sonoma Water's annual Capital Projects Plan (CPP) as funding is scheduled to occur. This will support identification of opportunities to accomplish mitigation actions as part of other efforts, programmed work, or necessary maintenance. As the highest priority mitigation actions are achieved, the implementation schedule and planning-level budget estimates for the next tier actions will be developed in future revisions to the CPP in consultation with Sonoma Water's management, contractors and the public. Many mitigation actions carried forward from the 2018 LHMP are already integrated into the CPP.

The CPP is administered by the Engineering and Resource Planning Division with the other division heads involved in the yearly CPP development cycle. Sonoma Water's Director of Engineering, Mr. Kent Gylfe, along with Operations Division Assistant General Manager, Ms. Pamela Jeane, and Maintenance Division Assistant General Manager, Mr. Michael Thompson, are involved in setting the course of the CPP, attending meetings, reviewing technical memoranda and final reports. Through the CPP Sonoma Water can incorporate the high priority mitigation actions into its long-range financial planning. Additionally, Sonoma Water will continue to consider funding sources through its maintenance budget and a possible reliability surcharge within Sonoma Water's rate structure.

As with the 2013 and 2018 LHMPs, Sonoma Water will also continue to actively identify external funding sources for the current LHMP mitigation actions, including FEMA's Building Resilient Infrastructure and Communities (BRIC), Hazard Mitigation Grant Program (HMGP), and FEMA's Public Assistance (PA) mitigation opportunities during disaster recovery operations, the National Oceanic Atmospheric Administration (NOAA), the California Department of Water Resources (CA DWR), the California Department of Forestry and Fire Protection (Cal FIRE), Federal and State loan programs, and other resources. Below is a list of known external funding sources that Sonoma Water has worked with or considered in the past. These have been incorporated into the LHMP Mitigation Strategy in Appendix B.

Table 16: External Funding Sources that Support Hazard Mitigation

Agency	Grant Program	Types of Hazard Mitigation Projects Eligible Under Funding Source
CA DWR (Continued)	Integrated Regional Water Management (IRWM (Continued)	• **Currently Funding: AQPI** • Projects consistent with the IRWM plan • Water reuse and recycling; Water-use efficiency and conservation; regional surface and underground water storage, including groundwater aquifer cleanup or recharge; watershed protection, restoration, and management, including to reduce the risk of wildfire or improve water supply reliability; Stormwater resource management; Improvement of water quality, including drinking water treatment and distribution, groundwater and aquifer remediation, management of urban and agricultural runoff
	Sustainable Groundwater Planning Grant Program	• This program funds projects that develop and implement sustainable groundwater planning and projects.
	Statewide Flood Emergency Response Projects (FERP)	• Public agencies with primary responsibility for flood emergency response & coordination can apply • Improve local flood emergency response and increase public safety
	Water Energy Grant Programs	• Water efficiency programs or projects that reduce greenhouse gas emissions, and reduce water and energy use
	Urban & Multibenefit Drought Relief Program	• These grants are intended to provide water to communities that face the loss or contamination of their water supplies, to address immediate impacts on human health and safety, and to protect fish and wildlife resources.
	Urban Streams Restoration Program	• This program provides grants to local communities for projects that reduce flooding, erosion, and associated property

		damage; restore, enhance, and/or protect the natural ecological values of streams; or promote community involvement, education, and stewardship.
	Agricultural Water Use Efficiency and State Water Efficiency and Enhancement Program: Agricultural Water Supplier Grants	• Water use efficiency projects in urban and agricultural communities for drought conditions • May support new NBWRA program or GSAs
CA Natural Resources Agency	State Responsibility Area (SRA) Fire Prevention Fund & Tree Mortality Grant Program	• Remove hazardous trees that pose threat to public health/safety • Vegetative fuel reduction
Cal FIRE	Forest Health Program	• Must decrease greenhouse gases overall • Landscape-scale fuels reduction projects; Reforestation; Conservation Easements; Biomass use
	Urban and Community Forestry Program	• Must decrease greenhouse gases overall • Project must take place in urban area as identified by Cal FIRE
CA Fire Safe Council	Grants Clearinghouse Wildfire Prevention Competitive Grants Program	• Training, planning, hazardous fuels treatments, and fire prevention education programs • Fuels reduction projects must be on nonfederal lands
USBR	WaterSmart: Water and Energy Efficiency Grants program	• Water conservation and energy efficiency projects
	WaterSMART: Drought Response Program	• Develop and update comprehensive drought plans and implement projects that will build long-term resiliency to drought such as infrastructure improvements, recharge projects, and decision support tools.
	WaterSMART: Basin Study Program	• Collaborative planning to help entities assess risks and water supplies from competing demands and to identify strategies to meet those demands

FEMA	HMGP & BRIC	• **Currently funding: LHMP update; seismic retrofits; utility elevation for flood mitigation; assessment of pipeline vulnerabilities at stream crossings; radar warning system** • Early warning systems; aquifer storage and recovery; floodplain restoration to reduce floods; elevations/acquisitions to reduce potential damage; infrastructure projects for seismic resiliency • Projects with potential BCR>1
Governor's Office of Planning and Research	Adaptation Planning Grant Program (APGP) & Regional Resilience Grant Program (RRGP)	• Planning and implementing regional projects that advance climate resilience and respond to the greatest climate risks in their regions
NOAA	Coastal Ecosystem Resiliency Grants Program	• Coastal jurisdictions (includes counties) only • Habitat restoration that increases coastal resilience ("natural or nature-based solutions")
	Habitat Blueprint – Coastal and Marine Habitat Focus Area Cooperative Agreements	• **Currently funding: FIRO activities under Habitat Blueprint**
CDFW	Restoration Grant Programs	• Water quality, river, and watershed protection and restoration projects of statewide importance; Projects to improve forest health; Modernize stream crossings, culverts, and bridges; reconnect historical flood plains; Acquisitions; remove sediment or trash
CA State Water Resources Control Board (SWRCB)	Clean Water State Revolving Fund	• Low-interest loans • Address water quality problems and prevent pollution
	Storm Water Grant Program (Prop 1)	• Implementation projects such as multi-benefit storm water management projects, including green infrastructure, rainwater and storm water capture projects and storm water treatment facilities

	Small Community Wastewater Projects (Prop 1)	• Planning grants and construction (implementation) grants for wastewater systems in small communities with DAC
	Drinking Water State Revolving Fund	• Infrastructure work needed to achieve or maintain compliance with the federal Safe Drinking Water Act (SDWA) • Both planning & infrastructure grants
Coastal Conservancy	Climate Adaptation Program	• Competitive grants for projects that plan, develop, and implement climate adaption and resiliency projects in the San Francisco Bay
	Coastal Conservancy Grants	• Wetland restoration: enhance wetlands and subtidal habitats to restore ecosystem function and provide flood protection; Urban greening: projects that use urban greening to increase groundwater recharge, reduce runoff; Stormwater projects listed in a SWRP
	Forest Health & Wildfire Resilience Program	• Grants for: on-the-ground activities to restore the health and increase resilience of California forests, grasslands, and natural lands to wildfire; and planning and capacity building to increase wildfire resilience in California.
PG&E	Resilient Communities Grant	• **Fuel management discussions at Lake Sonoma**
Wildlife Conservation Board (WCB)	Stream Flow Enhancement Program	• Enhance stream flow for multi-benefits; reduce floods and provide ecosystem restoration and protection
	Climate Adaptation and Resiliency	• Projects that: Protect and restore ecosystems on natural and working lands to provide climate change adaptation and resilience for wildlife; Assist natural and working lands managers in implementing practices that provide climate adaptation and resilience
	Habitat Enhancement and Restoration Program (HERP)	• Restoration & conservation of riparian habitat, inland wetlands, ecosystems on agriculture lands & more

	Forest Conservation Program	• Conservation, preservation, and restoration of forest reserve areas, redwood forests, and other forest types

Element D: Plan Maintenance

D1. Continued Public Involvement in Plan Maintenance

Sonoma Water, with its decision to incorporate the LHMP in its yearly Capital Projects Plan (CPP) planning process, has ensured continued public involvement throughout the plan maintenance process. The CPP approval is an open public process. As part of the approval process, the CPP is presented to the Agency's Board of Supervisors in an open public meeting, and by virtue of this progress towards achieving the mitigation strategies identified in the LHMP, will also be open for public review and comment. In addition, the public will always have access to the LHMP by going to https://www.sonomawater.org/hazard-mitigation-projects or by visiting one of the Sonoma County regional libraries.

The public can also submit any questions or comments to LHMP@scwa.ca.gov or call 707-547-1900 at any time. Lastly, the public can subscribe to Sonoma Water's newsletter to keep informed of any public meetings related to the LHMP or hazard mitigation efforts or projects.

The Agency will also keep its water contractors informed regarding progress towards meeting its mitigation strategy in a public forum through the monthly Water Advisory Committee (WAC) and Technical Advisory Committee (TAC) meetings.

D1a. Future Public Participation After the Plan Has Been Approved

When Sonoma Water initiates the next 5-year update to the LHMP, the planning process will begin by developing an outreach plan to engage stakeholders and the public in the mitigation plan update process. Stakeholders will include Sonoma County Office of Emergency Services, Sonoma County Department of Public Works, Sonoma County Regional Climate Protection Authority; cities, counties, local governments; state and federal agencies; Sonoma Water's water contractors; non-government organizations, service organizations, and the local business community; and the general public.

D2. Keeping the Plan Current Within a 5-Year Cycle

In order to ensure the effectiveness of the mitigation strategies, this plan relies on an ongoing program of assessing updated conditions to verify mitigation focus and priority. This process will be managed with continued monitoring and maintenance of this hazard mitigation plan through a five-year update cycle.

Sonoma Water's commitment to reducing its hazard vulnerability and improving the reliability of its systems is demonstrated by the fact that the Agency on its own initiative undertook a comprehensive natural hazard reliability assessment. The Agency recognizes that this commitment must be maintained through a dedicated ongoing effort. Development and updating of the Sonoma Water LHMP is part of this effort. In meeting the requirements of the DMA2000 and 44 CFR 201, Sonoma Water plans to update the LHMP every five years–or sooner if new information becomes available, priorities for implementation change, or an actual hazard event occurs that necessitates updating the plan sooner than five years.

D2a. Tracking Progress of Mitigation Actions

- By Whom: Sonoma Water Director of Engineering. Sonoma Water's department heads of Planning, Operations, Maintenance, and Capital Improvements were involved in developing the LHMP through the Technical Review Team and Oversight Committee; the entire executive management of Sonoma Water is committed to implementing the mitigation strategy laid out in the LHMP.
- How: This will be aided by including the high-priority mitigation actions that involve capital projects in Sonoma Water's existing annual CPP planning process, as explained in Element C. Inclusion of key mitigation actions in the CPP will ensure annual monitoring, evaluating, and tracking of the LHMP's mitigation strategy. Through the CPP process, the department heads will meet annually to review the implementation of specific mitigation actions within the overall operational priorities of Sonoma Water.
- When: Annually

D2b. Evaluating Plan Effectiveness

- By Whom: Sonoma Water Director of Engineering. Sonoma Water's department heads of Planning, Operations, Maintenance, and Capital Improvements were involved in developing the LHMP through the Technical Review Team and Oversight Committee; the entire executive management of Sonoma Water is committed to implementing the mitigation strategy laid out in the LHMP.
- How: This will be aided by including the high-priority mitigation actions that involve capital projects in Sonoma Water's existing annual CPP planning process, as explained in Element C. Inclusion of key mitigation actions in the CPP will ensure annual monitoring, evaluating, and tracking of the LHMP's mitigation strategy.
- When: Annually

D2c. Updating the Plan During the 5-Year Cycle

- By Whom: Sonoma Water Director of Engineering. Sonoma Water's department heads of Planning, Operations, Maintenance, and Capital Improvements were involved in developing the LHMP through the Technical Review Team and Oversight Committee; the entire executive management of Sonoma Water is committed to implementing the mitigation strategy laid out in the LHMP.
- How: This team will identify new studies and other resources that can be used to assess risks and integrate them into future LHMP update processes. For example, the flood hazard mitigation actions for the Russian River Sanitation District will be informed by the Final Project Report for a Cal OES Hazard Mitigation Grant-funded project, "RRCSD Pipeline Vulnerability Assessment," which concludes in October 2023. The team will assess damages caused by new natural hazard events and the level of degree the event impacted Sonoma Water's infrastructure, which may or may not change the current vulnerabilities identified in Element B and actions identified in Element C. Other items the team will consider are implementation challenges such as funding, political and social climate, etc. These efforts will continue to help the plan be successful and help elevate the priority of hazard mitigation projects. This method has already proven very successful, as Sonoma Water has completed several hazard mitigation projects over the last five years and will be in the process of completing several more prior to the next update.
- When: Every five years. Sonoma Water will also update the plan if there is a significant change in basic assumptions (for example, a major hazard event that highlights vulnerabilities in the system not anticipated at the present time).

D3. Integration of the Requirements of the Mitigation Plan into Other Planning Mechanisms

D3a. and D3b. Integration of Ideas, Information, Strategy, and Hazard Mitigation Actions into Other Planning Mechanisms

Sonoma Water has updated portions of its emergency response plan to include actions in this LHMP. Mitigation actions involving capital projects will be incorporated into Sonoma Water's annual Capital Improvement Plan as funding is scheduled to occur. Sonoma Water will actively work towards identifying outside funding sources for these projects, such as FEMA's pre-disaster mitigation program and hazard mitigation grants program. Depending on the level of funding, Sonoma Water will initiate implementation of the Priority A1 mitigation actions within 5 years following the adoption of the plan.

Mitigation actions listed in Appendix B that involve capital projects will be integrated into Sonoma Water's annual Capital Projects Plan (CPP) as funding is scheduled to occur. This will support identification of opportunities to accomplish mitigation actions as part of other efforts, programmed work, or necessary maintenance. As the highest priority mitigation actions are achieved, the implementation schedule and planning-level budget estimates for the next tier actions will be developed in future revisions to the CPP in consultation with the Water Agency's management, contractors, and the public. Many mitigation actions carried forward from the present LHMP are already integrated into the CPP.

Additionally, the updated LHMP's mitigation goals, objectives, and actions will be reviewed by plan managers during their annual review to inform and improve future updates to plans, as well as the County of Sonoma's General Plan, Strategic Plan, and Multi-Jurisdictional Hazard Mitigation Plan. The updated LHMP will be distributed to all plan managers during the public review comment period, along with the FEMA approved LHMP. The respective manager will be responsible for reviewing the updated LHMP and integrating relevant information into their updated planning documents.

Sonoma Water will continue to consider funding sources through its maintenance budget and a possible reliability surcharge within the rate structure. Sonoma Water will continue to actively identify external funding sources for the current LHMP mitigation actions, including FEMA's pre-disaster mitigation program (PDM) and Hazard Mitigation Grant Program (HMGP), FEMA's Public Assistance (PA) mitigation opportunities during disaster recovery operations, the National Oceanic Atmospheric Administration (NOAA), the California Department of Water Resources (CA DWR), the California Department of Forestry and Fire Protection (Cal FIRE), Federal and State loan programs, and other resources.

Element E. Plan Updates Since the 2018 Plan

The present LHMP updates Sonoma Water's Earthquake, Flood, Geologic, Fire, and Drought hazard assessments, descriptions, and histories in Element B, incorporating the significant natural hazard events that have occurred between 2018 and 2023. Updates to Sonoma Water systems and vulnerabilities are provided in Element B with a significant expansion of the vulnerability assessment for the flood protection and sanitation systems and infrastructure. The expanded vulnerability assessment is based on updated natural hazard GIS layers overlaid with maps of the sanitation and flood protection infrastructure and subsequently analyzed by Sonoma Water engineers and technical experts. New information also includes the Vulnerability Assessment and Risk Assessment in Element B from the 2021 *Sonoma Water Climate Adaptation Plan* and a description of Sonoma Water's Existing Authorities, Policies, Plans, Programs, and Resources in Element C.

E1. Revisions to Plan to Reflect Changes in Development Since the 2018 Plan

E1a. Changes in Development in Hazard-Prone Areas that Have Increased or Decreased Community Vulnerability Since the 2018 Plan

It is Sonoma Water's responsibility to maintain reliable services to its customers and ensure that the infrastructure is maintained and upgraded when needed. Development has not changed the Agency's overall vulnerability. Our primary consideration is that our infrastructure remains resilient and is not affected by growth and development.

E2. Revisions to Plan to Reflect Progress in Local Mitigation Efforts Since the 2018 Plan

During the last five years, Sonoma Water has initiated several high-priority projects identified in the 2018 LHMP to help reduce exposure to natural hazards and improve the reliability of its systems. Sonoma Water has also reassessed some of the priorities associated with the mitigation actions and added additional actions for the LHMP mitigation strategy. A summary of progress made on the 2018 LHMP mitigation actions is provided in Appendix A, and the updated Mitigation Actions for the LHMP are in Appendix B.

In the 2018 LHMP, Sonoma Water identified a series of actions as part of its implementation strategy and has made significant progress towards completing these actions. Implementation of these projects and actions has helped reduce the risk of catastrophic failure to Sonoma Water's critical infrastructure in the event of a natural hazard. Please see Appendix A for progress achieved since the 2018 LHMP.

E2a. Revisions to Plan to Reflect Changes in Priorities Since the 2018 Plan

Sonoma Water believes that the upgrades and safe operations of its systems will be accomplished most effectively with an implementation strategy consisting of an ongoing program in which the most significant vulnerabilities and those with the highest probability of occurrence are mitigated first, followed systematically by vulnerabilities of less significance and/or lower probability. Adding to that principle, however, Sonoma Water also believes that opportunities to address vulnerabilities that can be mitigated efficiently in conjunction with other necessary upgrades, planned maintenance work, or current pursuits, should be included among first-tier mitigation priorities. Mitigation of newly identified vulnerabilities—based on new or refined information—should be prioritized similarly and addressed as resources are available. Continued improvement in the reliability of the system and resilience to natural disasters is expected to be a key outcome of this approach.

E2b. Status Update for All Mitigation Actions Identified in the 2018 Plan

Please refer to Appendix A for status updates on mitigation actions identified in the 2018 plan.

E2c. Integration of the Mitigation Plan, When Appropriate, into Other Planning Mechanisms Since 2018

Sonoma Water updated portions of its emergency response plan to include actions in this LHMP. Mitigation actions involving capital projects were incorporated into Sonoma Water's annual Capital Improvement Plan as funding was scheduled to occur. Sonoma Water actively worked towards identifying outside funding sources for these projects, such as FEMA's pre-disaster mitigation program and hazard mitigation grants program. Depending on the level of funding, Sonoma Water initiated implementation of the Priority A1 mitigation actions within 5 years following the adoption of the plan.

Mitigation actions listed in Appendix B that involve capital projects were integrated into Sonoma Water's annual Capital Projects Plan (CPP) as funding was scheduled to occur. This supported identification of opportunities to accomplish mitigation actions as part of other efforts, programmed work, or necessary maintenance. As the highest priority mitigation actions were achieved, the implementation schedule and planning-level budget estimates for the next tier actions were developed in revisions to the CPP in consultation with the Water Agency's management, contractors, and the public. Many mitigation actions carried forward from the 2018 LHMP are integrated into the CPP.

Element F. Plan Adoption

F1. Formal Adoption by a Governing Body of the Jurisdiction

Upon FEMA's conditional approval of the updated LHMP, Sonoma Water's Board of Directors formally approved and adopted the LHMP on [date TBD insert date after FEMA conditional approval]. Formal FEMA approval of the District's LHMP was received [date TBD insert date of FEMA formal approval].

F1a. Documentation of Adoption

See Appendix G for the Board Resolution adopting the updated LHMP.

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Appendix A

2018 Local Hazard Mitigation Plan Progress

2018 SCWA LHMP Flood Protection Infrastructure Mitigation Actions (Table 11 in 2018 SCWA LHMP) - Status Update				
2018 LHMP Action #	**Tier**	**Priority**	**Action Description**	**Action Status**
3.1.1	1	A	Determine risk and develop an operational or design strategy to mitigate the ground rupture/deformation effects of the Spring Valley Fault/Bennett Valley Fault Zone and moderate to very high liquefaction hazard at and around the Spring Lake detention reservoir and associated flood protection elements (Spring Creek diversion, Santa Rosa Creek diversion, Vortex Tube).	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.2.1	1	A	Develop and implement operational or design strategy to mitigate the fault rupture and strong ground shaking effects of the Rodgers Creek Fault at the Piner Reservoir Dam.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.2	1	A	Assess concrete structures deteriorating from erosive effects of high storm flows, flooding, and sediment transport to ensure sustained integrity and flood protection reliability.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.1	1	A	Restore flood protection capacity of SMP-managed channels by removing accumulated sediment and vegetation.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.3	1	A	Assess conditions at Flood Detention Reservoirs to determine whether sediment removal is needed to preserve flood protection capacity.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.4	1	A	Assess design strategy options for addressing capacity deficiencies of the primary spillway at the Matanzas Dam and improve the flood protection function of the spillway structure.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.2	1	A	Participate with appropriate jurisdictional agencies and stakeholders to cooperatively develop operational or design strategies to mitigate the effects of flooding within the Petaluma River watershed resulting from alluvial fan avulsions of Copeland Creek and associated breakout flows.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.5	1	A	Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.3	1	B	Increase the designed flow conveyance capacity for portions of Santa Rosa Creek flood control channel to convey the 100-year flood event without overtopping.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
3.1.6	2	A	Assess the impacts of increased precipitation from climate change on engineered flood protection infrastructure.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.7	2	A	Continue to research and develop improved stormwater surface infiltration and recharge opportunities to reduce flooding impacts.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.10	2	A	Acquire flood easements from willing land owners in the Marin/Wilson/Wiggins Creek sub-watersheds of the Petaluma River watershed to preserve the benefits of existing downstream flood protection projects/improvements along the Petaluma River.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.2.4	2	A	Develop and implement operational or design strategy to mitigate against potential loss of tree canopy in the event of a fire near reservoirs or engineered channels.	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.8	2	B	Assess the potential ground deformation effects of fault rupture and moderate liquefaction hazard on the Brookhill School, Brigham Avenue, Colgan Avenue, Santa Rosa-Bellevue Avenue, Cook Creek, and Steel Creek Conduits.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.1.9	2	B	Determine the highly vulnerable locations subject to ground deformation effects of liquefaction, where resulting lateral spread and/or sedimentation will decrease the level of flood protection provided by the Sonoma Water's engineered flood protection infrastructure (e.g. channels, conduits, or reservoirs).	In progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.4	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Spring Creek Bypass Conduit.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.5	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Brigham Avenue Conduit.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.6	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Santa Rosa Creek Triple Box Culvert.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.7	2	B	Develop and implement operational and/or design strategy to mitigate the seismic effects of strong to very strong ground shaking (PGA = 0.4 to 0.6g) on flood control conduits.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
3.1.10	2	B	Conduct corrosion assessment of facilities located within areas of moderate to high corrosive soil conditions.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.2.2	2	B	Develop and implement an operational or design strategy to mitigate the erosive effects of fire, landslides, and floods in watershed areas where resulting increases in sedimentation, storm flows, landslides, and embankment failures will decrease the level of flood protection provided by Sonoma Water's engineered flood protection infrastructure (e.g. channels, conduits, or reservoirs).	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.2.3	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of landslides, where resulting ground deformation will damage Sonoma Water's flood protection infrastructure (e.g. channels, conduits, or reservoirs).	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.8	2	B	Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate to high liquefaction hazard on the Cherry-Magnolia and Thompson Conduits.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List
3.3.9	2	B	Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate liquefaction hazard on the Kenwood Creek Bypass Conduit.	No progress. Maintained in 2023 LHMP. Flood Protection Infrastructure Mitigation Action List

2018 RRCSD LHMP Sanitation System Mitigation Actions (Table 10 in 2018 RRCSD LHMP) - Status Update				
2018 LHMP Action #	**Tier**	**Priority**	**Action Description**	**Action Status**
1.1.1	1	A	Develop specific measures to include in an integrated Sonoma Water emergency response and recovery plan for sanitation operations.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.3.1)
1.2.1	1	A	Enhance the reliability of SCADA operations by upgrading network hardware, computer hardware, and radio hardware.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.3.2)
1.3.1	1	A	Obtain flexible hoses, emergency pumps, generators, and related emergency response equipment to enhance the RRCSD's ability to restore service in the collection system after a natural disaster.	Completed. Removed from 2023 LHMP.
2.1.6	1	A	Install equipment to protect the emergency generator against voltage spikes.	Completed. Removed from 2023 LHMP.
2.1.1	1	A	Seismically restrain/anchor the steel tertiary filter tanks at the RRCSD treatment plant.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.13)
3.4.1	1	A	Install quick connects at lift stations to allow emergency generator to be operated if loss of power occurs.	Completed. Removed from 2023 LHMP.
3.5.1	1	A	Develop and Implement a design strategy to mitigate the effects of wild-land fire on Russian River CSD critical facilities.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.32)
2.1.2	1	A	Seismically restrain/anchor miscellaneous equipment at the RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.14)
2.1.4	1	A	Develop and implement strategy to reinforce clarifier and/or modify operational procedures to mitigate seismic risk.	Completed. Removed from 2023 LHMP.

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
3.1.5	1	A	Update construction standards to address liquefaction potential along the collection system.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.26)
2.1.3	1	B	Seismically retrofit piping at the treatment plant to allow for differential movement at RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.15)
3.4.2	1	B	Replace power distribution system to lift stations located in Russian River CSD.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.30)
3.4.3	1	B	Develop and implement a design strategy to replace the existing emergency backup power system at the Main Lift Station.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.31)
3.1.4	1	B	Conduct vulnerability assessment of critical pipelines located in Russian River CSD.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.25)
3.1.1	1	B	Develop and implement a design strategy to mitigate the effects of liquefaction on the Russian River CSD collection system (including pump stations and related force mains) in areas that have very high and high liquefaction potential.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.23)
2.3.1	1	B	Conduct geotechnical assessment of the slopes bordering the Northern boundary of the RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.18)
2.4.1	1	B	Conduct site specific geotechnical assessment of the portions of the RRCSD treatment plant that are within the very high or high liquefaction zone.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.20)
3.2.1	1	B	Develop and implement a design strategy to mitigate the effects of embankment failure/landslides on portions of the Russian River CSD collection system that are in close proximity to creeks, drainage channels or steep slopes.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.27)
3.3.2	1	B	Develop and implement a design strategy to elevate and/or protect pump stations located in Russian River CSD from flood related damage.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.29)

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
2.1.5	2	A	Seismically retrofit suspended ceiling over SCADA Control Room at RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.16)
3.1.3	2	B	Develop and implement a design strategy to mitigate the effects of liquefaction on the Russain River CSD tertiary recycled water system.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.24)
3.1.2	2	B	Develop and implement a design strategy to mitigate the effects of liquefaction on the collection system (including lift stations and related force mains) in areas that have moderate liquefaction potential.	Completed. Removed from 2023 LHMP.
3.3.1	2	B	Develop and implement a design strategy to mitigate the effects of high stream flows (e.g., erosion and debris flows) on portions of the Russian River CSD collection system at creek crossings where the burial depth is unknown and assumed shallow.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.1.28)
2.2.1	2	B	Develop and implement a design strategy to provide additional storage capacity at the RRCSD treatment plant to enhance operational ability for storage during and after a natural disaster while repairs are made to restore treatment capabilities.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.17)
2.5.1	2	B	Develop and implement a design strategy to upgrade the asphalt shingle/tar and gravel roofs at the RRCSD treatment plant to mitigate the effects of wild-land fire.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.21)
2.3.2	2	B	Develop and implement a design strategy to mitigate the effects of landslides and debris flows at the RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List (2.2.19)

2018 SCWA LHMP Sanitation System Mitigation Actions (Table 10 in 2018 SCWA LHMP) - Status Update				
2018 LHMP Action #	**Tier**	**Priority**	**Action Description**	**Action Status**
2.2.1	1	A	Develop and implement operational or design strategy to mitigate the effects of flooding on percolation at the Geyserville SZ wastewater treatment plant.	No progress.Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.2	1	A	Develop and implement an operational or design strategy to mitigate the effects of flooding for Airport-Larkfield-Wikiup SZ treatment plant facilities that are subject to recurrent inundation or located within the 100-year floodplain.	No progress.Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.1	1	A	Update construction standards to address seismic resilient measures for the collection system.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.2	1	A	Develop and implement operational or design strategy to mitigate the effects of flooding for portions of Penngrove SZ collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of Lichau Creek.	Completed. Removed from 2023 LHMP.
2.1.3	1	A	Develop and implement an operational or design strategy to mitigate the debris hazard effects of high stream flows and wind on the exposed pipeline crossing the drainage in the vicinity of the Sea Ranch SZ treatment plant.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.3	1	A	Develop and implement an operational or design strategy to mitigate the effects of flooding on access to the Geyserville SZ wastewater treatment plant.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.4	1	A	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for the Geyserville SZ force main.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.5	1	A	Develop and implement operational or design strategy to mitigate the effects of flooding at the Penngrove SZ lift station.	Completed. Removed from 2023 LHMP.
2.2.6	1	A	Develop and implement an operational or design strategy to mitigate the adverse effects of flooding and/or high stream flows on the Penngrove SZ force main in the vicinity of Highway 101 and Deer Creek crossing.	Completed. Removed from 2023 LHMP.

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
2.2.7	1	A	Develop and implement an operational or design strategy to ensure auxiliary power reliability at the Sea Ranch SZ main lift station during storm events.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.4	1	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard on the Penngrove SZ force main adjacent to the Petaluma River and crossing Lynch Creek.	Completed. Removed from 2023 LHMP.
2.1.5	1	B	Develop and implement an operational or design strategy to mitigate the bank erosion effects of flooding and/or high stream flows near the overflow tanks at the Sea Ranch SZ main lift station.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.6	1	B	Develop and implement an operational or design strategy to mitigate the erosive effects of high stream flows in Dutch Bill Creek adjacent to the Occidental CSD lift station.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.7	1	B	Develop and implement an operational or design strategy to mitigate the effects of fire at the Occidental CSD lift station.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.8	1	B	Develop and implement an operational or design strategy to mitigate the ground rupture effects of the Rodgers Creek Fault for portions of the Airport/Larkfield/Wikiup SZ collection system within the rupture zone.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.8	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.9	1	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Airport/Larkfield/Wikiup SZ collection system crossing Mark West Creek.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.10	1	B	Develop and implement operational or design strategy to mitigate the effects of flooding for portions of the Geyserville SZ collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of the Russian River.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.11	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for the Geyserville SZ collection system, particularly where it crosses and is adjacent to Wood Creek.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
2.1.12	1	B	Develop and implement an operational or design strategy to mitigate damaging effects of fault rupture on the Airport-Larkfield-Wikiup SZ trunk main.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.13	1	B	Develop and implement operational or design strategy to mitigate the effects of flooding at the Geyserville SZ lift station, including reliability of auxiliary power supply and erosion-induced exposure of manhole M10-1.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.14	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.15	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ lift station.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.3	1	B	Seismically retrofit piping at the treatment plant to allow for differential movement at RRCSD treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.16	2	A	Develop and implement an operational or design strategy to mitigate the effects of flooding for portions of the Airport-Larkfield-Wikiup SZ collection system subject to infiltration within areas of recurrent inundation or located within the 100-year floodplain.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.17	2	A	Develop and implement an operational or design strategy to mitigate the effects of wildfire at the Airport-Larkfield Wikiup SZ Lift Station.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.18	2	A	Conduct corrosion assessment of Airport-Larkfield Wikiup SZ, Penngrove SZ, and Occidental CSD facilities located within areas of moderate to high corrosive soil conditions.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.19	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek and Owens Creek.	In progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.9	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard of portions of the Airport-Larkfield-Wikiup SZ recycled water system in the vicinity of the Mark West Creek and Woolsey Creek Crossing.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
2.2.10	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for portions of the Airport-Larkfield-Wikiup SZ recycled water system in the vicinity of Windsor Creek crossing.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.11	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard at the Airport-Larkfield-Wikiup SZ treatment plant.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.20	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard on the Penngrove SZ force main, between the Ely and Wilmington pump stations.	Completed. Removed from 2023 LHMP.
2.1.21	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of liquefaction for portions of the collection system (including lift stations and related force mains) subject to moderate liquefaction hazard.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.2.12	2	B	Develop and implement an operational or design strategy to mitigate the increased precipitation effects and fire risk from climate change in all sanitation areas.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List
2.1.22	2	B	Assess the potential for ground rupture effects of the Alexander Fault on Geyserville SZ facilities.	No progress. Maintained in 2023 LHMP. Sanitation System Mitigation Action List

2018 SCWA LHMP Water Transmission and Supply System Mitigation Actions (Table 9 in 2018 SCWA LHMP) - Status Update				
2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.1.1	1	A	Continue to support Forecast Informed Reservoir Operations (FIRO) and its efforts to provide drought resilient planning.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.2	1	A	Develop a modified hydrologic index to improve management of river flows and system storage.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.3	1	A	Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.4	1	A	Continue to research and pursue projects involved with aquifer storage and recovery.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.1	1	A	Develop and implement retrofit design for Collector 3 against liquefaction and lateral spread hazard.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.2	1	A	Develop and implement retrofit design for Collector 5 against liquefaction and lateral spread hazard.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.3	1	A	Develop and implement retrofit design for Collector 6 against liquefaction and lateral spread hazard.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.4	1	A	Develop and implement design strategy to mitigate liquefaction and lateral spread hazard to the River Diversion Structure (RDS).	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.7.1	1	A	Develop and implement design or operational strategy to mitigate liquefaction and/or fire related damage to electric power lines feeding collectors and pump stations.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.7.2	1	A	Develop a design or operational strategy to maintain communications and auxiliary power at all Water Supply Tanks and booster stations in the event of fire damage. Develop a design for additional infrastructure for redundancy and reliability of communication system.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.5	1	A	Provide operational capability to minimize uncontrolled release by controlling flows out of Agency facilities with automated throttling valves on the Santa Rosa Aqueduct, Cotati intertie, and Wohler Forestville Intertie.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.1	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Russian River crossing.	Completed. Removed from 2023 LHMP.
1.3.2	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Mark West Creek crossing.	Completed. Removed from 2023 LHMP.
1.4.1	1	A	Develop and implement retrofit design for mitigation of liquefaction and lateral spread hazard, and 100 year flood zone impacts, at the Ely Booster station.	Completed. Removed from 2023 LHMP.
1.4.2	1	A	Assess impact of Spring Creek Bennett Valley fault rupture on Sonoma Booster Station, and develop and implement a design or operational solution to mitigate the fault rupture hazard.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.4.3	1	A	Develop and implement seismic retrofit design or replacement of the Wilfred booster station building.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.3	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Santa Rosa Creek crossing.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.5.1	1	A	Perform piping retrofit by replacing existing rigid piping with piping with flexible joints at the storage reservoirs.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.4	1	A	Implement cathodic protection system improvements to the Santa Rosa and Russian River-Cotati Intertie aqueducts to mitigate corrosion hazard and extend the resilient life of those facilities.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.8.5	1	A	Coordinate with Army Corps of Engineers to support its efforts to address operational reliability of the outlet works at Warm Springs Dam.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.8.1	1	B	Design and implement mitigation schemes for reducing the potential of flood damage to the well fields, collector wells, and caissons in the Mirabel, Wohler, and Laguna de Santa Rosa areas.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.5	1	B	Develop a design strategy and operational plan to address flooding at the Mirabel facility.	In progress. Maintained in 2023 LHMP. WTS Mitigation Action List
1.10.1	1	B	Work with the U.S. Army Corps of Engineers to expedite the earthquake safety assessment of Warm Springs and Coyote Valley dams; and reassessment of these under the revised Probable Maximum Flood conditions as impacted by the Probable Maximum Precipitation study.	No progress. Maintained in 2023 LHMP. WTS Mitigation Action List
1.8.2	1	B	Conduct assessment of vegetation around Lake Sonoma and Lake Mendocino for potential vegetation management projects that will protect water quality and storage from fire.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.2.6	1	B	Develop and implement an operational and design strategy to mitigate against potential fire damage to Mirabel and Wohler facilities. Include consideration of removing debris, trees, or other fire-hazard materials; installing fire resilient building materials; and modifying treatment processes to accommodate water quality changes.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.6	1	B	Develop a design or operational strategy to respond to unexpected pipeline damage within the Wohler-Mirabel area from liquefaction.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.7.3	1	B	Conduct an assessment to determine if powerlines should be moved underground.	Completed. Removed from 2023 LHMP.
1.3.5	1	B	Develop plans to relocate pipeline that crosses beneath the Spring Lake and the Spring Lake dam.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.6	1	B	Develop and implement an operational or design strategy to mitigate fault rupture hazard to the aqueducts that cross the Bennett Valley fault.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.3.7	1	B	Develop and implement an operational or design strategy to mitigate the liquefaction and lateral spread hazard at the Petaluma River crossing.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.8	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Calabasas Creek crossing.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.9	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Lawndale and Madrone Road crossings of Sonoma Creek.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.3.10	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Verano Avenue crossing of Sonoma Creek.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.5.2	1	B	Implement other retrofits such as removing overconstrained conditions at storage reservoirs identified in the natural hazard reliability study.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.9.1	1	B	Conduct a detailed seismic vulnerability assessment of structural and non-structural elements of the Agency's administrative facilities.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.7	2	A	Continue to research and develop improved stormwater surface infiltration and recharge for water supply.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.8.3	2	A	Assess potential damage to Water Agency infrastructure in the event of Warm Springs and/or Coyote dam failure.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.8	2	A	Improve secondary water quality in the Todd Road, Sebastopol, and Occidental Wells to provide additional water supply in the event that one of the Caissons is damaged by flood, drought, or earthquake.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.9.2	2	A	Develop plans to repair the slide on the Wohler access road.	Completed. Removed from 2023 LHMP.

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.3.11	2	A	Develop a long term strategy to address lower probability damage to transmission system pipelines.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.9	2	A	Install flow measuring devices at key turnouts for real time monitoring of flow.	Completed. Removed from 2023 LHMP.
1.1.10	2	A	Work with the United States Geological Survey (USGS) to design and conduct a detailed geologic study of Bennett Valley and Rodgers Creek faults to more accurately define the fault activity, paleoseismic history, rupture zone, and extent of surface rupture.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.7.4	2	A	Assess sufficiency of standby power at administrative buildings and Water Agency EOC, and develop design strategy to ensure core functions are maintained in the event of a power failure.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.6.1	2	A	Conduct first responder training of a broad pool of Agency's personnel to respond in an emergency.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.11	2	A	Provide seismic restraints to electrical and communication equipment at various facilities.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.4.4	2	B	Develop and implement design or operational strategy to mitigate lateral spread damage to the Wohler-Mirabel Intertie.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.8.4	2	B	Assess vulnerability of Russian River supply upstream of the Russian River aquifer to contamination from earthquake and non-earthquake induced landslides, wildland fire, and resulting post-fire erosion, especially to Lake Sonoma and Lake Mendocino water supply sources.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.10.2	2	B	Conduct a detailed seismic vulnerability assessment of electric power station at the Warm Springs dam.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.9.3	2	B	Develop operational strategy to maintain water collection and pumping plant in the event that Wohler Bridge is damaged by earthquake, flood, or landslide.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List

2018 LHMP Action #	Tier	Priority	Action Description	Action Status
1.2.7	2	B	Develop and implement an operational and design strategy to mitigate against turbid water at Collector 5 from burn area runoff due to this being the only collector under the influence of surface water during certain flow levels.	In progress. Maintained in 2023 LHMP. WTS Mitigation Action List
1.1.12	2	B	Plan, design and add redundant/emergency supply sources to minimize dependence on the Russian River aquifer as the main source of water supply. Install new emergency ground water wells located strategically throughout the system (assumed three locations).	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.13	2	B	Assess backwater culverts at Mirabel facility and consider remote operation of their valves.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.6.2	2	B	Procure, or contract for, a mobile EOC and Communication trailer.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.5.3	2	B	Develop larger and more redundant storage facilities to minimize future water supply issues due to increased variability in supply and likely increased demand, which may stress existing conveyance, pumping, and storage systems.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.1.14	2	B	Develop a GPS based system map with real-time monitoring at critical locations. For example, significant portions of the Agency's aqueducts run through large zones of undeveloped areas and pipe leaks in such areas are hard to precisely locate.	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.6.3	2	B	Develop an alternate EOC location.	Completed. Removed from 2023 LHMP.
1.1.15	2	B	Install emergency manifolds at strategic locations to connect emergency hoses to Booster Stations. Utilize Capital Project planning process and planned Booster Station upgrades as a means to accomplish this.	No progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List
1.10.3	2	B	Develop standard project design criteria document for new construction (water system, sanitary system and flood protection system).	In progress. Maintained in 2023 LHMP. Water Transmission & Supply System Mitigation Action List

Appendix B

2023 Hazard Mitigation Tables

2023 FLOOD PROTECTION MITIGATION ACTIONS

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Flood Zone	Infrastructure Type	Hazard(s) Mitigated	Timeframe	Responsible Entity	Potential Funding*
3.1.1	1	A	Determine risk and develop an operational or design strategy to mitigate the ground rupture/deformation effects of the Spring Valley Fault/Bennett Valley Fault Zone and moderate to very high liquefaction hazard at and around the Spring Lake detention reservoir and associated flood protection elements (Spring Creek diversion, Santa Rosa Creek diversion, Vortex Tube).	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Preserves capacity of existing flood protection infrastructure • Reduces asset damage	• More information/study required to implement • Construction/implementation complexities • Capital costs • Potential environmental impacts • Permitting challenges	1A	Reservoirs, Conduits	Earthquake	0-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB , CA DWR FERP
3.2.1	1	A	Develop and implement operational or design strategy to mitigate the fault rupture and strong ground shaking effects of the Rodgers Creek Fault at the Piner Reservoir Dam.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Preserves capacity of existing flood detention facility and downstream flood protection • Reduces asset damage	• More information/study required to implement • Construction/implementation complexities • Capital Costs • Potential Environmental impacts • Permitting challenges	1A	Reservoirs	Earthquake	0-5 years	Design Engineering	NRCS, FEMA, Sonoma Water, SWRCB, CA DWR
3.1.2	1	A	Assess concrete structures deteriorating from erosive effects of high storm flows, flooding, and sediment transport to ensure sustained integrity and flood protection reliability.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	•Low cost to assess •May facilitate funding partnerships	• Some elements may require participation of other responsible parties	1A, 2A, 3A	All	Flood	0-5 years	Water/Wastewater Operations, Maintenance	FEMA, Sonoma Water, SWRCB, CA DWR
3.3.1	1	A	Restore flood protection capacity of SMP-managed channels by removing accumulated sediment and vegetation.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Covered under SMP general permit • Public support • Vegetation managment can also improve riparian habitat • Preserves capacity of existing flood protection infrastructure • Reduces risks of uncontrolled flood flows • Reduces asset damage • Sediment management can help restore/enhance aquatic habitat.	• Potential environmental impacts • On-going effort • Cost	1A, 2A, 3A	Channels	Flood, Fire	0-5 years	Water/Wastewater Operations, Maintenance	Sonoma Water, WCB, CSCC, CDFW
3.1.3	1	A	Assess conditions at Flood Detention Reservoirs to determine whether sediment removal is needed to preserve flood protection capacity.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Low cost to assess • Preserves/restores capacity of existing flood protection infrastructure	• More information/study required to implement	1A	Reservoirs	Flood	0-5 years	Water/Wastewater Operations, Maintenance	Sonoma Water, CDFW
3.1.4	1	A	Assess design strategy options for addressing capacity deficiencies of the primary spillway at the Matanzas Dam and improve the flood protection function of the spillway structure.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Preserves capacity of existing flood protection infrastructure • Reduces asset damage	• More information/study required to implement • Potential environmental impacts • Permitting challenges • Requires participation of other responsible parties	1A	Reservoirs	Flood	0-5 years	Design Engineering	NRCS, FEMA, Sonoma Water, SWRCB, CA DWR
3.3.2	1	A	Participate with appropriate jurisdictional agencies and stakeholders to cooperatively develop operational or design strategies to mitigate the effects of flooding within the Petaluma River watershed resulting from alluvial fan avulsions of Copeland Creek and associated breakout flows.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Already in progress • Minimizing potential losses from a major flood, including critical access.	• More information/study required • Requires participation of other responsible parties	1A, 2A	Channels & Conduits	Flood	0-5 years	Water/Wastewater Operations, Maintenance, Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR, WCB, CSCC
3.1.5	1	A	Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Already in progress • Benefits region as a whole •Received grant funding • Minimizing potential losses from a major flood	• Program cost for development and upkeep • On-going costs/effort/training/maintenance	1A, 2A, 3A	All	Drought, Flood	0-5 years	Resource Planning	CA DWR IRWM, FEMA, Sonoma Water
3.3.3	1	B	Increase the designed flow conveyance capacity for portions of Santa Rosa Creek flood control channel to convey the 100-year flood event without overtopping.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Minimizing potential losses from a major flood • Incorporate climate change impacts in vulnerability assessment	• Long-term plan / Extended implementation timeline • Capital Cost • Potential environmental impacts • Permitting challenges	1A	Channels	Flood	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR FERP, WCB, CSCC

3.1.6	2	A	Assess the impacts of increased precipitation from climate change on engineered flood protection infrastructure.	In progress. From 2013 LHMP (was 3.1.1). Will be Maintained in 2023 LHMP.	• Minimizing potential losses from a major flood • Incorporate climate change impacts in vulnerability assessment	• Facilitates potential future mitigation opportunities, but does not in itself mitigate hazard	1A, 2A, 3A	All	Flood	0-5 years	Energy Resources	Sonoma Water, FEMA planning
3.1.7	2	A	Continue to research and develop improved stormwater surface infiltration and recharge opportunities to reduce flooding impacts.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Relatively low cost • Aligns with current stormwater planning process • Recharge could also provide drought benefits	• Long-term plan / Extended timeline implementation •Public opposition has stalled prior similar projects • Requires participation of other responsible parties	1A, 2A, 3A	All	Flood	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR IRWM, CSCC
3.3.10	2	A	Acquire flood easements from willing land owners in the Marin/Wilson/Wiggins Creek sub-watersheds of the Petaluma River watershed to preserve the benefits of existing downstream flood protection projects/improvements along the Petaluma River.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Minimizing potential losses from a major flood • Preserves capacity of existing flood protection infrastructure • Reduces asset damage	• Long-term plan / Extended timeline implementation • Uncertain funding sources • Easement challenges	2A	Channels	Flood	0-5 years	Survey/Right of Way	Sonoma Water, Sonoma County Agriculture and Open Space, SWRCB , CA DWR FERP & IRWM
3.2.4	2	A	Develop and implement operational or design strategy to mitigate against potential loss of tree canopy in the event of a fire near reservoirs or engineered channels.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Riparian habitat benefit. Intact canopy preserves flood capacity of channels by limiting channel-clogging undergrowth.	• More information/study required to implement • Cost	1A, 2A, 3A	Reservoirs, Channels	Fire	0-5 years	Water/Wastewater Operations, Maintenance	Sonoma Water, CA DWR IRWM & FERP, CA NRA SRA, Cal FIRE, CA Fire Safe Council
3.1.8	2	B	Assess the potential ground deformation effects of fault rupture and moderate liquefaction hazard on the Brookhill School, Brigham Avenue, Colgan Avenue, Santa Rosa-Bellevue Avenue, Cook Creek, and Steel Creek Conduits.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	•Low cost to assess individual sites	• Limited service area effect at individual sites	1A	Conduits	Earthquake	5-10 years	Design Engineering	Sonoma Water, FEMA planning
3.1.9	2	B	Determine the highly vulnerable locations subject to ground deformation effects of liquefaction, where resulting lateral spread and/or sedimentation will decrease the level of flood protection provided by the Sonoma Water's engineered flood protection infrastructure (e.g. channels, conduits, or reservoirs).	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Facilitates future preservation of flood protection capacity	• More information/study required to implement • Cost	1A, 2A, 3A	All	Earthquake	5-10 years	Design Engineering	Sonoma Water, FEMA planning
3.3.4	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Spring Creek Bypass Conduit.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost	1A	Conduits	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB , CA DWR FERP
3.3.5	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Brigham Avenue Conduit.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Limited service area effect • Cost	1A	Conduits	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB , CA DWR FERP
3.3.6	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate to very high liquefaction hazard at the Santa Rosa Creek Triple Box Culvert.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost	1A	Conduits	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB , CA DWR FERP
3.3.7	2	B	Develop and implement operational and/or design strategy to mitigate the seismic effects of strong to very strong ground shaking (PGA = 0.4 to 0.6g) on flood control conduits.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost	1A, 2A, 3A	Conduits	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB , CA DWR FERP
3.1.10	2	B	Conduct corrosion assessment of facilities located within areas of moderate to high corrosive soil conditions.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Low cost to assess	• Facilitates potential future mitigation, but does not itself mitigate hazard	1A, 2A	All	Flood (Corrosion)	5-10 years	Energy Resources	Sonoma Water, FEMA planning

3.2.2	2	B	Develop and implement an operational or design strategy to mitigate the erosive effects of fire, landslides, and floods in watershed areas where resulting increases in sedimentation, storm flows, landslides, and embankment failures will decrease the level of flood protection provided by Sonoma Water's engineered flood protection infrastructure (e.g. channels, conduits, or reservoirs).	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost • Potential environmental impacts • Permitting challenges	1A, 2A, 3A	All	Fire, Flood, Earthquake	5-10 years	Water/Wastewater Operations, Maintenance, Design Engineering	Sonoma Water, CA DWR IRWM, CA NRA SRA, Cal FIRE, CA Fire Safe Council, FEMA, CDFW
3.2.3	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of landslides, where resulting ground deformation will damage Sonoma Water's flood protection infrastructure (e.g. channels, conduits, or reservoirs).	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost • Potential environmental impacts • Permitting challenges	1A, 2A, 3A	All	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR
3.3.8	2	B	Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate to high liquefaction hazard on the Cherry-Magnolia and Thompson Conduits.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost • Limited service area effect for individual sites	2A	Conduits	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR
3.3.9	2	B	Assess the potential ground deformation effects and develop and implement operational or design strategy to mitigate the moderate liquefaction hazard on the Kenwood Creek Bypass Conduit.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• More information/study required to implement • Cost • Limited service area effect	3A	Conduits	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR
3.1.11	2	B	Identify critical watersheds or sub-watersheds that represent high fire risk and likely to represent high flood management impact (sediment) to agency's operations.	New 2023 Action	• Reduces asset damage • Preserves capacity of existing flood protection infrastructure	• Cost • Potential Environmental Impacts • Permitting challenges	All	All	Fire	5-10 years	Resource Planning	Sonoma Water, Cal FIRE, CA Fire Safe Council, FEMA
			***Potential Funding: External agencies and programs listed in this column are described in Section C5.b.: Funding Sources, of the Sonoma Water LHMP.**									
			***Responsible Entity: Sections and Divisions listed in this column are shown in Appendix F: Water Agency Organizational Charts, of the Sonoma Water LHMP.**									

2023 SANITATION MITIGATION ACTIONS

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.2.1	1	A	Develop and implement operational or design strategy to mitigate the effects of flooding on percolation at the Geyserville SZ wastewater treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	• On-going costs, effort, and training • Accessibility constraints More study required	Geyserville SZ	Flood	0-5 years	Operation & Maintenance	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.2.2	1	A	Develop and implement an operational or design strategy to mitigate the effects of flooding for Airport-Larkfield-Wikiup SZ treatment plant facilities that are subject to recurrent inundation or located within the 100-year floodplain.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	Permitting challenges	ALW SZ	Flood	0-5 years	Operations & Maintenance, Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.1	1	A	Update construction standards to address seismic resilient measures for the collection system.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Additional cost for development • Training required • Requires participation by other responsible parties	All	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, RRCSD
2.1.3	1	A	Develop and implement an operational or design strategy to mitigate the debris hazard effects of high stream flows and wind on the exposed pipeline crossing the drainage in the vicinity of the Sea Ranch SZ treatment plant.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	Sea Ranch SZ	Flood	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.2.3	1	A	Develop and implement an operational or design strategy to mitigate the effects of flooding on access to the Geyserville SZ wastewater treatment plant.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Reduces risk of releasing inadequately or untreated wastewater	• Capital Cost • Requires participation of other resposible parties	Geyserville SZ	Flood	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB, CA DWR IRWM & FERP
2.2.4	1	A	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for the Geyserville SZ force main.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	Capital Cost	Geyserville SZ	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.34	1	A	Develop and implement operational or design strategy to mitigate the effects of flooding for portions of the RRCSD collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of the Russian River.	New 2023 Action	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	• More study required for implementation	Russian River CSD	Flood	5-10 years	Operations & Maintenance	FEMA, RRCSD, SWRCB Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.35	1	A	Update construction standards to address inflow and infiltration for the collection system.	New 2023 Action	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Additional cost for development • Training required • Requires participation by other responsible parties	All	All	0-5 years	Design Engineering, Resouce Planning	FEMA, Sonoma Water, RRCSD
2.2.7	1	A	Develop and implement an operational or design strategy to ensure auxiliary power reliability at the Sea Ranch SZ main lift station during storm events.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	• Ongoing effort and costs to maintain plan and train staff on implementation	Sea Ranch SZ	Flood	0-5 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.3.1	1	A	Develop specific measures to include in an integrated Sonoma Water emergency response and recovery plan for sanitation operations.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Ongoing effort and costs to maintain plan and train staff on implementation	All	All	0-5 years	Emergency Response	RRCSD, State Water Resources Control Board
2.3.2	1	A	Enhance the reliability of SCADA operations by upgrading network hardware, computer hardware, and radio hardware.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Reduces energy use • Can be completed within existing authority	• Ongoing effort and costs to maintain system and train staff on implementation	All	All	0-5 years	Emergency Response, Information Technology	RRCSD, State Water Resources Control Board
2.2.13	1	A	Seismically restrain/anchor the steel tertiary filter tanks at the RRCSD treatment plant.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Can be completed within existing authority	• Ongoing operational effort for some systems	Russian River CSD	Earthquake	0-5 years	Operations & Maintenance	RRCSD, FEMA, State Water Resources Control Board
2.1.32	1	A	Develop and Implement a design strategy to mitigate the effects of wild-land fire on Russian River CSD critical facilities.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Improves risk awareness • Can be completed within existing authority	• Requires training to adapt to new standards	Russian River CSD	Fire	0-5 years	Resource Planning	RRCSD, State Water Resources Control Board
2.2.14	1	A	Seismically restrain/anchor miscellaneous equipment at the RRCSD treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Can be completed within existing authority	• Ongoing operational effort for some systems	Russian River CSD	Earthquake	0-5 years	Operations & Maintenance	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.26	1	A	Update construction standards to address liquefaction potential along the collection system.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Can be completed within existing authority	• Requires additional resources to implement public outreach and training to adapt to new standards • Increased cost to new development	All	Earthquake	0-5 years	Design Engineering	RRCSD
2.1.5	1	B	Develop and implement an operational or design strategy to mitigate the bank erosion effects of flooding and/or high stream flows near the overflow tanks at the Sea Ranch SZ main lift station.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	Sea Ranch SZ	Flood	5-10 years	Operations & Maintenance, Design Engineering	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.6	1	B	Develop and implement an operational or design strategy to mitigate the erosive effects of high stream flows in Dutch Bill Creek adjacent to the Occidental CSD lift station.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	Occidental CSD	Flood	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.7	1	B	Develop and implement an operational or design strategy to mitigate the effects of fire at the Occidental CSD lift station.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	Feasible measures may only have incremental risk reduction benefit	Occidental CSD	Fire	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, CA NRA SRA, Cal FIRE, CA Fire Safe Council

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.1.8	1	B	Develop and implement an operational or design strategy to mitigate the ground rupture effects of the Rodgers Creek Fault for portions of the Airport/Larkfield/Wikiup SZ collection system within the rupture zone.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • Construction complexities	ALW SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.2.8	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• More study required for implementation • Technically Challenging	Geyserville SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.9	1	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Airport/Larkfield/Wikiup SZ collection system crossing Mark West Creek.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • Potential environmental impacts • Permitting challenges	ALW SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.10	1	B	Develop and implement operational or design strategy to mitigate the effects of flooding for portions of the Geyserville SZ collection system subject to inflow within areas of recurrent inundation or located within the 100-year floodplain of the Russian River.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	• More study required for implementation	Geyserville SZ	Flood	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.11	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for the Geyserville SZ collection system, particularly where it crosses and is adjacent to Wood Creek.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	Geyserville SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.12	1	B	Develop and implement an operational or design strategy to mitigate damaging effects of fault rupture on the Airport-Larkfield-Wikiup SZ trunk main.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • More study required for implementation	ALW SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.13	1	B	Develop and implement operational or design strategy to mitigate the effects of flooding at the Geyserville SZ lift station, including reliability of auxiliary power supply and erosion-induced exposure of manhole M10-1.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	Capital Cost	Geyserville SZ	Flood	5-10 years	Resource Planning	FEMA, Sonoma Water, SWRCB & Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.14	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • Potential environmental impacts • Permitting challenges	Penngrove SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.1.15	1	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of very high liquefaction hazard at the Geyserville SZ lift station.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • More study required for implementation	Geyserville SZ	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.3	1	B	Seismically retrofit piping at the treatment plant to allow for differential movement at RRCSD treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Can be completed within existing authority	• Capital cost	Russian River CSD	Earthquake	5-10 years	Operations & Maintenance, Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.30	1	B	Replace power distribution system to lift stations located in Russian River CSD.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Reduces energy use • Improves risk awareness • Can be completed within existing authority	• Facilitates potential future mitigation efforts, but does not in itself mitigate any hazard	Russian River CSD	All	5-10 years	Operations & Maintenance, Design Engineering	RRCSD, State Water Resources Control Board
2.1.31	1	B	Develop and implement a design strategy to replace the existing emergency backup power system at the Main Lift Station.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Reduces energy use • Improves risk awareness • Can be completed within existing authority	• Capital cost	Russian River CSD	All	5-10 years	Operations & Maintenance, Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.25	1	B	Conduct vulnerability assessment of critical pipelines located in Russian River CSD.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Facilitates potential future mitigation efforts, but does not in itself mitigate any hazard	Russian River CSD	Flood	5-10 years	Operations & Maintenance, Design Engineering	RRCSD, State Water Resources Control Board
2.1.23	1	B	Develop and implement a design strategy to mitigate the effects of liquefaction on the Russian River CSD collection system (including pump stations and related force mains) in areas that have very high and high liquefaction potential.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Capital cost • Community impacts • Construction complexities • Extended implementation timeline	Russian River CSD	Earthquake	10+ years	Operations & Maintenance, Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.2.18	1	B	Conduct geotechnical assessment of the slopes bordering the Northern boundary of the RRCSD treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Facilitates potential future mitigation efforts, but does not in itself mitigate any hazard	Russian River CSD	Earthquake, Flood	5-10 years	Design Engineering	RRCSD, State Water Resources Control Board

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.2.20	1	B	Conduct site specific geotechnical assessment of the portions of the RRCSD treatment plant that are within the very high or high liquefaction zone.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Facilitates potential future mitigation efforts, but does not in itself mitigate any hazard	Russian River CSD	Earthquake	5-10 years	Design Engineering	RRCSD, State Water Resources Control Board
2.1.27	1	B	Develop and implement a design strategy to mitigate the effects of embankment failure/landslides on portions of the Russian River CSD collection system that are in close proximity to creeks, drainage channels or steep slopes.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness	• Capital cost • Environmental impacts • Community impacts • Permitting challenges • Construction complexities • Extended implementation timeline	Russian River CSD	Earthquake, Flood	10+ years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.29	1	B	Develop and implement a design strategy to elevate and/or protect pump stations located in Russian River CSD from flood related damage.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Capital cost	Russian River CSD	Flood	10+ years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.16	2	A	Develop and implement an operational or design strategy to mitigate the effects of flooding for portions of the Airport-Larkfield-Wikiup SZ collection system subject to infiltration within areas of recurrent inundation or located within the 100-year floodplain.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	More study required for implementation	ALW SZ	Flood	0-5 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP
2.1.17	2	A	Develop and implement an operational or design strategy to mitigate the effects of wildfire at the Airport-Larkfield Wikiup SZ Lift Station.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Requires participation of other responsible parties • Limited Service Area benefit	ALW SZ	Fire	0-5 years	Operations & Maintenance	FEMA, Sonoma Water, CA NRA SRA, Cal FIRE, CA Fire Safe Council
2.1.18	2	A	Conduct corrosion assessment of Airport-Larkfield Wikiup SZ, Penngrove SZ, and Occidental CSD facilities located within areas of moderate to high corrosive soil conditions.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Low cost to assess	• Facilitates potential future mitigation, but does not itself mitigate hazard	ALW SZ, Penngrove SZ, Occidental CSD	Flood (Corrosion)	0-5 years	Energy Resources	FEMA planning, Sonoma Water
2.2.16	2	A	Seismically retrofit suspended ceiling over SCADA Control Room at RRCSD treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Can be completed within existing authority		Russian River CSD	Earthquake	5-10 years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.19	2	B	Develop and implement operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard for portions of the Penngrove SZ collection system crossing and/or adjacent to Lichau Creek and Owens Creek.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	Penngrove SZ	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.2.9	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard of portions of the Airport-Larkfield-Wikiup SZ recycled water system in the vicinity of the Mark West Creek and Woolsey Creek Crossing.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	ALW SZ	Earthquake	10+ years	Design Engineering	Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR
2.2.10	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of high to very high liquefaction hazard for portions of the Airport-Larkfield-Wikiup SZ recycled water system in the vicinity of Windsor Creek crossing.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of uncontrolled release of treated wastewater • Reduces asset damage	• Potential environmental impacts • Permitting challenges	ALW SZ	Earthquake	10+ years	Design Engineering	Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR
2.2.11	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of moderate liquefaction hazard at the Airport-Larkfield-Wikiup SZ treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• More study required for implementation • Technically Challenging	ALW SZ	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.1.21	2	B	Develop and implement an operational or design strategy to mitigate the ground deformation effects of liquefaction for portions of the collection system (including lift stations and related force mains) subject to moderate liquefaction hazard.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital Cost • Extended implementation timeline	All	Earthquake	10+ years	Design Engineering	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan)
2.2.12	2	B	Develop and implement an operational or design strategy to mitigate the increased precipitation effects and fire risk from climate change in all sanitation areas.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• High Cost • Long term goal	All	All	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Clean Water State Revolving Fund (loan), CA DWR IRWM & FERP, CA NRA SRA, Cal FIRE, CA Fire Safe Council
2.1.22	2	B	Assess the potential for ground rupture effects of the Alexander Fault on Geyserville SZ facilities.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Low cost to assess	Facilitates potential future mitigation, but does not itself mitigate hazard	Geyserville SZ	Earthquake	5-10 years	Design Engineering	FEMA planning, Sonoma Water
2.1.24	2	B	Develop and implement a design strategy to mitigate the effects of liquefaction on the Russain River CSD tertiary recycled water system.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Reduces water use • Improves risk awareness • Can be completed within existing authority	• Capital cost • Community impacts • Environmental impacts	Russian River CSD	Earthquake	10+ years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.33	2	B	Study potential for vacuum system in RRCSD collection system	New 2023 Action	Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater	• Capital cost • Community impacts • Environmental impacts	Russian River CSD	Flood	10+ years	Resource Planning	RRCSD, FEMA
2.1.28	2	B	Develop and implement a design strategy to mitigate the effects of high stream flows (e.g., erosion and debris flows) on portions of the Russian River CSD collection system at creek crossings where the burial depth is unknown and assumed shallow.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness	• Capital cost • Environmental impacts • Permitting challenges • Construction complexities • Extended implementation timeline	Russian River CSD	Flood	10+ years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	Sanitation Area	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
2.2.17	2	B	Develop and implement a design strategy to provide additional storage capacity at the RRCSD treatment plant to enhance operational ability for storage during and after a natural disaster while repairs are made to restore treatment capabilities.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Capital cost	Russian River CSD	All	10+ years	Design Engineering	RRCSD FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.2.21	2	B	Develop and implement a design strategy to upgrade the asphalt shingle/tar and gravel roofs at the RRCSD treatment plant to mitigate the effects of wild-land fire.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces asset damage • Can be completed within existing authority	• Capital cost	Russian River CSD	Fire	10+ years	Design Engineering	RRCSD, FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.2.19	2	B	Develop and implement a design strategy to mitigate the effects of landslides and debris flows at the RRCSD treatment plant.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Improves risk awareness • Can be completed within existing authority	• Capital cost	Russian River CSD	All	10+ years	Design Engineering	RRCSDm FEMA, State Water Resources Control Board, State Revolving Fund (loan)
2.1.36	2	B	Establish sanitation level planning	New 2023 Action	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Additional cost for development • Training required • Requires paricipation by other responsible parties	All	All	10+ years	Operations & Maintenance, Design Engineering, Resource Planning	Sonoma Water, RRCSD, FEMA
2.2.22	2	B	Establish long-term solution for Occidental CSD treatment plant	New 2023 Action	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater	• Capital cost	Occidental CSD	Flood	10+ years	Operations & Maintenance, Design Engineering, Resource Planning	Sonoma Water, RRCSD, FEMA
2.1.37	2	B	Establish property partnerships and ordinances to reduce sanitary sewer overflows	New 2023 Action	• Reduces service disruption • Reduces risk of releasing inadequately or untreated wastewater • Reduces asset damage	• Capital cost	All	Flood	10+ years	Operations & Maintenance, Design Engineering, Resource Planning	Sonoma Water, RRCSD, FEMA

***Potential Funding: External agencies and programs listed in this column are described in Section 6.2: Funding Sources, of the Sonoma Water LHMP.**

***Responsible Entity: Sections and Divisions listed in this column are shown in Appendix F: Sonoma Water Organizational Charts, of the Sonoma Water LHMP.**

2023 WATER SUPPLY AND TRANSMISSION MITIGATION ACTIONS

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.1.1	1	A	Continue to support Forecast Informed Reservoir Operations (FIRO) and its efforts to provide drought resilient planning.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Preserves water for fire fighting. Enhances drought resilience. Prolong water supply to service area through drought	Program Cost for development and upkeep	Supply	Flood	0-5 years	Resource Planning	Elements of this currently funded by NOAA Habitat Blueprint and Sonoma Water; potential future funding source includes USBR WaterSMART
1.1.2	1	A	Develop a modified hydrologic index to improve management of river flows and system storage.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Critical to overall water supply and reliability	Program Cost for development and upkeep	Supply	Flood	0-5 years	Resource Planning	Elements of this currently funded by NOAA and CDFW
1.1.3	1	A	Continue to support Advanced Quantitative Precipitation Initiative (AQPI) efforts to provide drought and flood resilient planning.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Critical to overall water supply and reliability	Program Cost for development and upkeep	Supply	Flood	0-5 years	Resource Planning	Elements of this currently funded by CA DWR IRWM and Sonoma Water, potential future funding source includes FEMA
1.1.4	1	A	Continue to research and pursue projects involved with aquifer storage and recovery.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Enhances drought resilience Prolong water supply to service area through drought	Program Cost for development and upkeep	Supply	All	0-5 years	Groundwater Resources	FEMA, CSCC, USBR WaterSMART, Sonoma Water
1.2.1	1	A	Develop and implement retrofit design for Collector 3 against liquefaction and lateral spread hazard.	In progress. From 2013 LHMP (was 1.2.1). Will be Maintained in 2023 LHMP	• Critical elements of system • Very high replacement cost • Avoiding loss of water supply • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Potential for impacting water quality	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.2	1	A	Develop and implement retrofit design for Collector 5 against liquefaction and lateral spread hazard.	In progress. From 2013 LHMP (was 1.2.1). Will be Maintained in 2023 LHMP	• Critical elements of system • Very high replacement cost • Avoiding loss of water supply • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Potential for impacting water quality	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.3	1	A	Develop and implement retrofit design for Collector 6 against liquefaction and lateral spread hazard.	In progress. Ffrom 2013 LHMP (was 1.2.1). Will be Maintained in 2023 LHMP	• Critical element of system • Highest production capacity • Avoiding significant loss of water supply • Very high replacement cost • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Potential for impacting water quality • Downtime during construction	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.4	1	A	Develop and implement design strategy to mitigate liquefaction and lateral spread hazard to the River Diversion Structure (RDS).	In progress. From 2013 LHMP (was 1.2.2). Will be Maintained in 2023 LHMP	• Critical element of system • High replacement cost • Minimizing risk of river diversion capability • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Water quality impact • Constructability constraints due to buried infrastructure	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.7.1	1	A	Develop and implement design or operational strategy to mitigate liquefaction and/or fire related damage to electric power lines feeding collectors and pump stations.	In progress. From 2013 LHMP (was 1.7.1). Will be Maintained in 2023 LHMP	• Power availability critical for operations • Power loss will delay restoration time • Maintain safe drinking water to service area	• Emergency generators already located at key facilities • New redundant cable installed • Post-earthquake repair of overhead lines can restore power relatively quickly	Supply	Earthquake, Fire	0-5 years	Design Engineering	FEMA, Sonoma Water, CNRA SRA Fund, CA Fire Safe Council, PG&E, SWRCB Drinking Water Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.7.2	1	A	Develop a design or operational strategy to maintain communications and auxiliary power at all Water Supply Tanks and booster stations in the event of fire damage. Develop a design for additional infrastructure for redundancy and reliability of communication system.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Necessary for remote operations of critical facilities • Improves water supply reliability • Reduces reliance on field staff for on site operations and data collection • Maintain reliable drinking and fire fighting water to service area	• Capital Costs • Additional Maintenance Costs	Transmission	Earthquake, Fire	0-5 years	Design Engineering	FEMA, Sonoma Water, CNRA SRA Fund, CA Fire Safe Council, PG&E, SWRCB Drinking Water Revolving Fund (loan)
1.1.5	1	A	Provide operational capability to minimize uncontrolled release by controlling flows out of Agency facilities with automated throttling valves on the Santa Rosa Aqueduct, Cotati intertie, and Wohler Forestville Intertie.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain reliable drinking water to service area	Capital cost	Transmission	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.12	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Russian River crossing on the Wohler-Mirabel Intertie.	New 2023 Action	• Preventing catastrophic failure of Santa Rosa Aqueduct • Avoiding loss of water to a large population • Preventing erosion of environmentally sensitive area	• Capital costs • Construction in riparian habitat • Difficult construction due to pipe depth • Potential for impacting aquifer water quality	Transmission	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water
1.3.13	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Willow Brook Creek crossing of the Petaluma Aqueduct.	New 2023 Action	• Preventing catastrophic failure of Petaluma Aqueduct • Avoiding loss of water to large population • Preventing erosion of environmentally sensitive area	• Capital costs • Construction in riparian habitat • Difficult construction due to pipe depth • Difficult construction due to access from private land	Transmission	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water
1.2.8	1	A	Develop and implement retrofit design for Collector 1 against liquefaction and lateral spread hazard.	New 2023 Action	• Critical elements of system • Very high replacement cost • Avoiding loss of water supply • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Potential for impacting water quality	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.9	1	A	Develop and implement retrofit design for Collector 2 against liquefaction and lateral spread hazard.	New 2023 Action	• Critical elements of system • Very high replacement cost • Avoiding loss of water supply • Maintain safe drinking water to service area	• Capital costs • Technically challenging retrofit options • Potential for impacting water quality	Supply	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.4.2	1	A	Assess impact of Spring Creek Bennett Valley fault rupture on Sonoma Booster Station, and develop and implement a design or operational solution to mitigate the fault rupture hazard.	In Progress. From 2013 LHMP (was 1.4.4). Will be Maintained in 2023 LHMP.	• Critical pump station • Maintain reliable drinking water to service area • Emergency response planning • Reducing restoration time • Determining the system vulnerabilities within assessment area	• Storage logistics, staff training • Capital cost • Ongoing maintenance and checking of operational reliability • Cost to study	Transmission	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.4.3	1	A	Develop and implement seismic retrofit design or replacement of the Wilfred booster station building.	In Progress from 2013 LHMP (was 1.4.3). Will be Maintained in 2023 LHMP.	• Post event repair costs • Diversion of staff from other critical tasks following a major event • Relatively small retrofit costs	• Not critical for system operation when Kawana Booster Station is operational	Transmission	Earthquake	0-5 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.3	1	A	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Santa Rosa Creek crossing.	In Progress. From 2013 LHMP (was 1.3.2). Will be Maintained in 2023 LHMP.	• Avoiding loss of water to large population • Located in populated area, reducing risk of seismic risks	• Liquefaction hazard is Medium to high • Capital costs	Transmission	Earthquake	0-5 years	Design Engineering	FEMA HMGP
1.5.1	1	A	Perform piping retrofit by replacing existing rigid piping with piping with flexible joints at the storage reservoirs.	In Progress. From 2013 LHMP (was 1.5.1). Will be Maintained in 2023 LHMP.	• Reduce risk of loss of storage capacity • Minimizing risk of erosion due to water release • Relatively low cost retrofit	• Capital cost	Storage	Earthquake	0-5 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.3.4	1	A	Implement cathodic protection system improvements to the Santa Rosa and Russian River-Cotati Intertie aqueducts to mitigate corrosion hazard and extend the resilient life of those facilities.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Maintain safe and reliable drinking water to service area • Prevent damage to facilities within influence of corrosion	• Capital costs	Transmission	Flood (Corrosion)	0-5 years	Design Engineering	Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.8.5	1	A	Coordinate with Army Corps of Engineers to support its efforts to address operational reliability of the outlet works at Warm Springs Dam.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Maintain safe and reliable drinking water to service area • Reduce risk of loss of storage capacity and/or hydroelectric power production	• Work and implementation not controlled by Sonoma Water • Capital Cost	Supply	Flood	0-5 years	Resource Planning, Operations & Maintenance	ACOE
1.6.4	1	A	Coordinate with PG&E to identify locations, where buried electrical and high pressure gas lines overlap water transmission system.	New 2023 Action	• Critical to overall water transmission and delivery	• Work and implementation not controlled by Sonoma Water	Transmission	All	0-5 years	Design Engineering, Emergency Response	FEMA, Sonoma Water, CalOES
1.3.14	1	A	Conduct site specific geotechnical assessment of the portions of the water transmission system that are within the mostly and many historic landslide occurrence zones.	New 2023 Action	• Critical to overall water transmission and delivery	• Landslide hazard is Medium to high • Capital costs	Transmission	All	0-5 years	Design Engineering, Emergency Response	FEMA, Sonoma Water, CalOES
1.8.1	1	B	Design and implement mitigation schemes for reducing the potential of flood damage to the well fields, collector wells, and caissons in the Mirabel, Wohler, and Laguna de Santa Rosa areas.	No progress. From 2013 LHMP (was 1.8.3). Will be Maintained in 2023 LHMP.	• Redundancy in water supply • Cost of post-event repair • Enhance system resilience and provide safe drinking water to service area during flooding	• Capital Cost	Supply	Flood	5-10 years	Design Engineering, Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.5	1	B	Develop a design strategy and operational plan to address flooding at the Mirabel facility.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Preserves fresh water for the community • Eliminates the need to dredge infiltration ponds	• Maintained access and facilities through a flood.	Supply	Flood	5-10 years	Design Engineering, Operations & Maintenance	Elements of this currently funded by FEMA PA Hazard Mitigation; potential future funding sources include Sonoma Water, SWRCB Drinking Water Revolving Fund (loan) & , CA DWR , WCB
1.10.1	1	B	Work with the U.S. Army Corps of Engineers to expedite the earthquake safety assessment of Warm Springs and Coyote Valley dams; and reassessment of these under the revised Probable Maximum Flood conditions as impacted by the Probable Maximum Precipitation study.	No progress. From 2013 LHMP (was 1.11.1 and 3.1.2). Will be Maintained in 2023 LHMP.	• Important element of flood control and fish population • Critical storage in droughts	• Cost to study • Responsibility with the U.S. Army Corps • Long-term effort	Supply	Earthquake, Flood	5-10 years	Resource Planning	USACE, Sonoma Water
1.8.2	1	B	Conduct assessment of vegetation around Lake Sonoma and Lake Mendocino for potential vegetation management projects that will protect water quality and storage from fire.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Critical to overall water supply quality and reliability	• Cost to study • Project implementation cost	Supply	Fire	5-10 years	Operations & Maintenance	FEMA planning, Sonoma Water, CalFIRE, PG&E

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.2.6	1	B	Develop and implement an operational and design strategy to mitigate against potential fire damage to Mirabel and Wohler facilities. Include consideration of removing debris, trees, or other fire-hazard materials; installing fire resilient building materials; and modifying treatment processes to accommodate water quality changes.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain safe drinking water to service area	• Cost to study • Project implementation cost	Supply	Fire	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, CA DWR , CA NRA SRA Fund, CalFIRE, CA Fire Safe Council, CDFW
1.1.6	1	B	Develop a design or operational strategy to respond to unexpected pipeline damage within the Wohler-Mirabel area from liquefaction.	No progress. From 2013 LHMP (was 1.3.6). Will be Maintained in 2023 LHMP.	• Critical for emergency preparedness and response plan • Likelihood of damage is high because of high liquefaction hazard • Maintain safe drinking water to service area	• Cost to study • Project implementation cost	Supply	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.5	1	B	Develop plans to relocate pipeline that crosses beneath the Spring Lake and the Spring Lake dam.	In Progress. From 2013 LHMP (was 1.3.5). Will be Maintained in 2023 LHMP.	• Maintain reliable drinking water to Sonoma Valley and Eastern Santa Rosa Area. • Protect from potential Erosion/environmental impact from failure	• Cost of retrofit because of access • New pipeline under consideration	Transmission	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.6	1	B	Develop and implement an operational or design strategy to mitigate fault rupture hazard to the aqueducts that cross the Bennett Valley fault.	In Progress. From 2013 LHMP (was 1.3.1). Will be Maintained in 2023 LHMP.	• Maintain safe and reliable drinking water to service area • Catastrophic damage to Santa Rosa Aqueduct • Potential damage to Ralphine tanks • Catastrophic damage to Sonoma Booster Station	• Lack of specific information on the fault • Requires long-term study of fault • Cost to study • Project implementation cost	Transmission, Storage	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.7	1	B	Develop and implement an operational or design strategy to mitigate the liquefaction and lateral spread hazard at the Petaluma River crossing.	No Progress. From 2013 LHMP (was 1.3.2). Will be Maintained in 2023 LHMP.	• Reduce risk of damage to aqueduct • Reduce environmental impact from release of chlorinated water into Petaluma River • Reducing the potential of loss of water supply to MMWD	• Repair requires construction within the river • Capital costs • Construction in riparian habitat	Transmission	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.8	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Calabasas Creek crossing.	In Progress. From 2013 LHMP (was 1.3.2). Will be Maintained in 2023 LHMP.	• Reduce risk of damage to aqueduct • Reduce risk of environmental impact from release of chlorinated water into Calabasas Creek • Reducing the potential of water supply loss to City of Sonoma	• Capital cost • Repair requires construction within the creek • Construction in riparian habitat	Transmission	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.9	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Lawndale and Madrone Road crossings of Sonoma Creek.	No Progress. From 2013 LHMP (was 1.3.3). Will be Maintained in 2023 LHMP.	• Reduce risk of damage to aqueduct • Reduce risk of environmental impact from release of chlorinated water into Sonoma Creek • Reducing the potential of water supply loss to City of Sonoma	• Above ground crossing, relatively easy to do post-earthquake repair • Capital Cost	Transmission	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.3.10	1	B	Develop and implement design strategy to mitigate the liquefaction and lateral spread hazard at the Verano Avenue crossing of Sonoma Creek.	No Progress. From 2013 LHMP (was 1.3.3). Will be Maintained in 2023 LHMP.	• Reduce risk of damage to aqueduct • Reduce risk of environmental impact from release of chlorinated water into Sonoma Creek • Reducing the potential of water supply loss to City of Sonoma • Mitigating bridge vulnerability would be an added benefit	• Above ground crossing easy to repair • Pipeline also impacted by bridge vulnerability • Capital Cost	Transmission	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.5.2	1	B	Implement other retrofits such as removing overconstrained conditions at storage reservoirs identified in the natural hazard reliability study.	In Progress. From 2013 LHMP (was 1.5.2). Will be Maintained in 2023 LHMP.	• Reduce risk of damage to tank piping • Reduce risk of water loss • Low cost measure	• Capital Cost	Storage	Earthquake	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.9.1	1	B	Conduct a detailed seismic vulnerability assessment of structural and non-structural elements of the Agency's administrative facilities.	No Progress. From 2013 LHMP (was 1.9.1). Will be Maintained in 2023 LHMP.	• Key administration building • Facility houses most of the staff and decision makers	• Relatively new facility	All	Earthquake	5-10 years	Design Engineering	FEMA planning, Sonoma Water
1.7.5	1	B	Design and construct a new 12-kV electrical feeder for the Mirabel facilit ies which reduces risk due to seismic, fire and flood hazards.	New 2023 Action	Maintain reliable drinking water to service area	• Capital Cost	Supply	All	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.8.3	2	A	Assess potential damage to Sonoma Water infrastructure in the event of Warm Springs and/or Coyote dam failure.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain safe drinking water to service area	Program Development Cost and Improvement Cost	Supply	Flood	0-5 years	Resource Planning	USACE, FEMA planning, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.1.8	2	A	Improve secondary water quality in the Todd Road, Sebastopol, and Occidental Wells to provide additional water supply in the event that one of the Caissons is damaged by flood, drought, or earthquake.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Provide drinking water supply redundancy to mitigate loss of other sources	Cost to rehabilitate	Supply	Earthquake, Flood	0-5 years	Operations & Maintenance	Sonoma Water, SWRCB Drinking Water Revolving Fund (loan), CA DWR , USBR WaterSMART, FEMA
1.3.11	2	A	Develop a long term strategy to address lower probability damage to transmission system pipelines.	In progress. From 2013 LHMP (was 1.3.7). Will be Maintained in 2023 LHMP.	• Emergency response planning • Reducing restoration time	• Long-term planning effort • Damage detection • Ongoing effort	Transmission	All	0-5 years	Operations & Maintenance	FEMA planning, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.1.10	2	A	Work with the United States Geological Survey (USGS) to design and conduct a detailed geologic study of Bennett Valley and Rodgers Creek faults to more accurately define the fault activity, paleoseismic history, rupture zone, and extent of surface rupture.	In Progress. From 2013 LHMP (was 1.10.1). Will be Maintained in 2023 LHMP.	• Critical to understanding of hazards to system • Critical to planning for future system upgrades	• Long-term goal • Research funding mechanism • Establishing priority of work with the USGS	Transmission	Earthquake	0-5 years	Design Engineering	USGS, Sonoma Water
1.7.4	2	A	Assess sufficiency of standby power at administrative buildings and Sonoma Water EOC, and develop design strategy to ensure core functions are maintained in the event of a power failure.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain communication capability with emergency staff at administrative facilities	• Ongoing maintenance • Equipment depreciation	All	All	0-5 years	Operations & Maintenance	FEMA, Sonoma Water, PG&E, USBR WaterSMART, SWRCB Drinking Water Revolving Fund (loan)
1.6.1	2	A	Conduct first responder training of a broad pool of Agency's personnel to respond in an emergency.	In Progress. From 2013 LHMP (was 1.6.2). Will be Maintained in 2023 LHMP.	• Emergency preparedness • Reduce service restoration time • FEMA fuding requirement	• Long-term commitment with refresher training • Costs for staff time in formal FEMA approved courses can be high	All	All	0-5 years	Emergency Response	FEMA, CalOES, Sonoma Water
1.1.11	2	A	Provide seismic restraints to electrical and communication equipment at various facilities.	In Progress. From 2013 LHMP (was 1.1.3). Will be Maintained in 2023 LHMP.	• Low cost high return measure • Expedites system recovery efforts • Allows staff to focus on major damage	• Ongoing effort as part of maintenance • Large number of small pieces of equipment	All	Earthquake	0-5 years	Operations & Maintenance	FEMA, Sonoma Water
1.4.4	2	B	Develop and implement design or operational strategy to mitigate lateral spread damage to the Wohler-Mirabel Intertie.	In progress. From 2013 LHMP (was 1.3.4)	• Provides redundancy to system operations • Crosses high vulnerability lateral spread zone • Reducing erosion/environmental damage from uncontrolled release of water	• Capital costs • Construction in riparian habitat	Supply	Earthquake	5-10 years	Design Engineering	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.8.4	2	B	Assess vulnerability of Russian River supply upstream of the Russian River aquifer to contamination from earthquake and non-earthquake induced landslides, wildland fire, and resulting post-fire erosion, especially to Lake Sonoma and Lake Mendocino water supply sources.	In progress. From 2013 LHMP (was 1.8.1 and 1.8.2). Will be Maintained in 2023 LHMP.	• Critical to overall water supply quality and reliability	• Long-term planning effort • Identification/planning for supply redundancy • Costs/water rights • Landslide mitigation efforts	Supply	Earthquake, Fire	5-10 years	Resource Planning	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan), PG&E, CA Geological Survey
1.10.2	2	B	Conduct a detailed seismic vulnerability assessment of electric power station at the Warm Springs dam.	No progress. From 2013 LHMP (was 1.11.2).	• Source of revenue for the Sonoma Water • Provides a renewable source of power	• Cost to study • Responsibility with the U.S. Army Corps • Long-term effort	Supply	Earthquake	5-10 years	Design Engineering	FEMA planning, Sonoma Water, USACE
1.9.3	2	B	Develop operational strategy to maintain water collection and pumping plant in the event that Wohler Bridge is damaged by earthquake, flood, or landslide.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain safe drinking water to service area	• Cost to study • Project implementation cost	Supply	Earthquke, Flood	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan)
1.2.7	2	B	Develop and implement an operational and design strategy to mitigate against turbid water at Collector 5 from burn area runoff due to this being the only collector under the influence of surface water during certain flow levels.	New 2023 Action	Maintain safe drinking water to service area	• Cost to study • Project implementation cost	Supply	Fire	5-10 years	Operations & Maintenance	Sonoma Water, USBR WaterSMART, SWRCB Drinking Water Revolving Fund (loan), PG&E
1.1.12	2	B	Plan, design and add redundant/emergency supply sources to minimize dependence on the Russian River aquifer as the main source of water supply. Install new emergency ground water wells located strategically throughout the system (assumed three locations).	In progress. From 2013 LHMP (was 1.1.2). Will be Maintained in 2023 LHMP.	• Emergency supply • Addition of redundancy to the system • Alternate source of water supply • Provide drinking water supply redundancy to mitigate loss of other sources	• Acquisition of new easement • Water quality/blending issues • City of Santa Rosa already considering an action • Capital costs	Supply	All	5-10 years	Resource Planning	CA DWR, USBR WaterSMART, FEMA, Sonoma Water
1.1.13	2	B	Assess backwater culverts at Mirabel facility and consider remote operation of their valves.	No progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	Maintain infiltration ponds for reliable source of drinking water during peak demands	• Cost to study • Project implementation cost	Supply	Flood	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, SWRCB Drinking Water Revolving Fund (loan), CA DWR
1.6.2	2	B	Procure, or contract for, a mobile EOC and Communication trailer.	In Progress. From 2013 LHMP (was 1.6.4). Will be Maintained in 2023 LHMP.	• Part of emergency response planning • Provides redundancy and portability • Leasing during emergencies reduces cost and maintenance of ownership	• Cost • Training and logistics • Long-term storage and maintenance, if owned	All	All	5-10 years	Emergency Response	FEMA, CalOES, Sonoma Water
1.5.3	2	B	Develop larger and more redundant storage facilities to minimize future water supply issues due to increased variability in supply and likely increased demand, which may stress existing conveyance, pumping, and storage systems.	In progress. From 2018 LHMP. Will be Maintained in 2023 LHMP.	• Provide drinking water supply redundancy to mitigate loss of other sources	• Capital Cost	Storage	Flood, Fire	5-10 years	Design Engineering	CA DWR, USBR WaterSMART, FEMA, Sonoma Water
1.1.14	2	B	Develop a GPS based system map with real-time monitoring at critical locations. For example, significant portions of the Agency's aqueducts run through large zones of undeveloped areas and pipe leaks in such areas are hard to precisely locate.	In progress. From 2013 LHMP (was 1.1.5). Will be Maintained in 2023 LHMP.	• Critical emergency response • Critical for reducing post-event restoration time • Avoiding significant loss of water supply • Reducing environmental damage from uncontrolled release of water	• Ongoing effort • Long-term goal	All	All	5-10 years	Resource Planning	FEMA, Sonoma Water, USBR WaterSMART, SWRCB Drinking Water Revolving Fund (loan)
1.1.15	2	B	Install emergency manifolds at strategic locations to connect emergency hoses to Booster Stations. Utilize Capital Project planning process and planned Booster Station upgrades as a means to accomplish this.	No Progress. From 2013 LHMP (was 1.1.7). Will be Maintained in 2023 LHMP.	• Effective backup mechanism • Help with quick service restoration	• Capital costs • Security/vandalism • Potential for contamination	All	All	5-10 years	Operations & Maintenance	FEMA, Sonoma Water, USBR WaterSMART, SWRCB Drinking Water Revolving Fund (loan)

#	Tier	Priority	Action Description	Action Status	Benefits (Pros)	Costs (Cons)	System Function	Hazard Mitigated	Timeframe	Responsible Entity*	Potential Funding*
1.10.3	2	B	Develop standard project design criteria document for new construction (water system, sanitary system and flood protection system).	In Progress. From 2013 LHMP (was 1.11.3, 2.1.2 and 3.1.4). Will be Maintained in 2023 LHMP.	• Improving risk awareness across Sonoma Water staff • Incorporation of system reliability in long-term planning efforts starting from conceptual and planning stages of a project • Reducing the potential for costly future retrofits	• Long-term planning effort • Potential for confusion with project specific design criteria • Requires staff training and awareness education	All	All	5-10 years	Design Engineering	FEMA, Sonoma Water

Appendix C

PLACEHOLDER

Proof of Stakeholder and Public Outreach

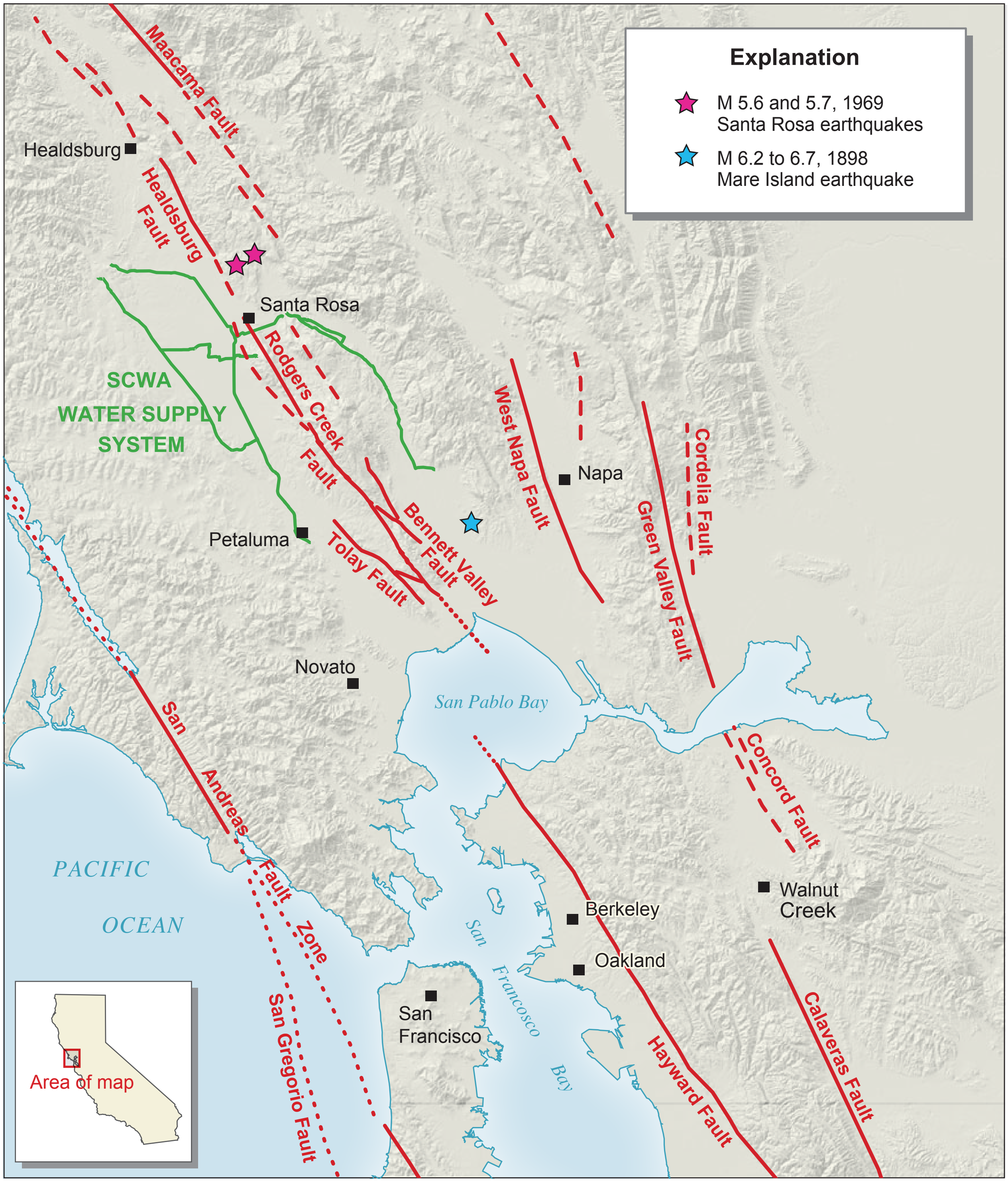
Appendix D

PLACEHOLDER

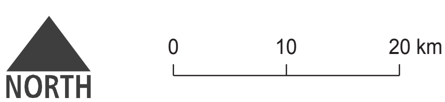
Internal Meetings

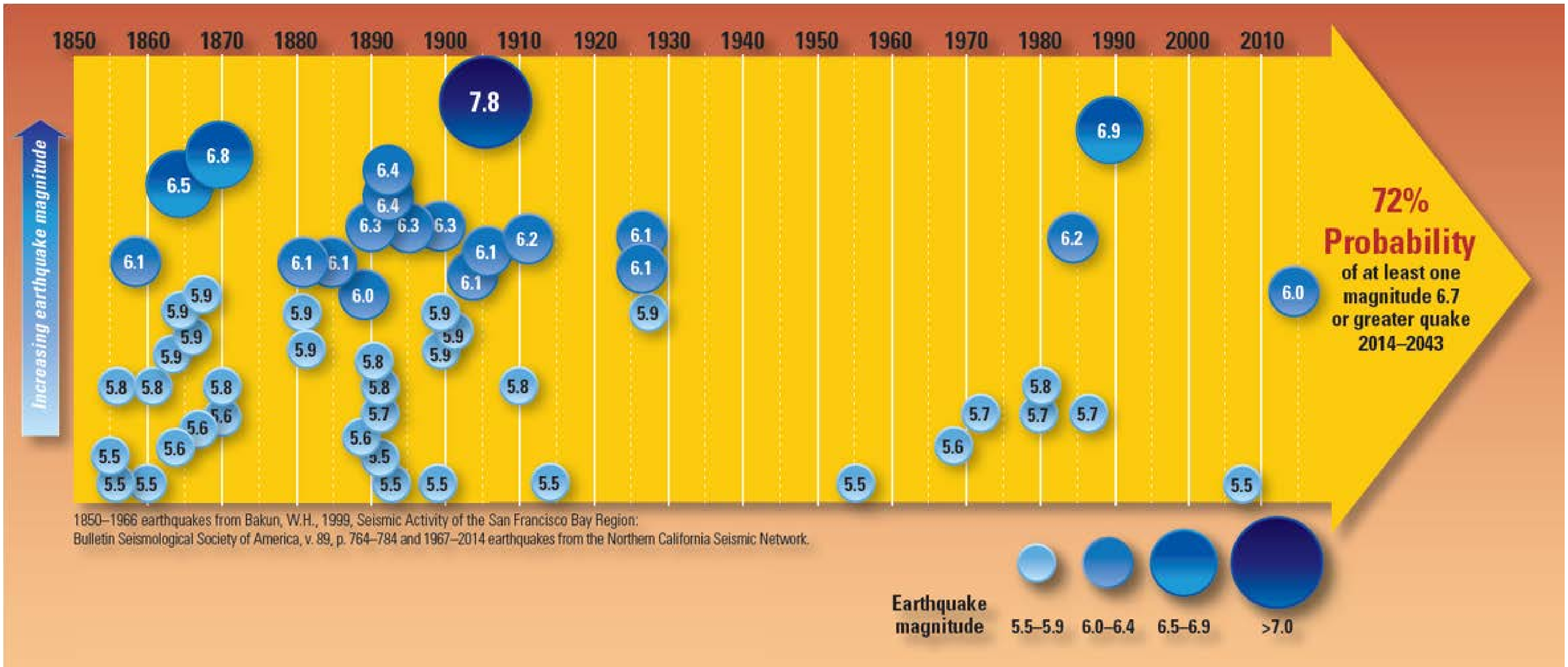
Appendix E

Figures



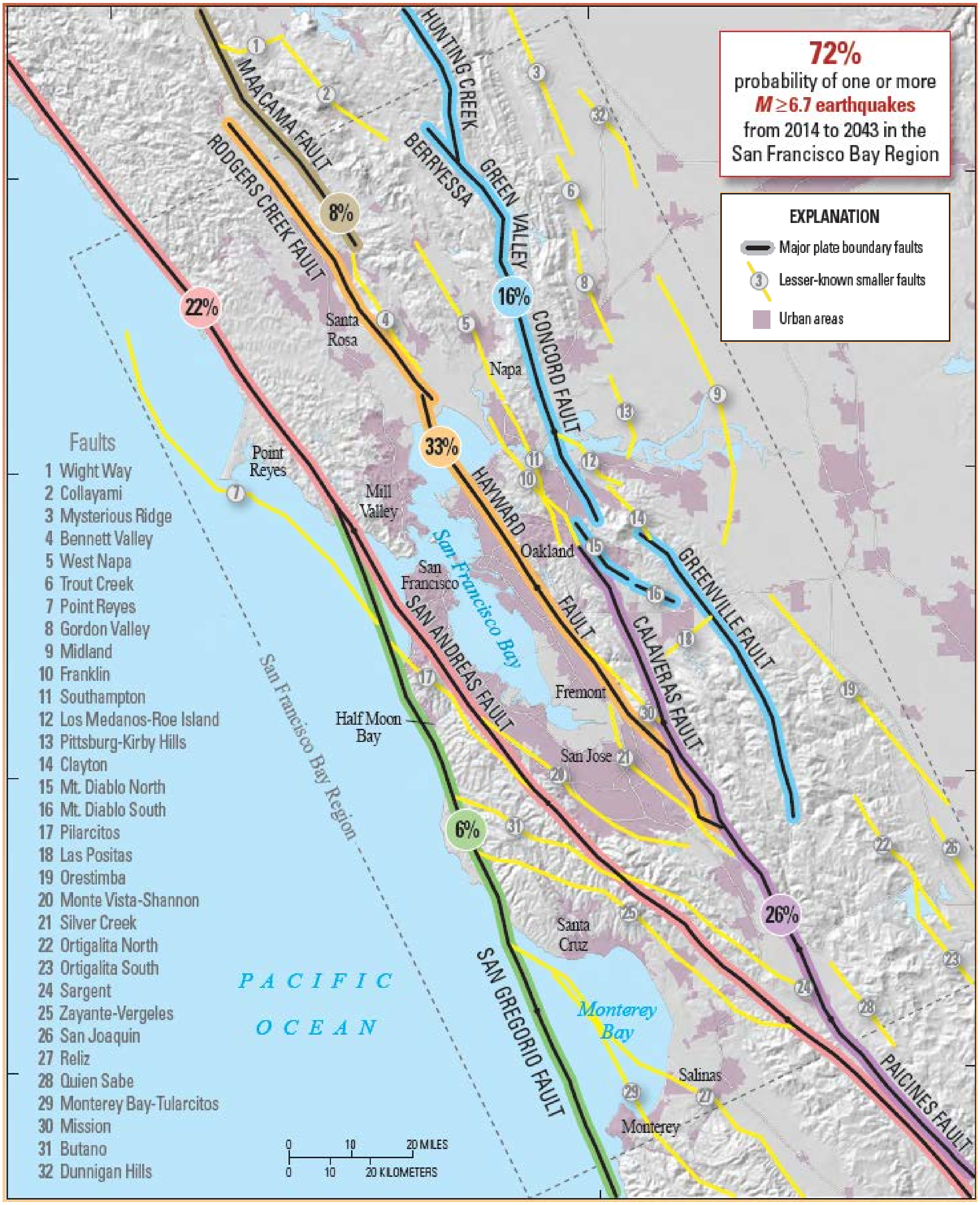
Faults modified from Jennings (1994)





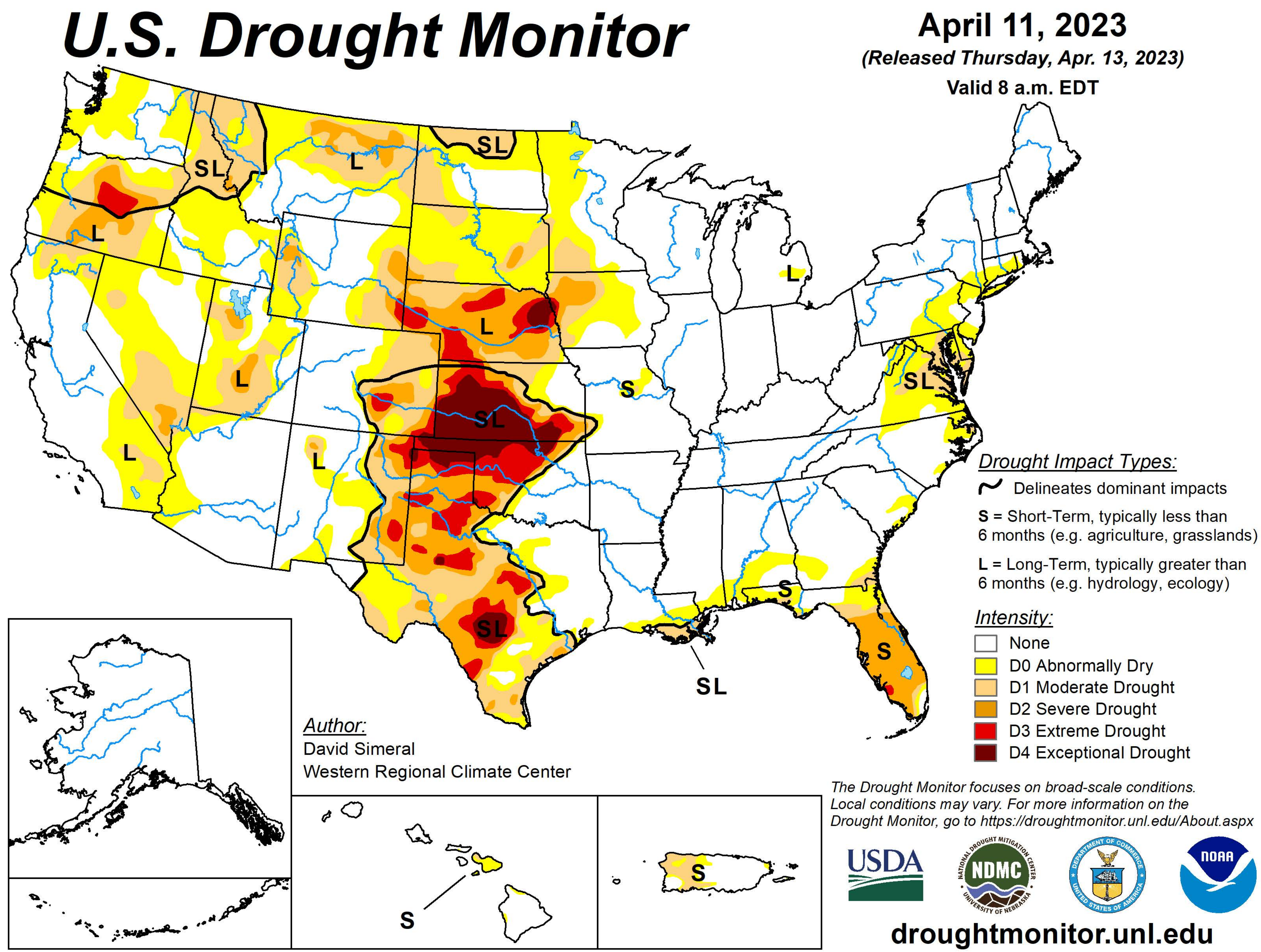
Historic Earthquakes in the Bay Area

Figure 2



72%
probability of one or more
M ≥6.7 earthquakes
from 2014 to 2043 in the
San Francisco Bay Region
EXPLANATION
Major plate boundary faults
Lesser-known smaller faults
Urban areas
Faults
1 Wight Way
2 Collayami
3 Mysterious Ridge
4 Bennett Valley
5 West Napa
6 Trout Creek
7 Point Reyes
8 Gordon Valley
9 Midland
10 Franklin
11 Southampton
12 Los Medanos-Roe Island
13 Pittsburg-Kirby Hills
14 Clayton
15 Mt. Diablo North
16 Mt. Diablo South
17 Pilarcitos
18 Las Positas
19 Orestimba
20 Monte Vista-Shannon
21 Silver Creek
22 Ortigalita North
23 Ortigalita South
24 Sargent
25 Zayante-Vergeles
26 San Joaquin
27 Reliz
28 Quien Sabe
29 Monterey Bay-Tularcitos
30 Mission
31 Butano
32 Dunnigan Hills
MAACAMA FAULT
RODGERS CREEK FAULT
HUNTING CREEK
BERRYESSA
GREEN VALLEY
CONCORD FAULT
HAYWARD FAULT
CALAVERAS FAULT
GREENVILLE FAULT
SAN ANDREAS FAULT
SAN GREGORIO FAULT
PAICINES FAULT
8%
22%
16%
33%
6%
26%
Santa Rosa
Napa
Point Reyes
Mill Valley
San Francisco
San Francisco Bay
Oakland
Fremont
San Jose
Half Moon Bay
Santa Cruz
Monterey Bay
Salinas
Monterey
San Francisco Bay Region
PACIFIC OCEAN
0 10 20 MILES
0 10 20 KILOMETERS

Figure 3



Sonoma Water LHMP

U.S. Drought Monitor

NORTH

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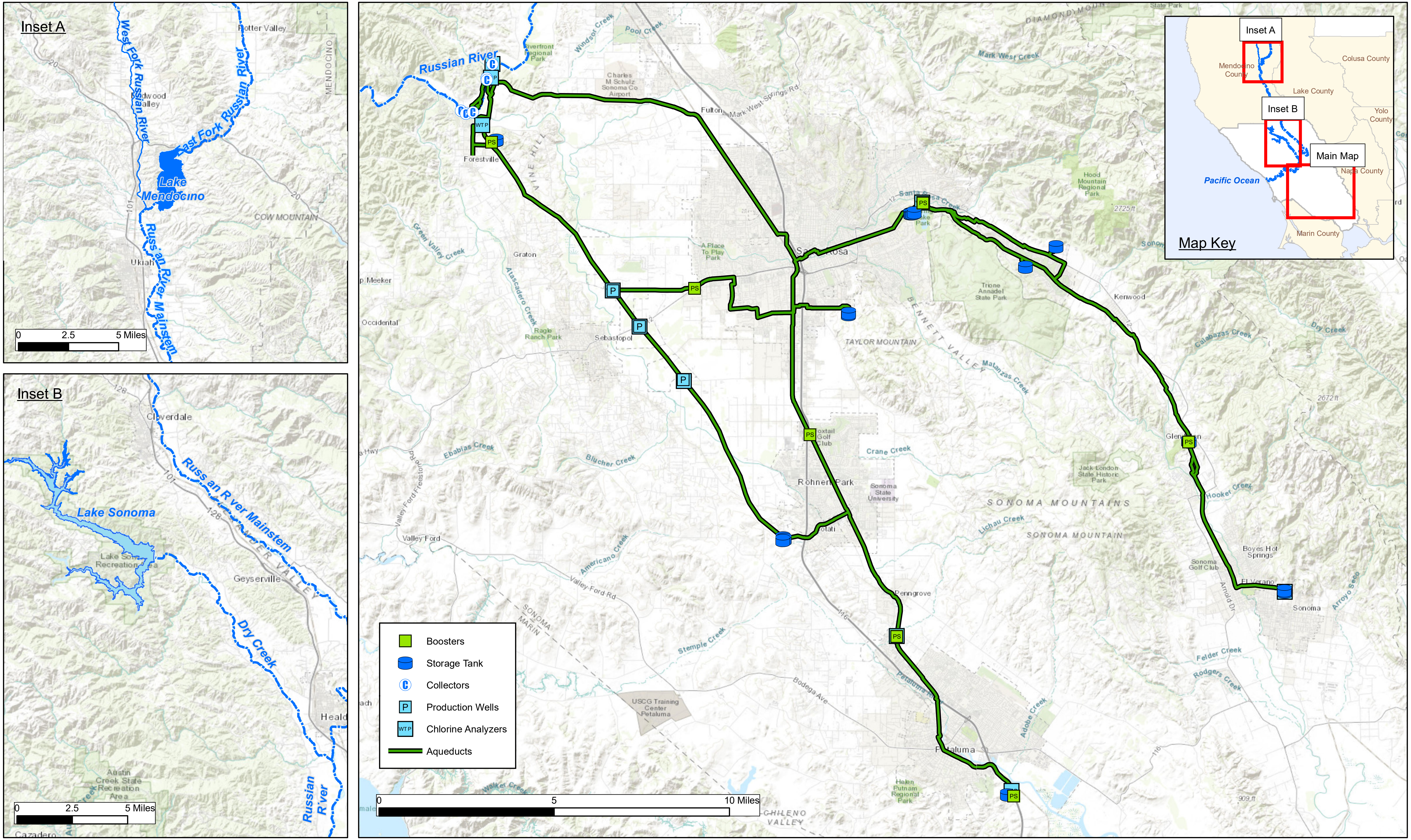
Sonoma Water

Figure 4



Sonoma Water LHMP

Water Supply and Transmission Facilities

NORTH

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Figure 5

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Sonoma Water LHMP

Water Supply and Transmission System - Power System

NORTH

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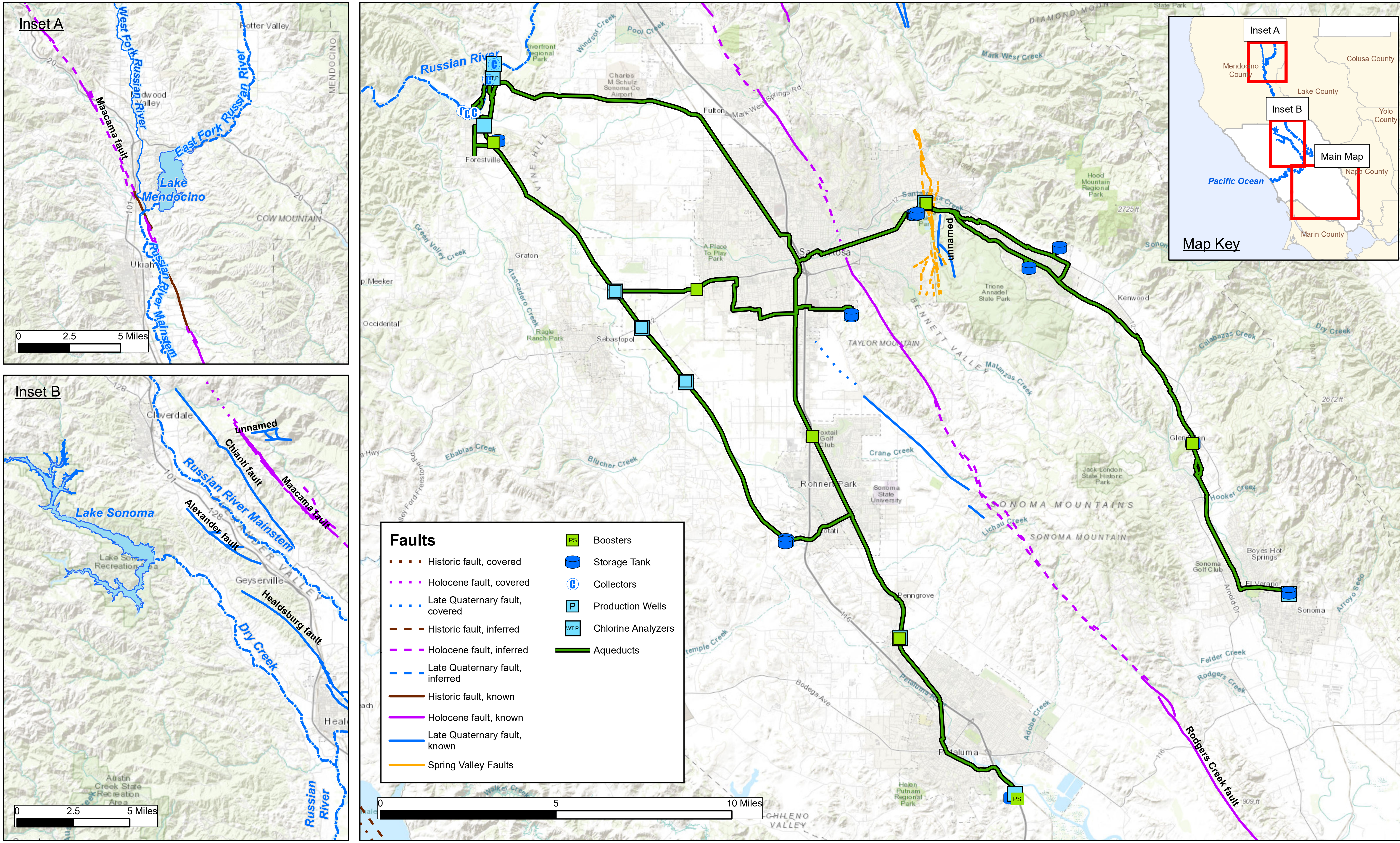
Figure 6



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Sonoma Water LHMP

Water Supply and Transmission System - Fault Hazard

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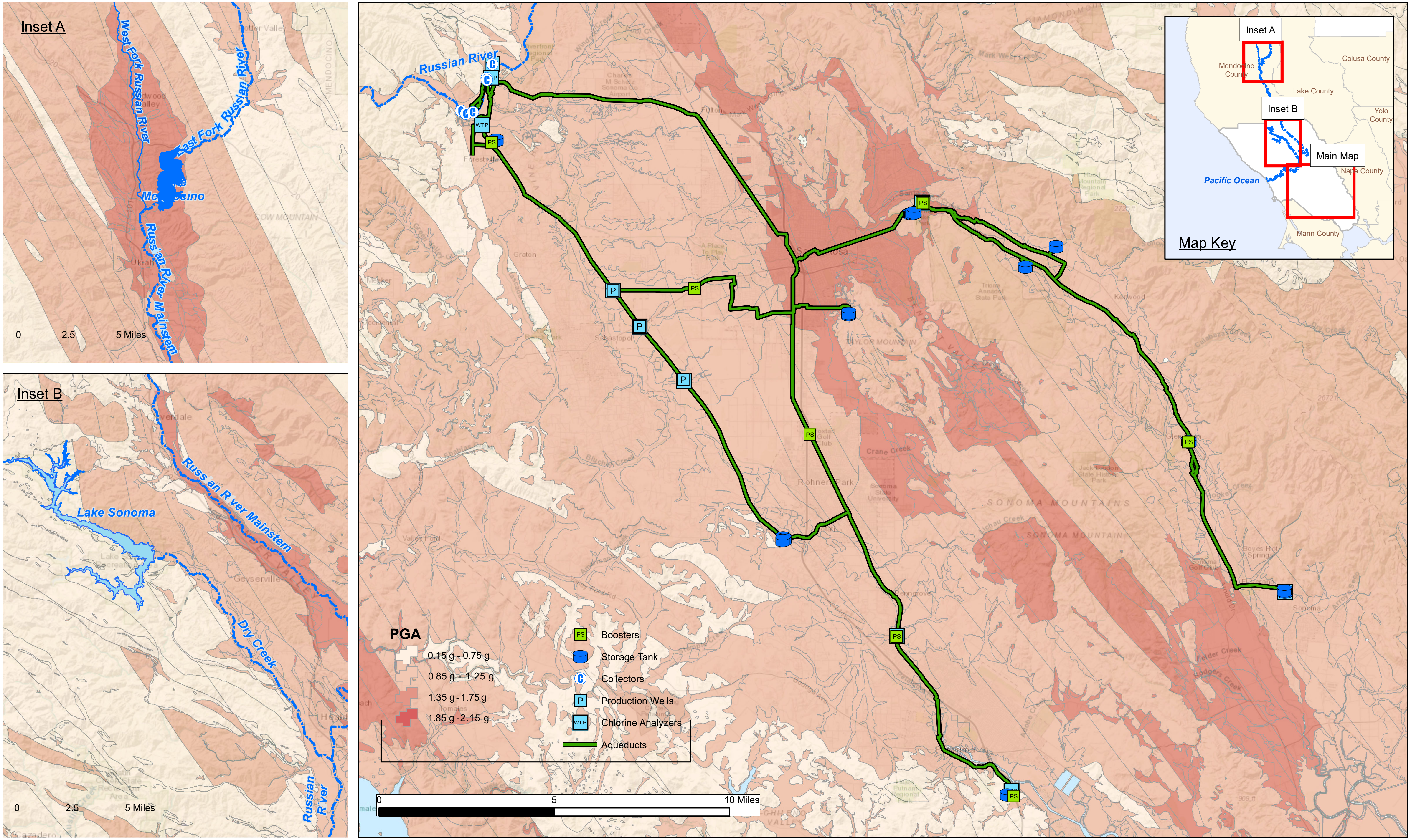
Figure 7



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Sonoma Water LHMP

Water Supply and Transmission System - Ground Shaking Hazard

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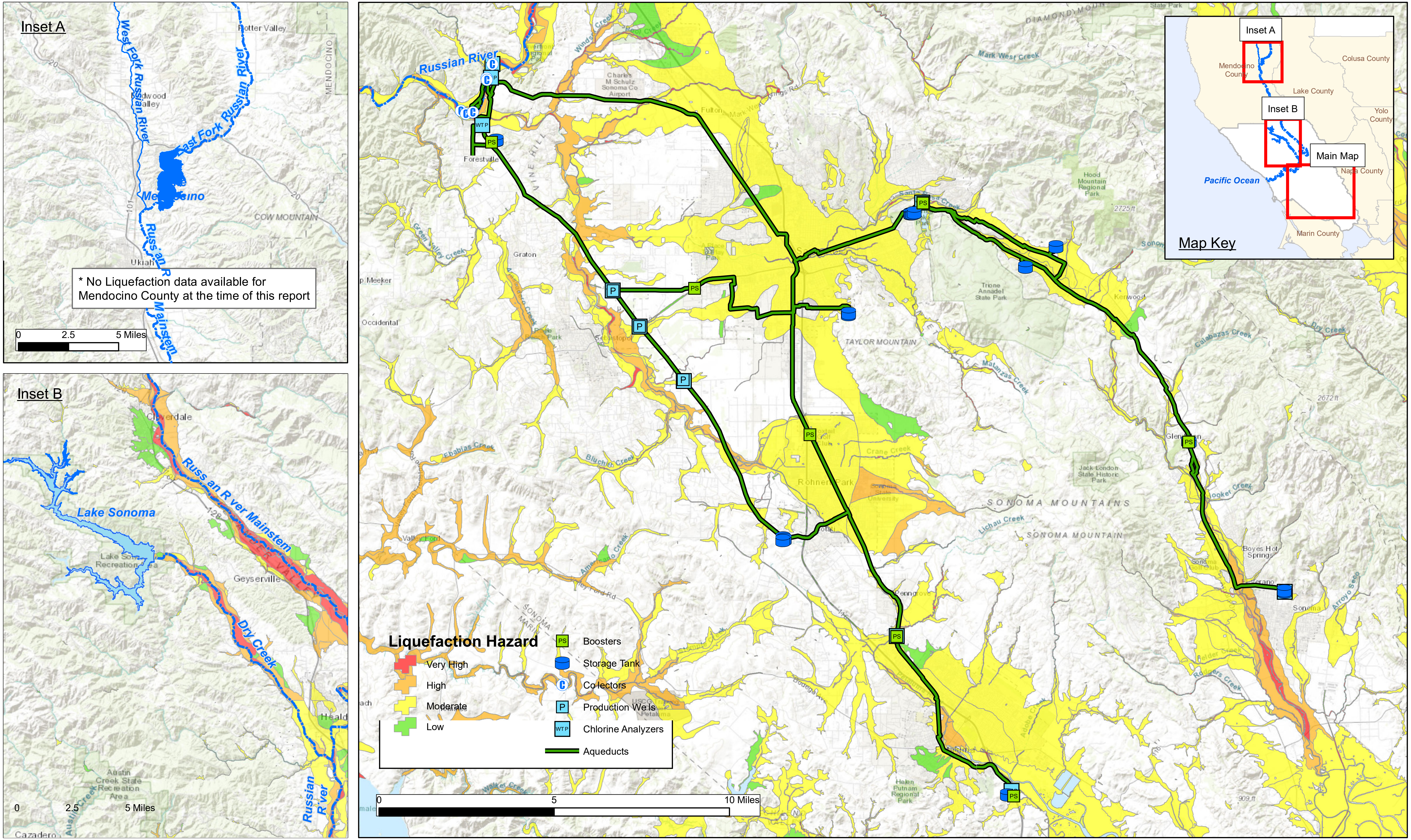
Figure 8



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Sonoma Water LHMP

Water Supply and Transmission System - Liquefaction Hazard

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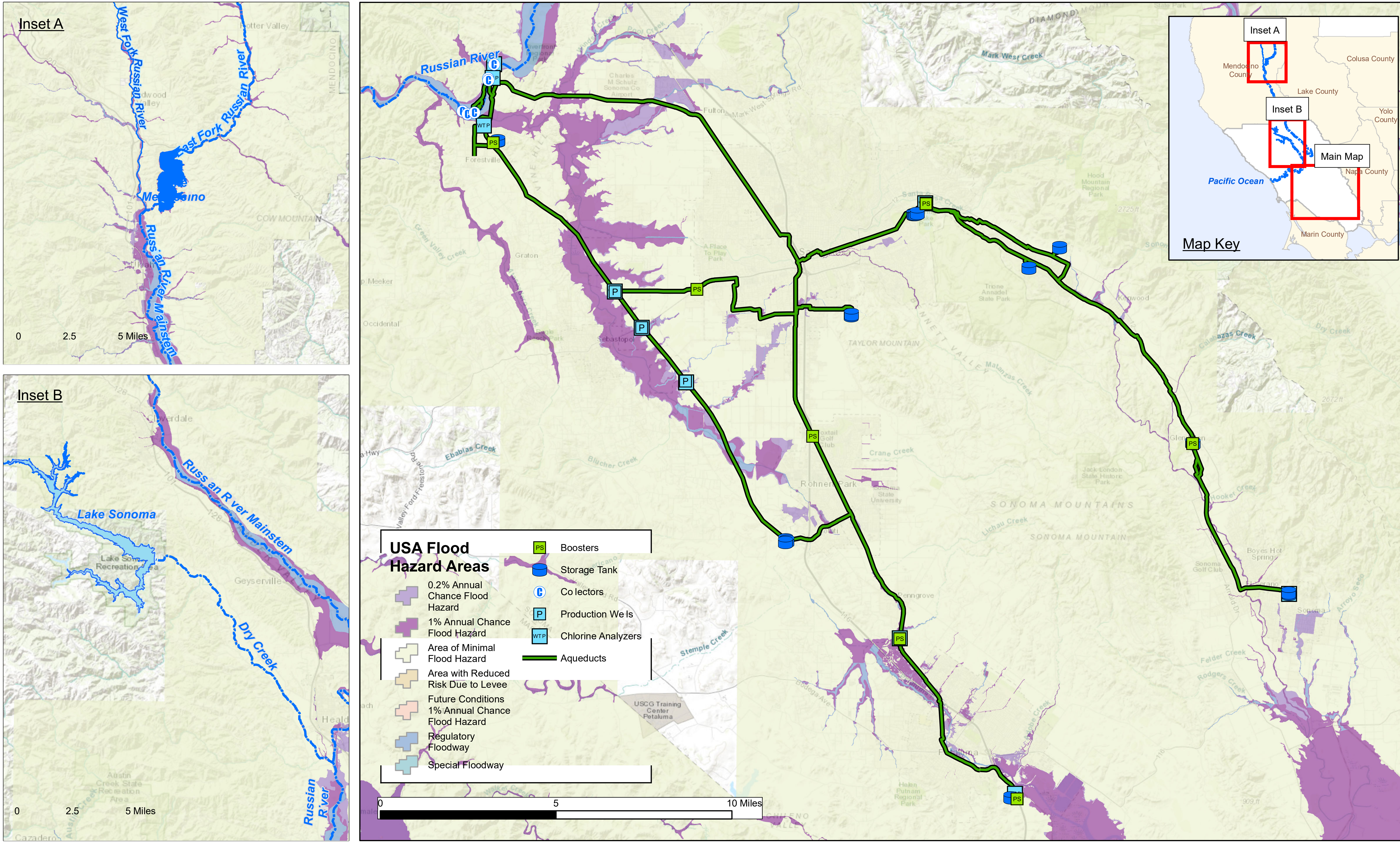
Figure 9



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Sonoma Water LHMP

Water Supply and Transmission System - Flood Hazard

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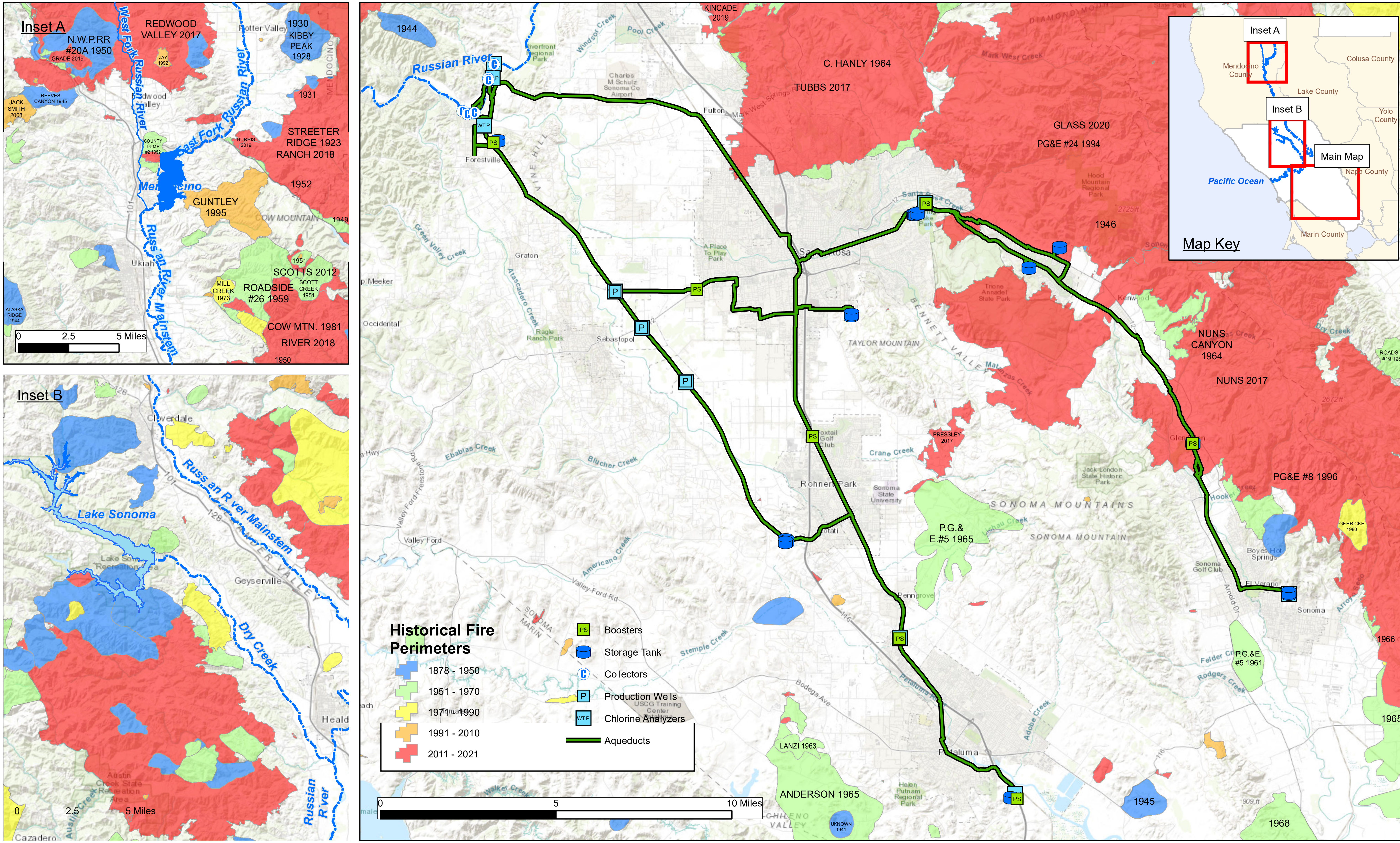
Figure 10



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Sonoma Water LHMP

Water Supply and Transmission System - Historic Fire Hazard

NORTH

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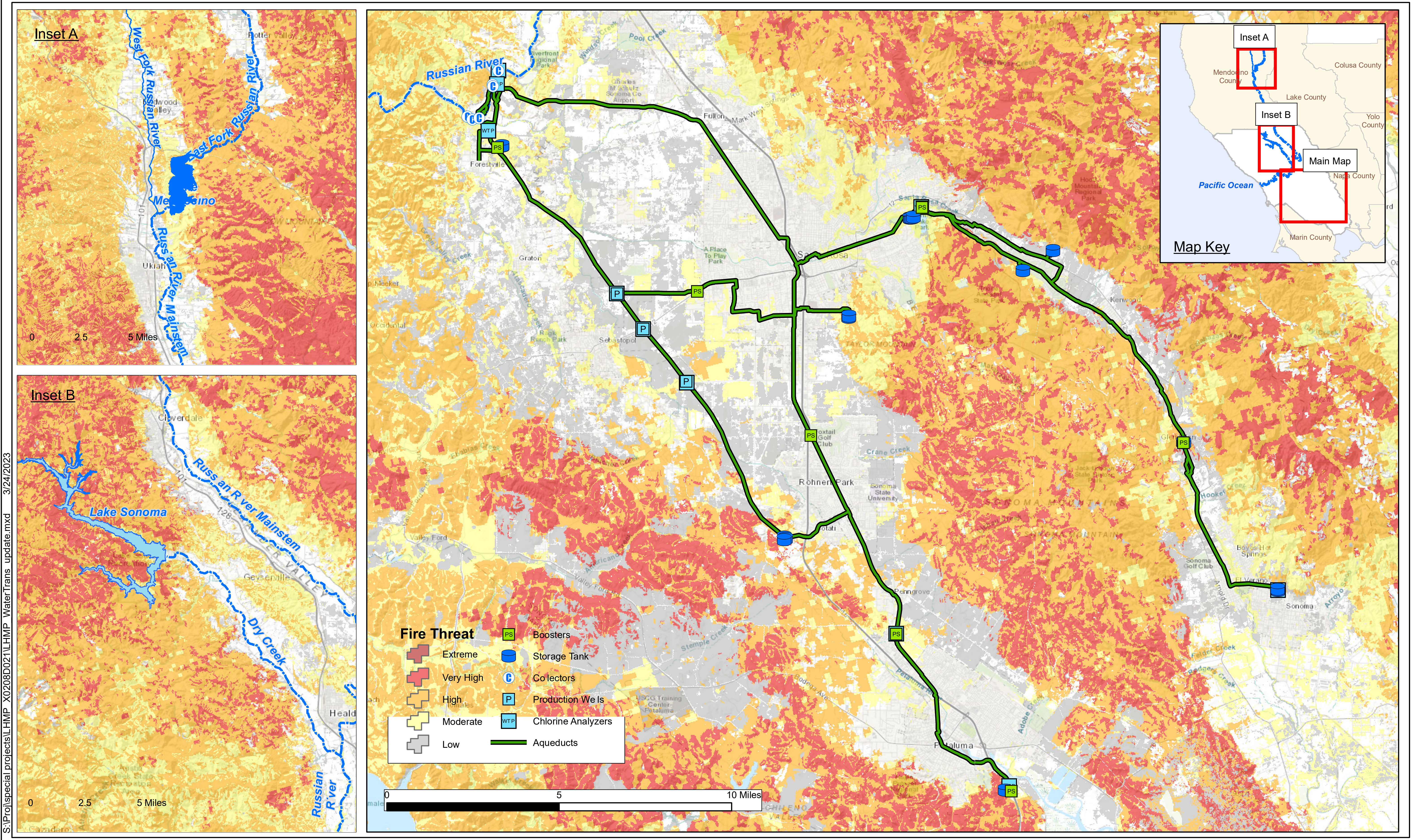
Figure 11



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Sonoma Water LHMP

Water Supply and Transmission System - Fire Threat Hazard

NORTH

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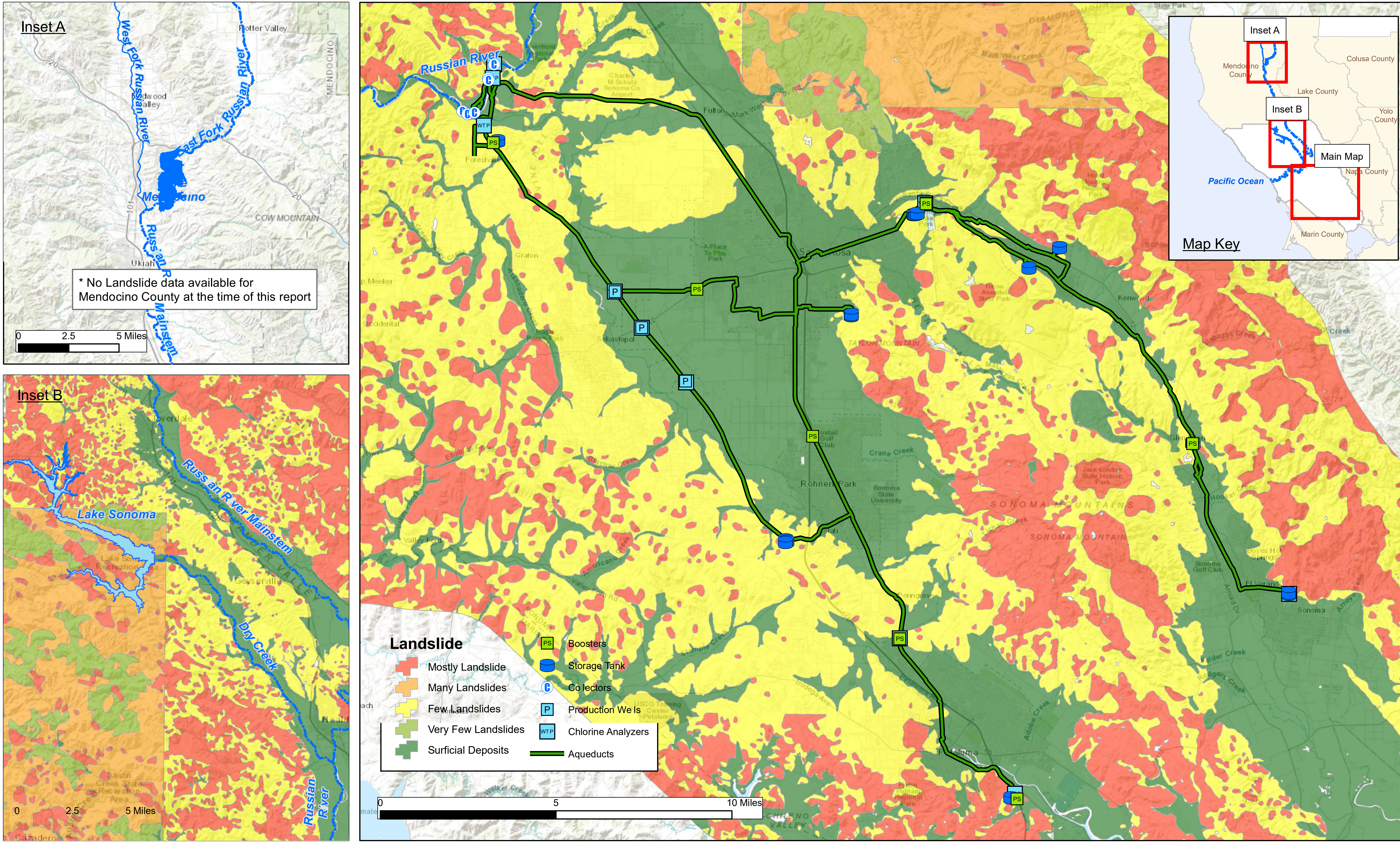
Figure 12



Sonoma Water LHMP

Water Supply and Transmission System - Landslide Hazard

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Figure 13

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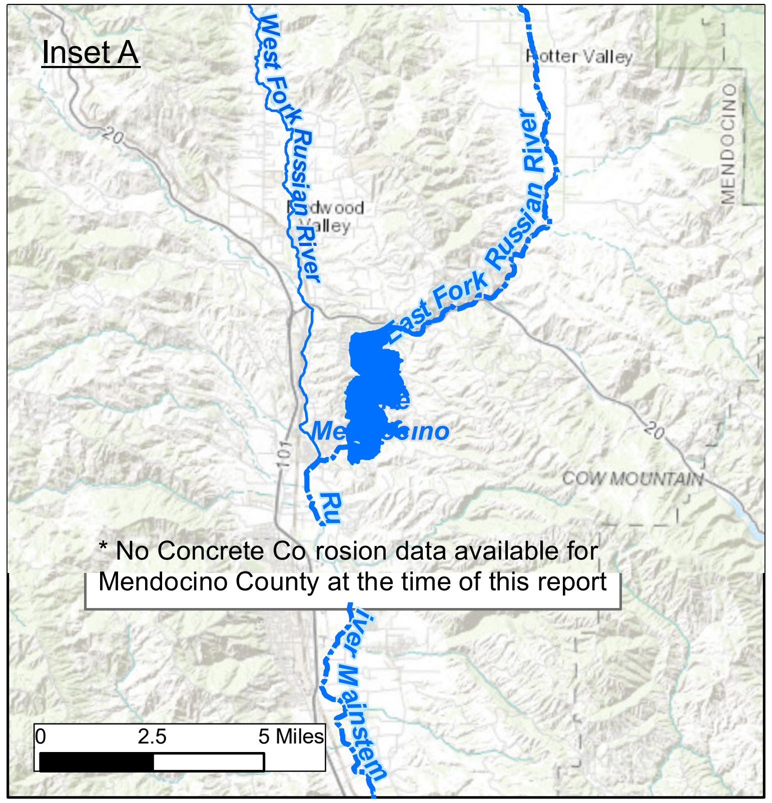

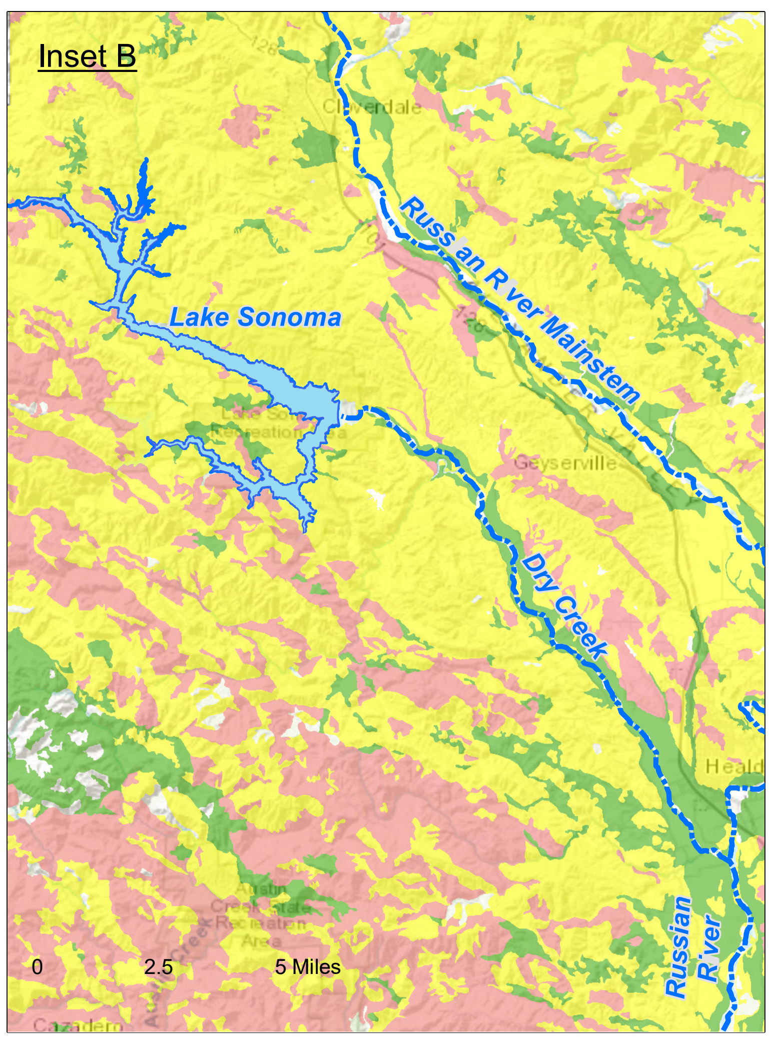

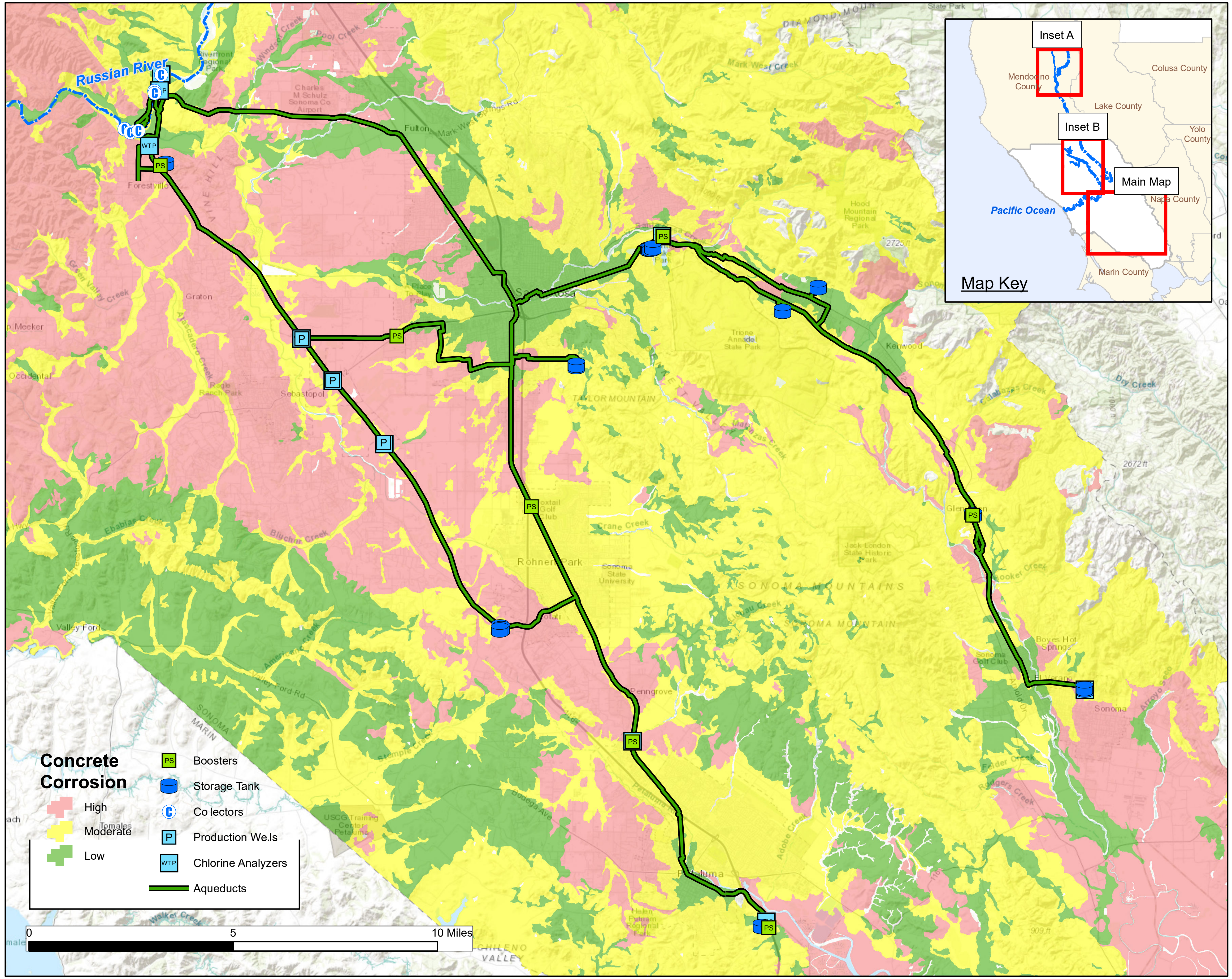

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Sonoma Water LHMP

Water Supply and Transmission System - Corrosive Soils - Concrete

NORTH

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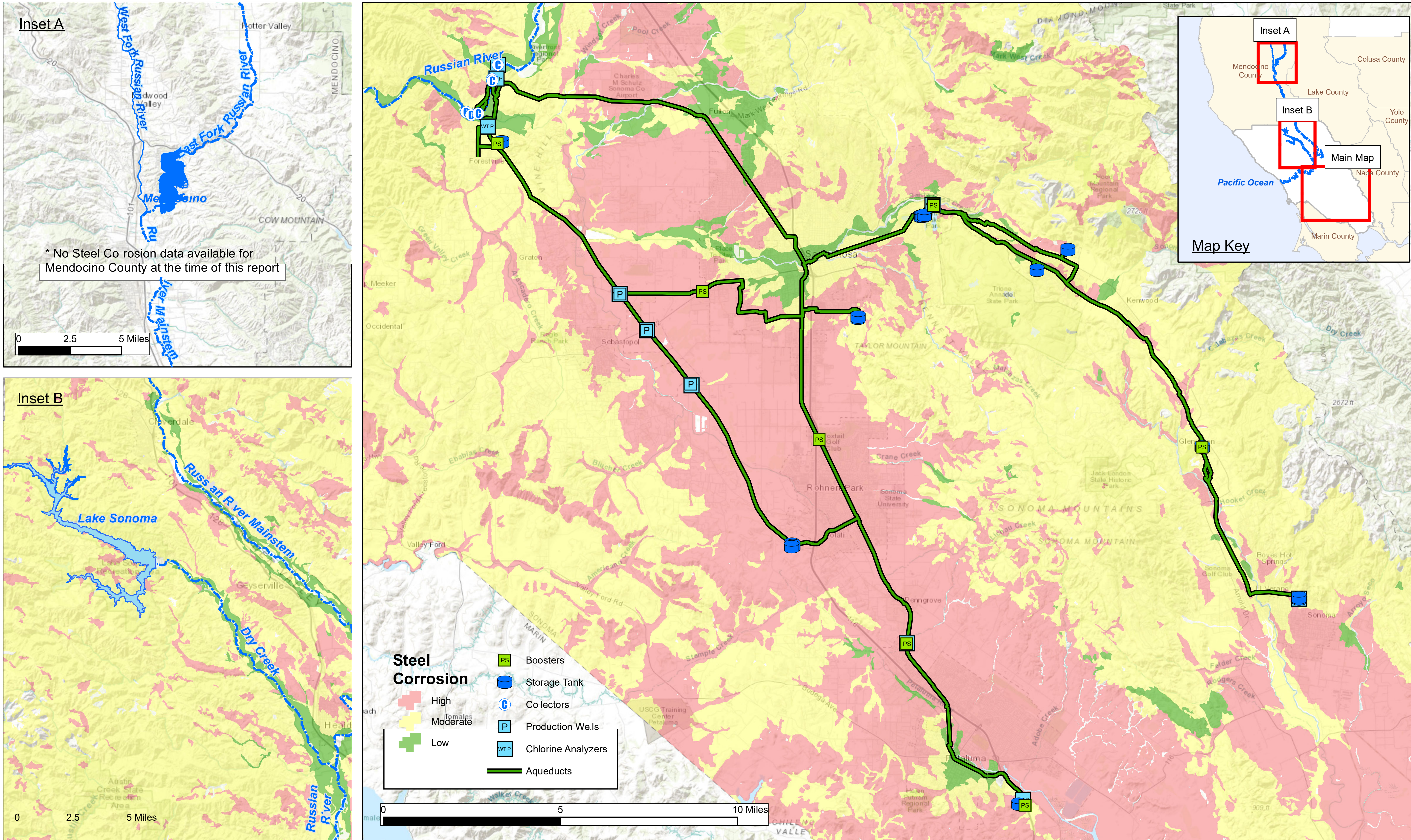
Sonoma Water

Figure 14



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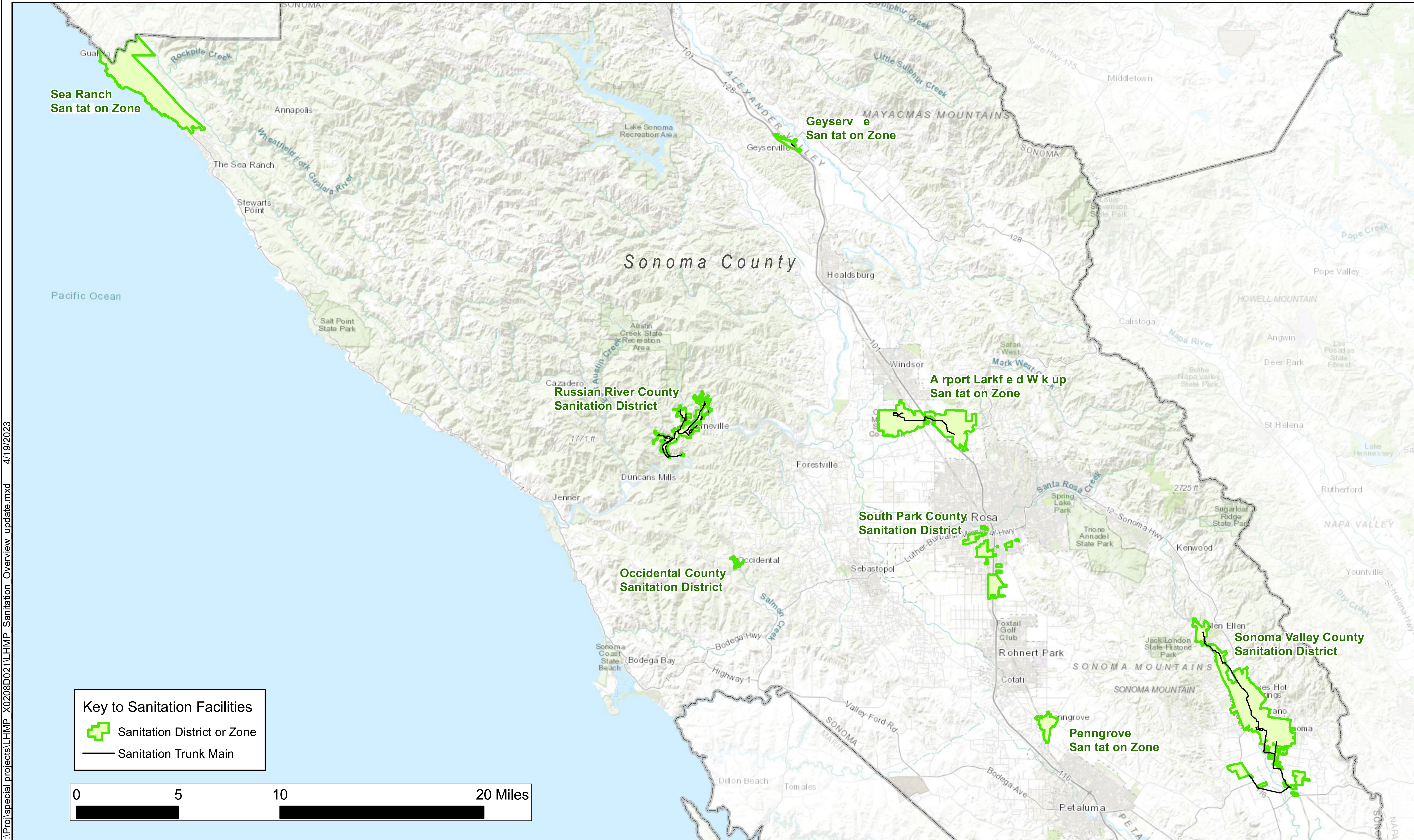
Sonoma Water LHMP

Water Supply and Transmission System - Corrosive Soils - Steel

Sonoma Water

Figure 15



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Sonoma Water LHMP

Sanitary Sewer System - Sanitation Zones and Districts

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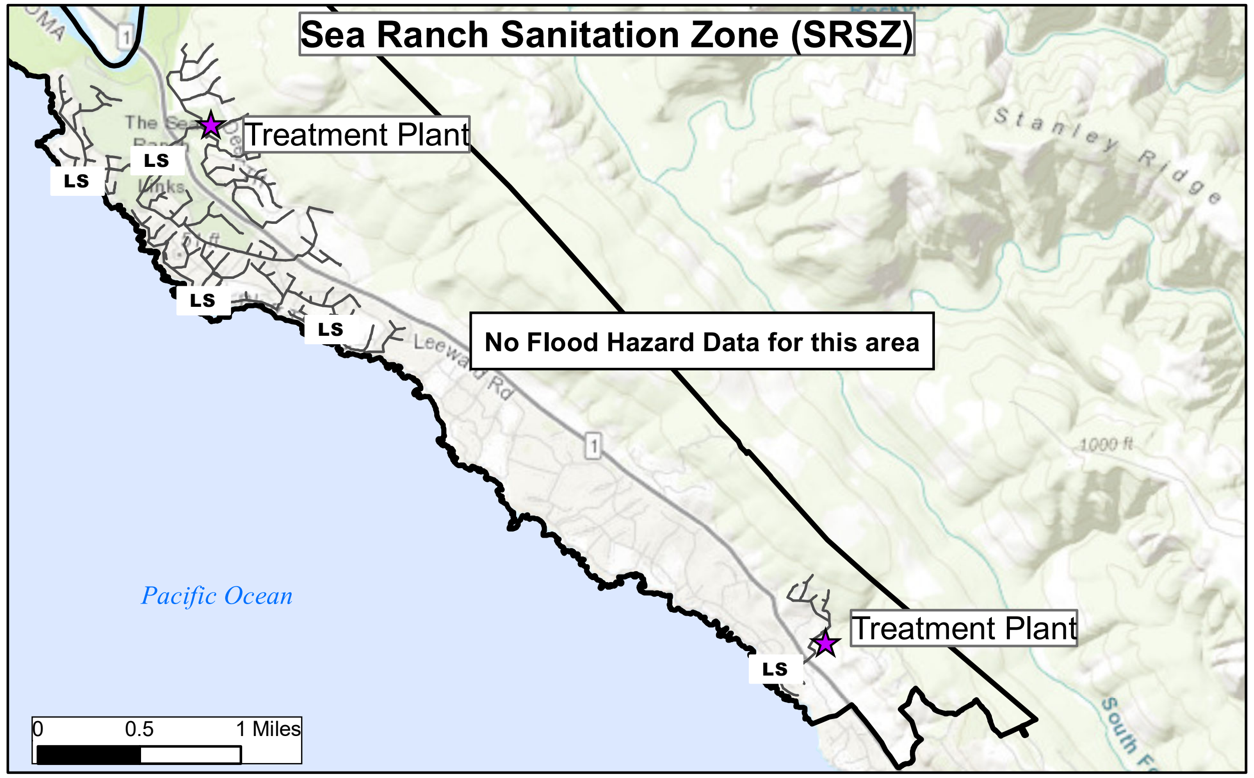
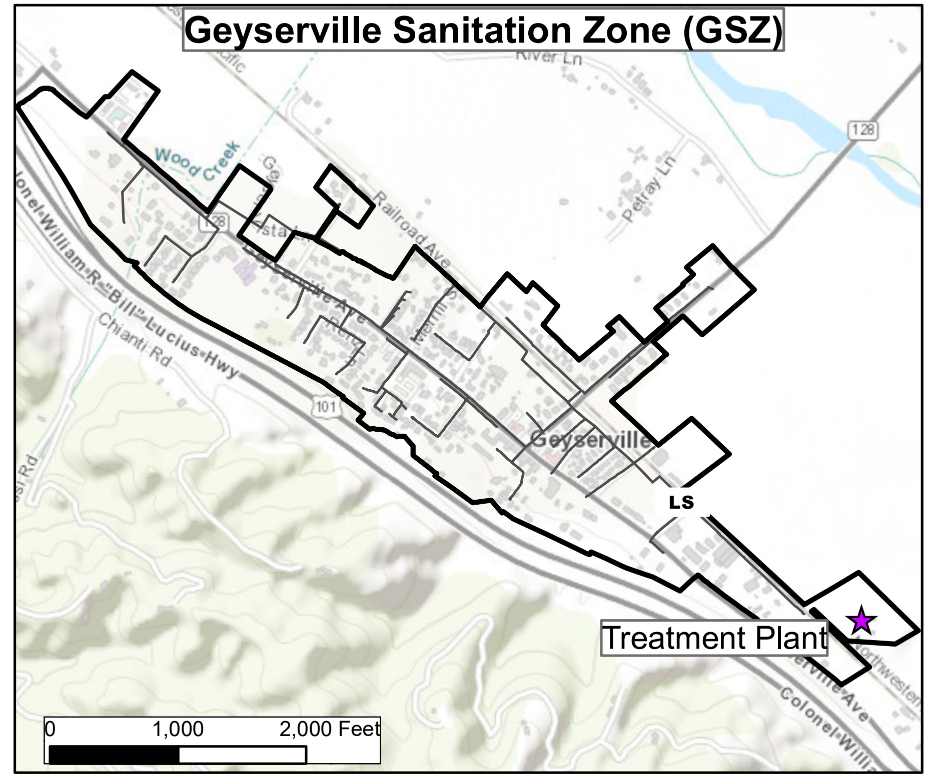
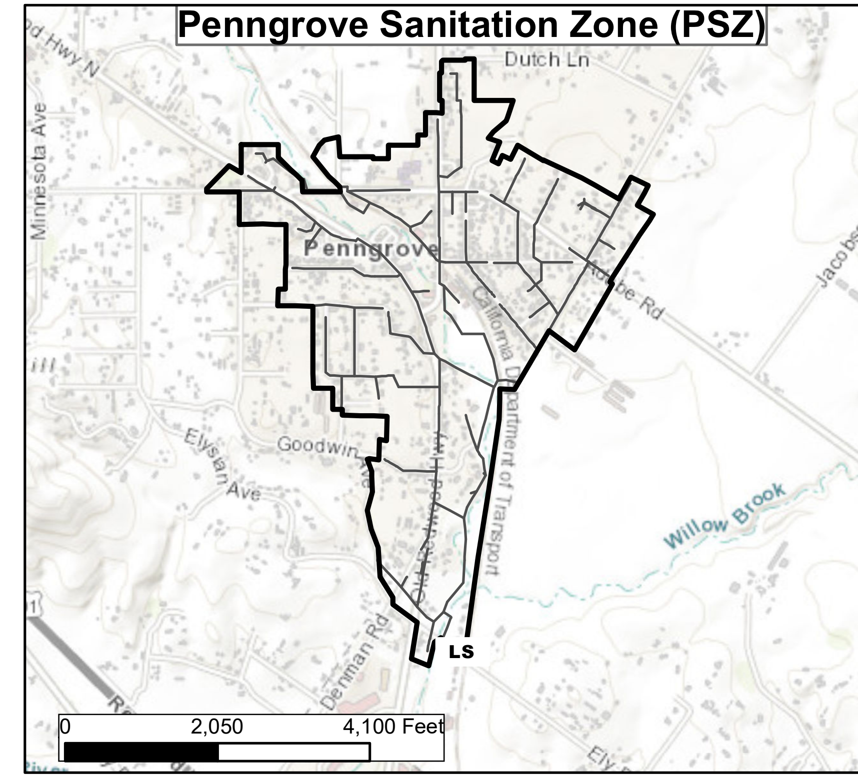
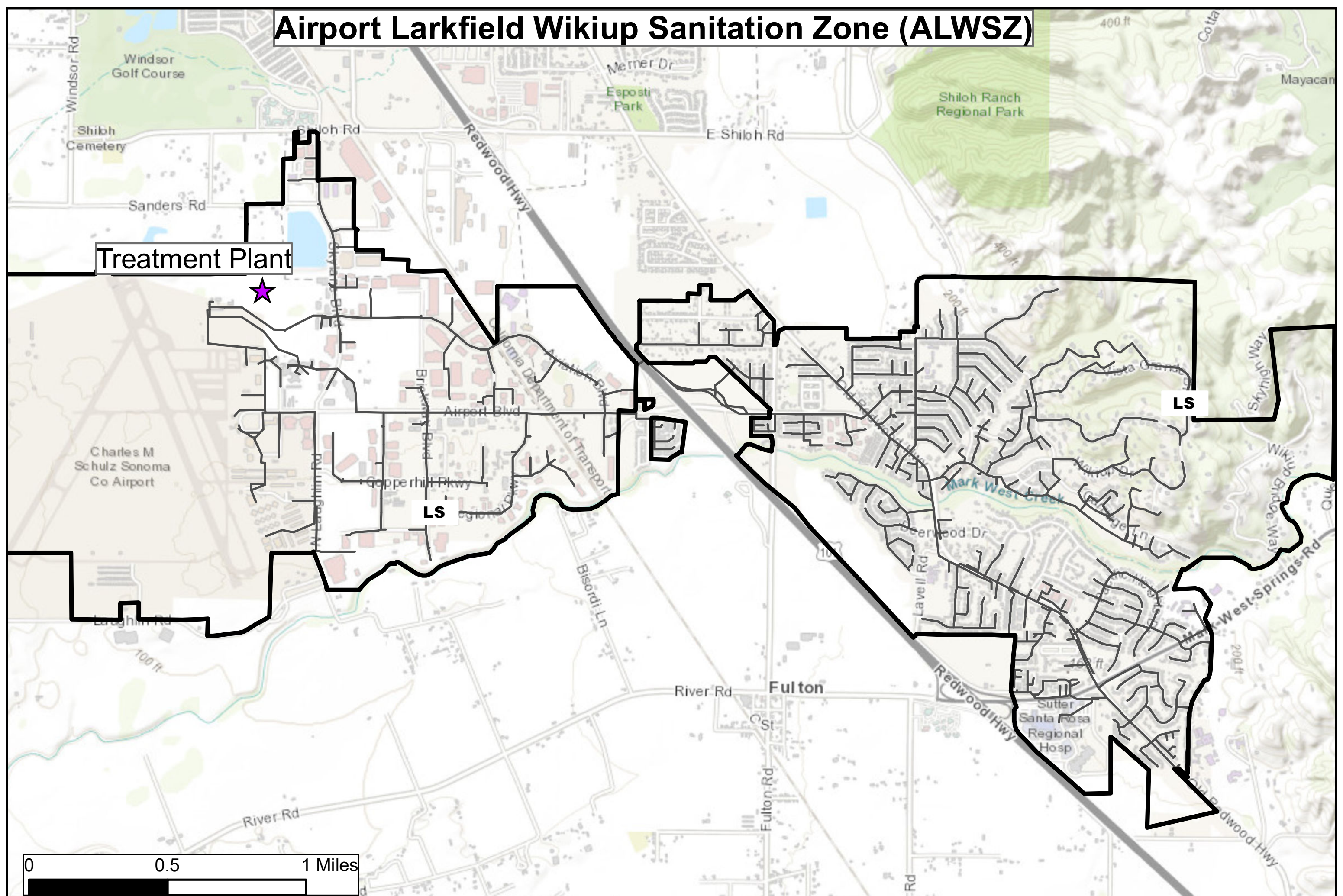
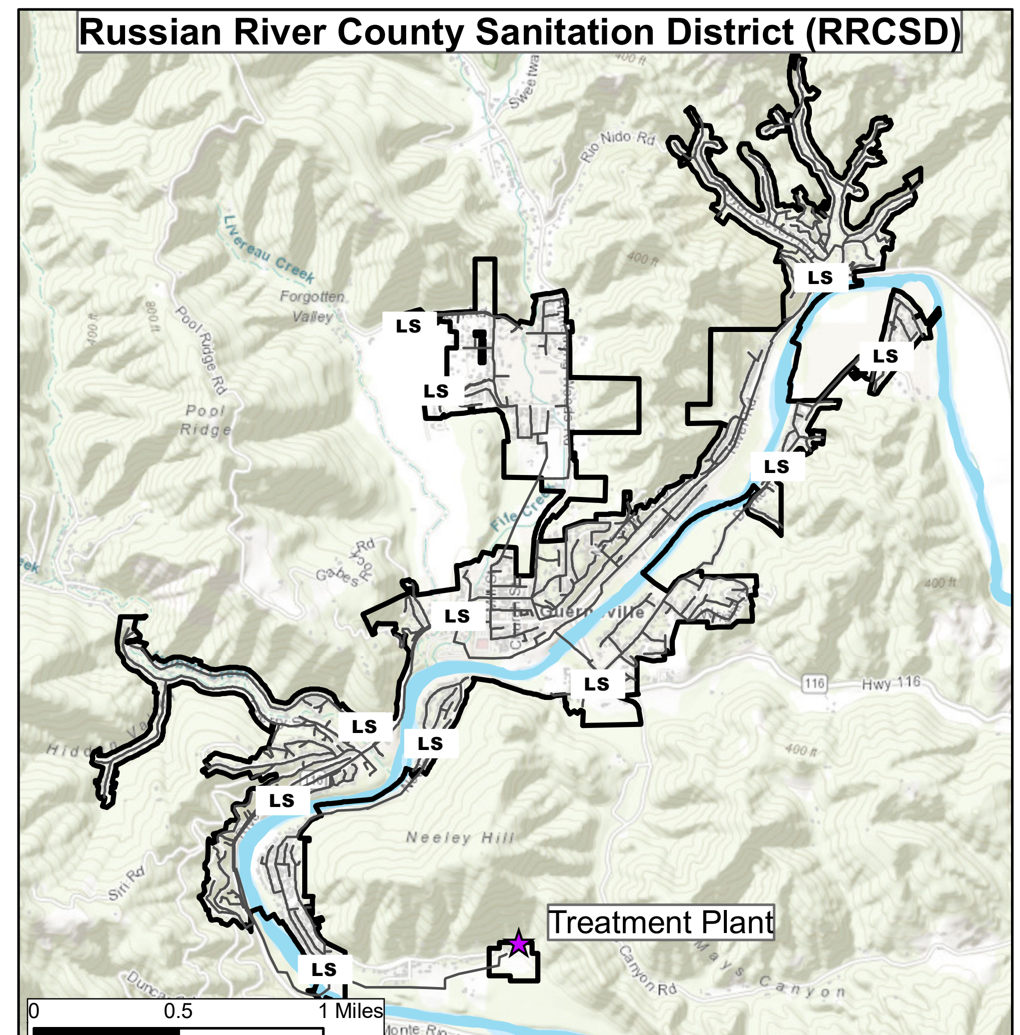
Figure 16

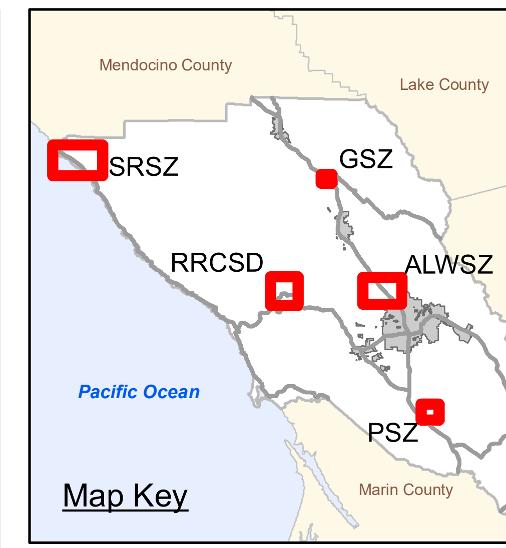












Service Area Boundary

LS Lift Station

Sanitation Pipes

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Sonoma Water LHMP

Sanitary Sewer System - Assessed Sanitation Zones/Facilities

NORTH

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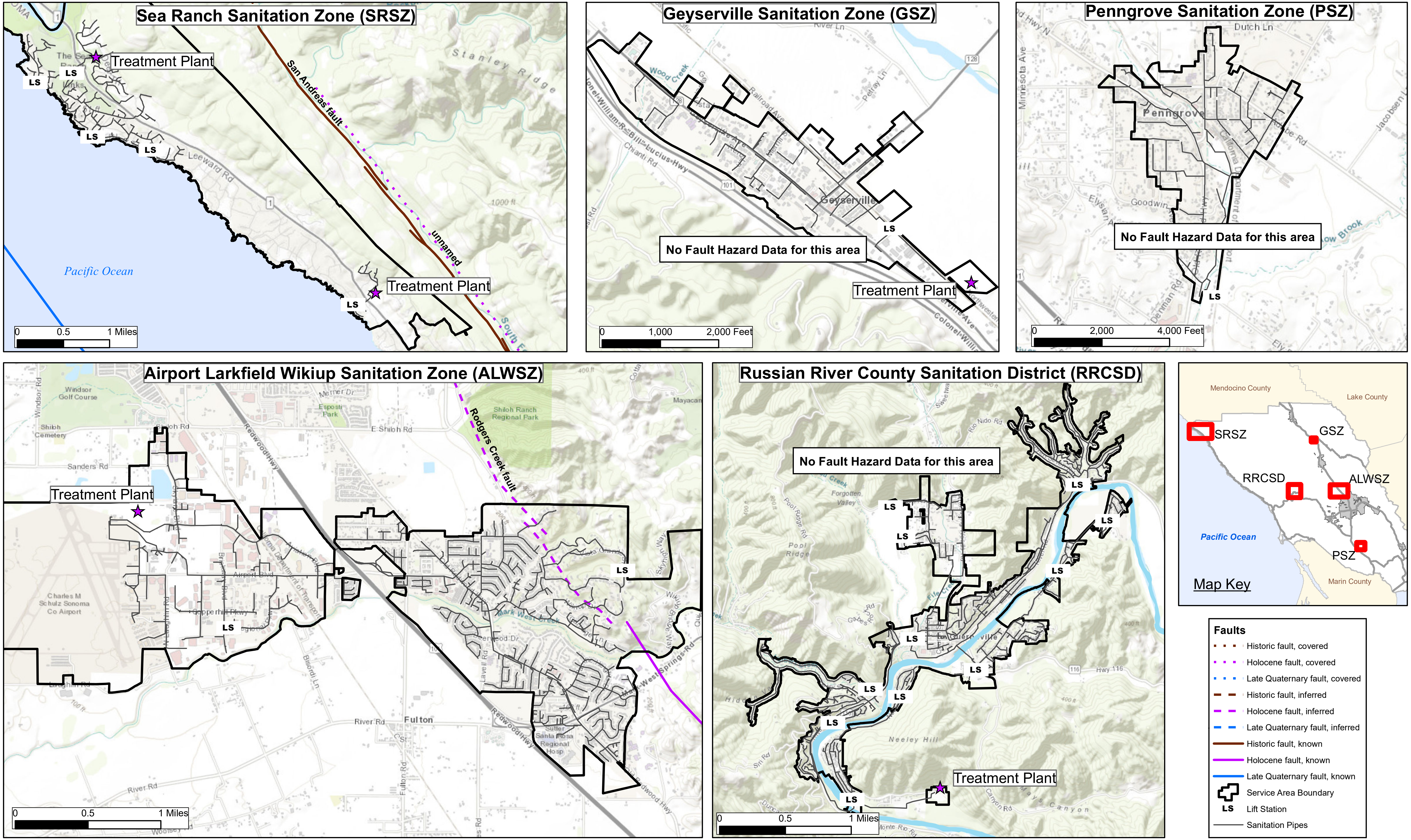
Figure 17



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Sonoma Water LHMP

Sanitary Sewer System - Fault Hazard

NORTH

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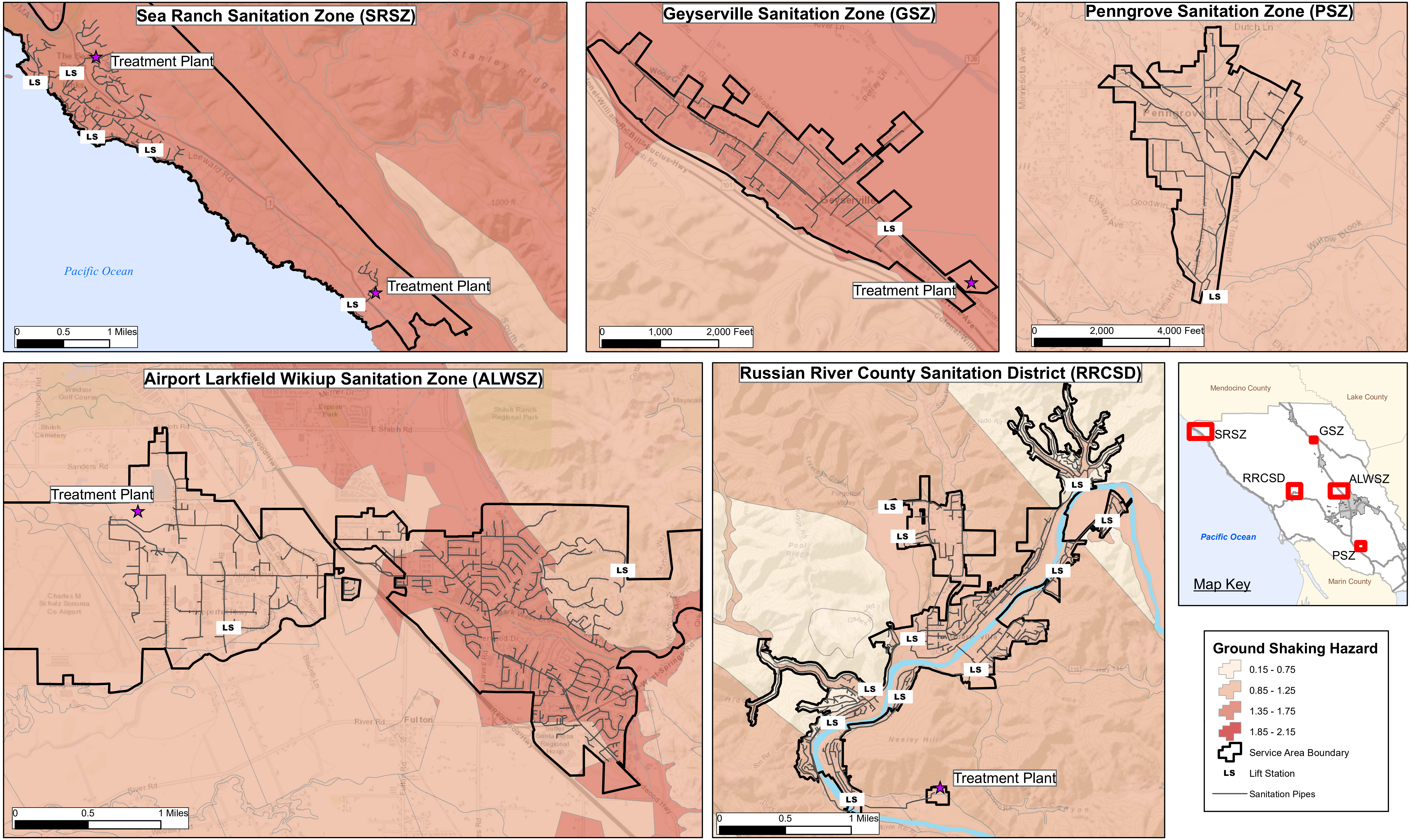
Figure 18



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Sonoma Water LHMP

Sanitary Sewer System - Ground Shaking Hazard

NORTH

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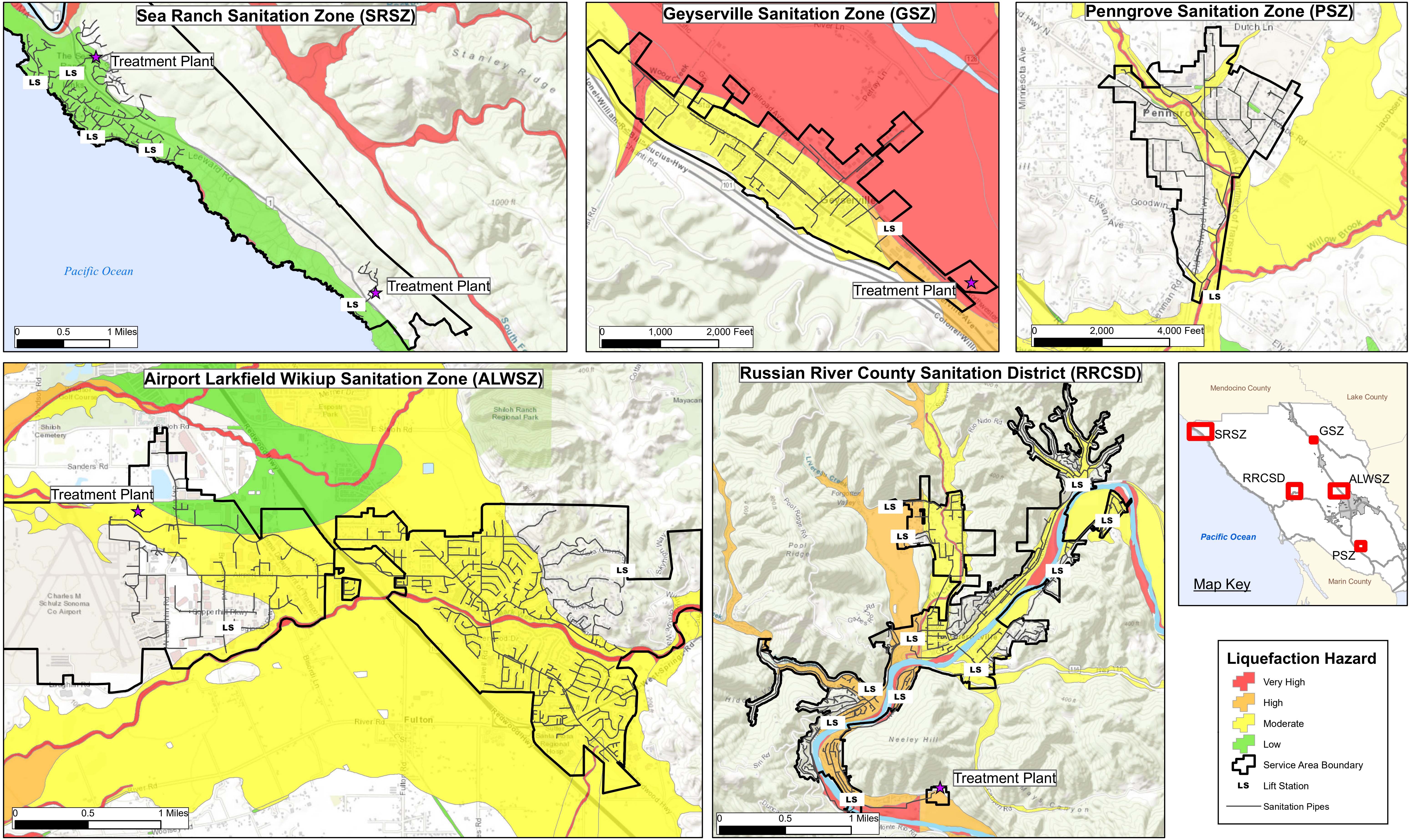
Figure 19



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Sonoma Water LHMP

Sanitary Sewer System - Liquefaction Hazard

NORTH

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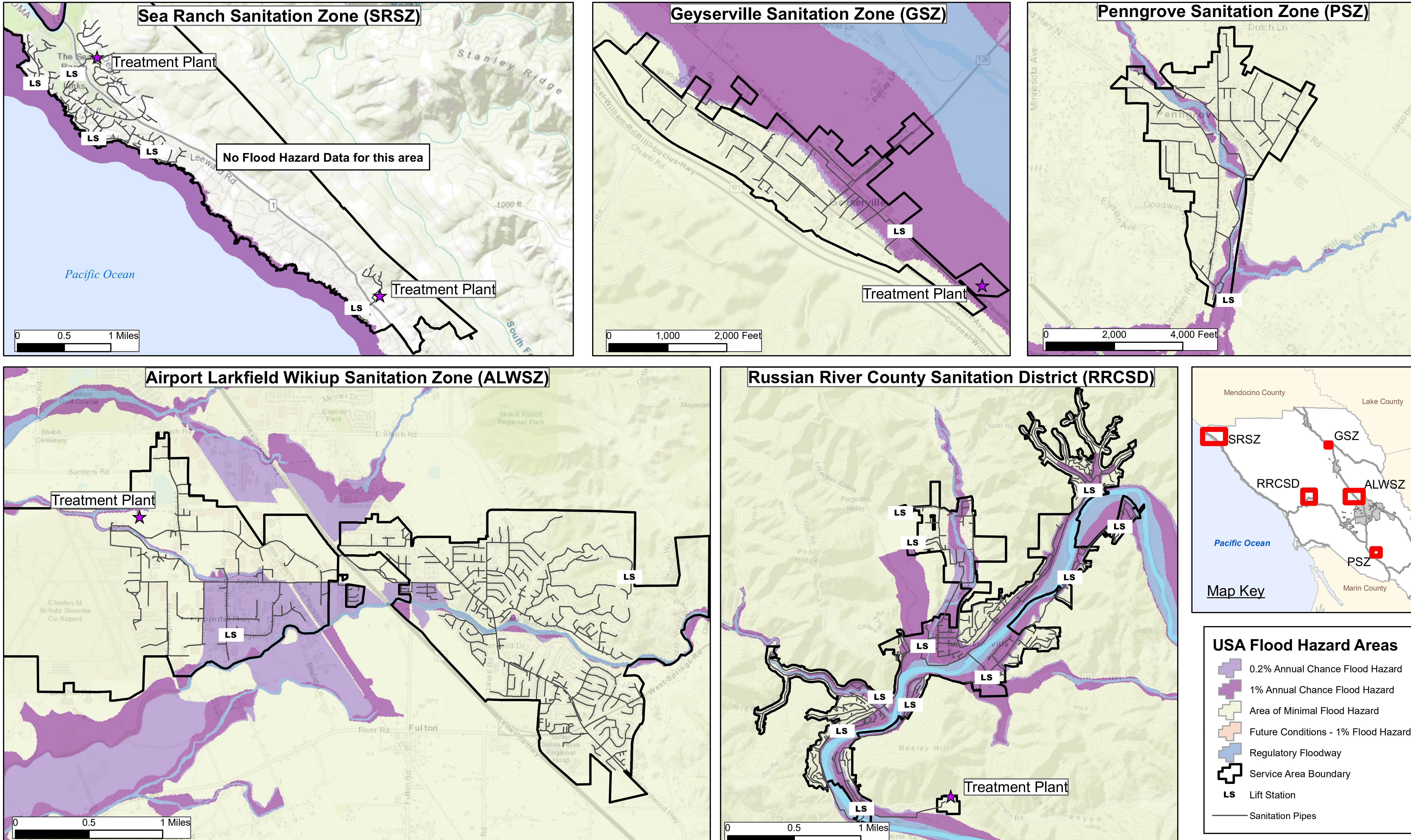
Figure 20



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Sonoma Water LHMP

Sanitary Sewer System - Flood Hazard

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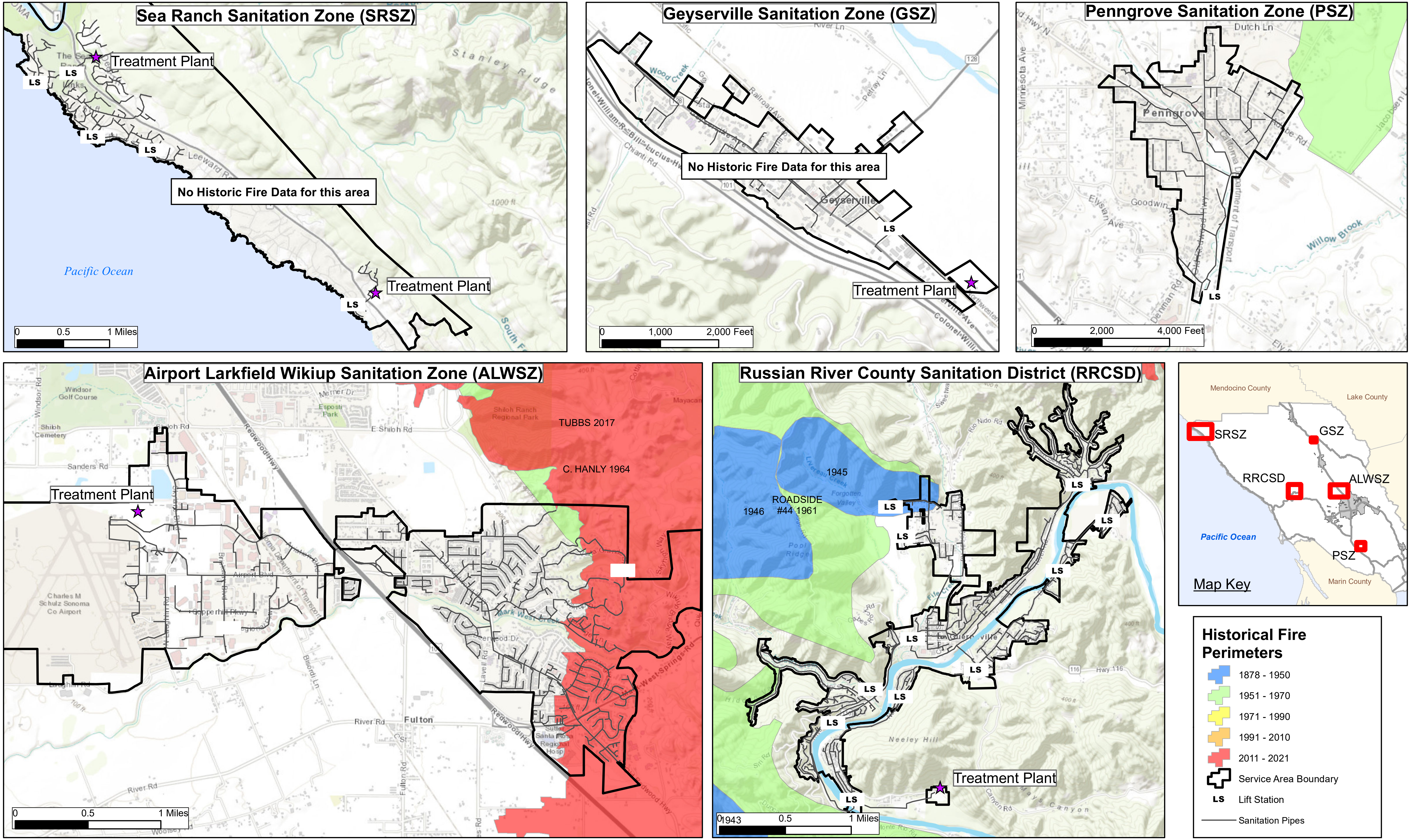
Figure 21



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Sonoma Water LHMP

Sanitary Sewer System - Historic Fire Hazard

NORTH

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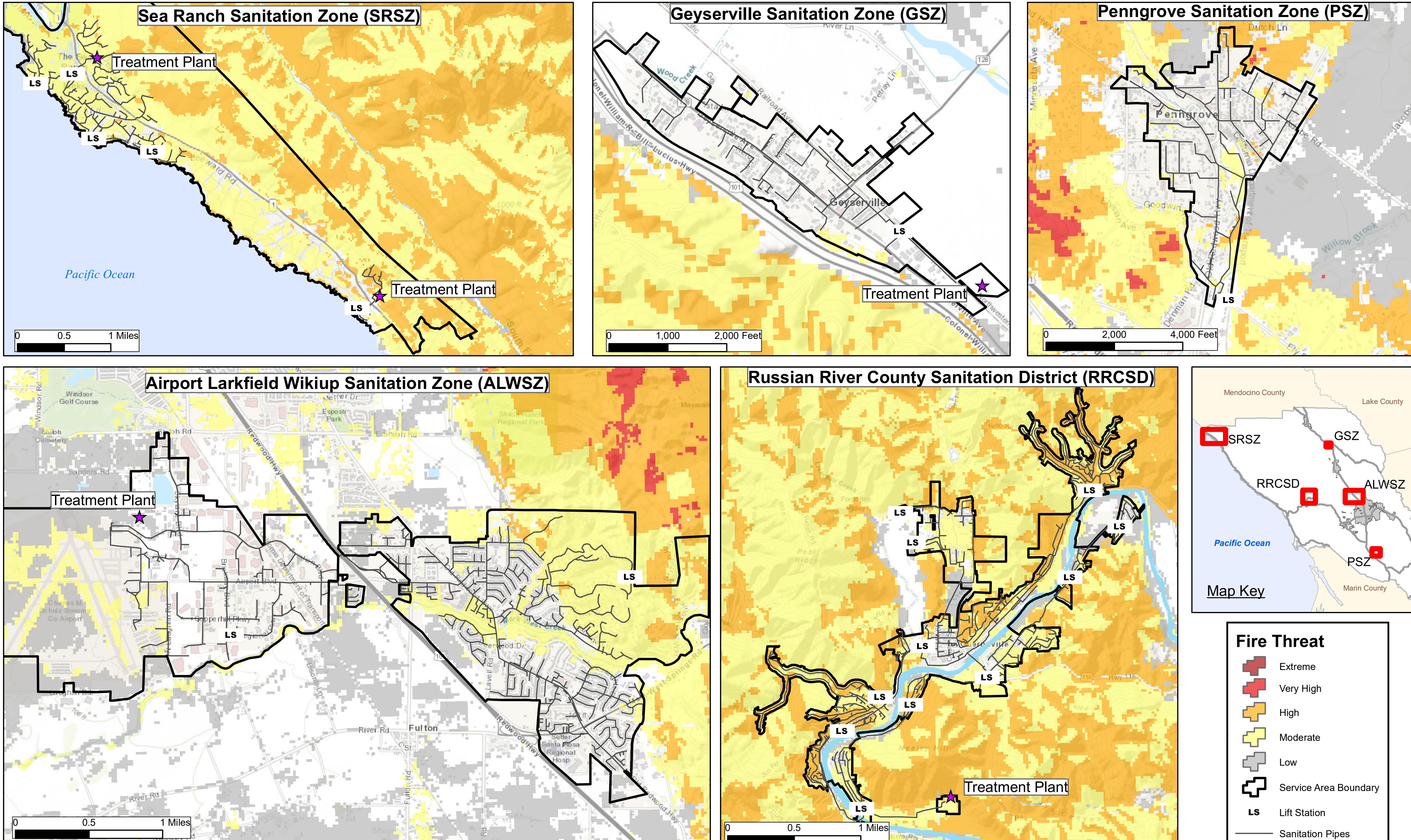
Figure 22



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Sonoma Water LHMP

Sanitary Sewer System - Fire Threat Hazard

NORTH

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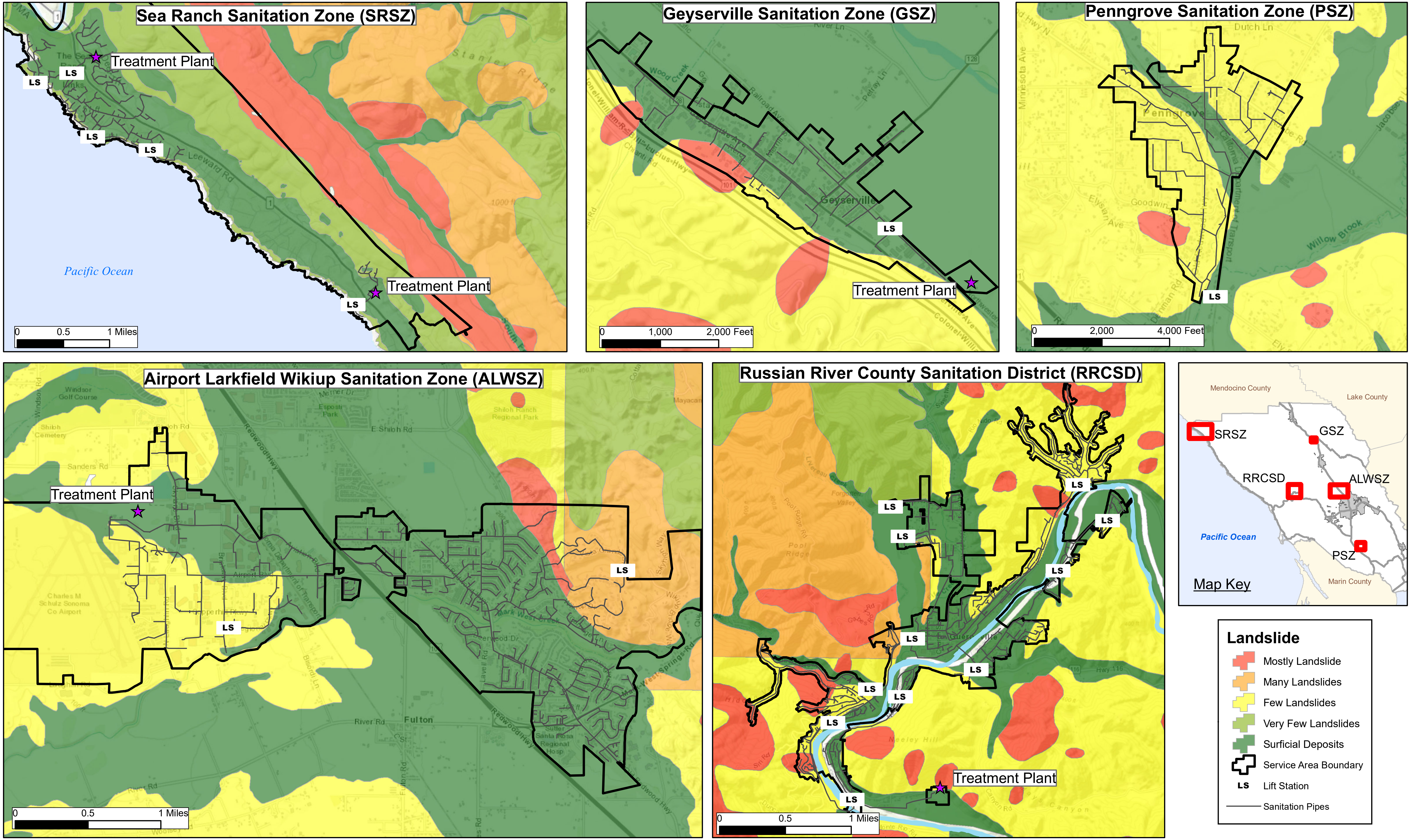
Figure 23



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Sonoma Water LHMP

Sanitary Sewer System - Landslide Hazard

NORTH

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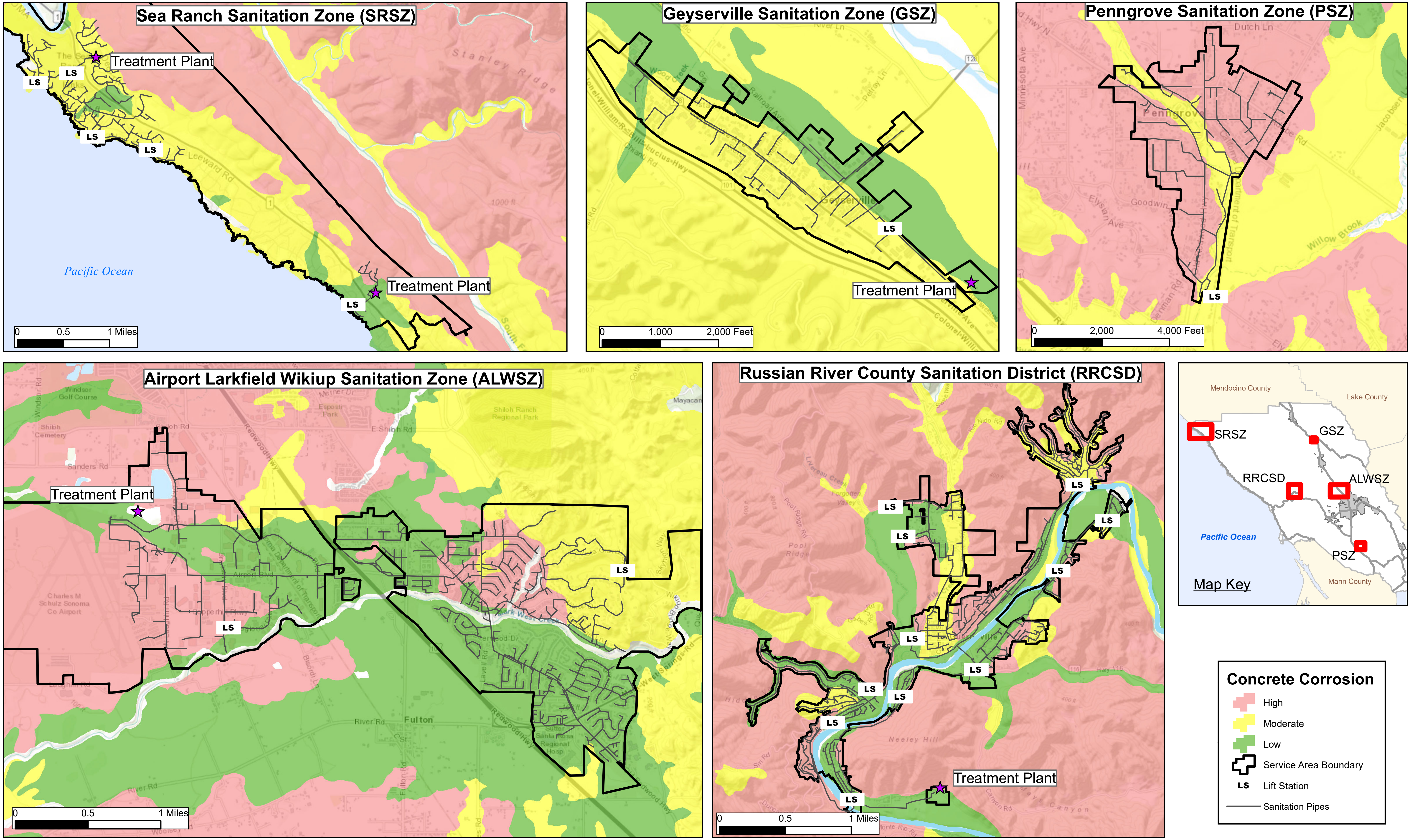
Figure 24



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Sonoma Water LHMP

Sanitary Sewer System - Corrosive Soil - Concrete Hazard

NORTH

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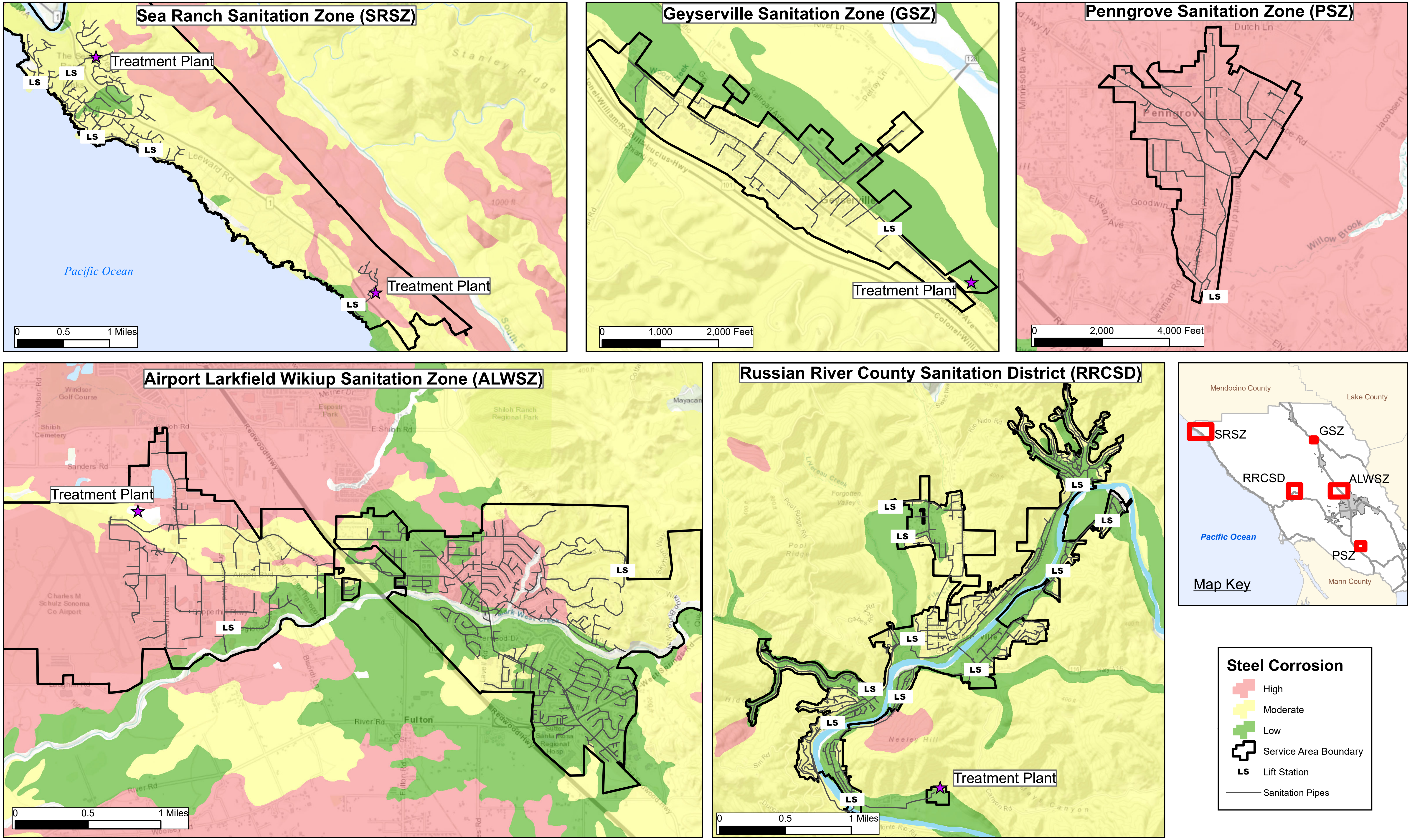
Figure 25



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Sonoma Water LHMP

Sanitary Sewer System - Corrosive Soil - Steel Hazard

NORTH

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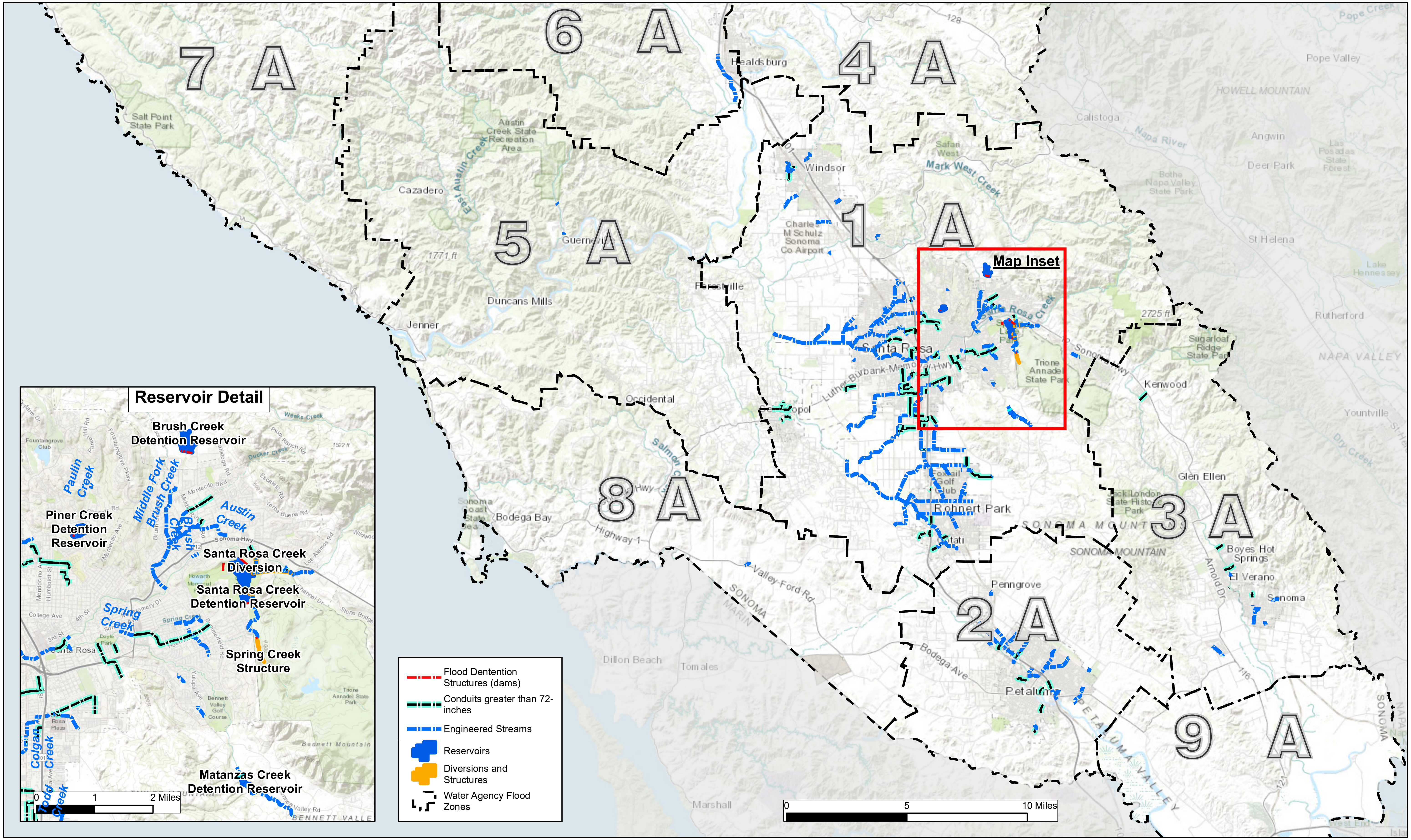
Figure 26



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Sonoma Water LHMP

Flood Protection Infrastructures - Flood Protection Facilities

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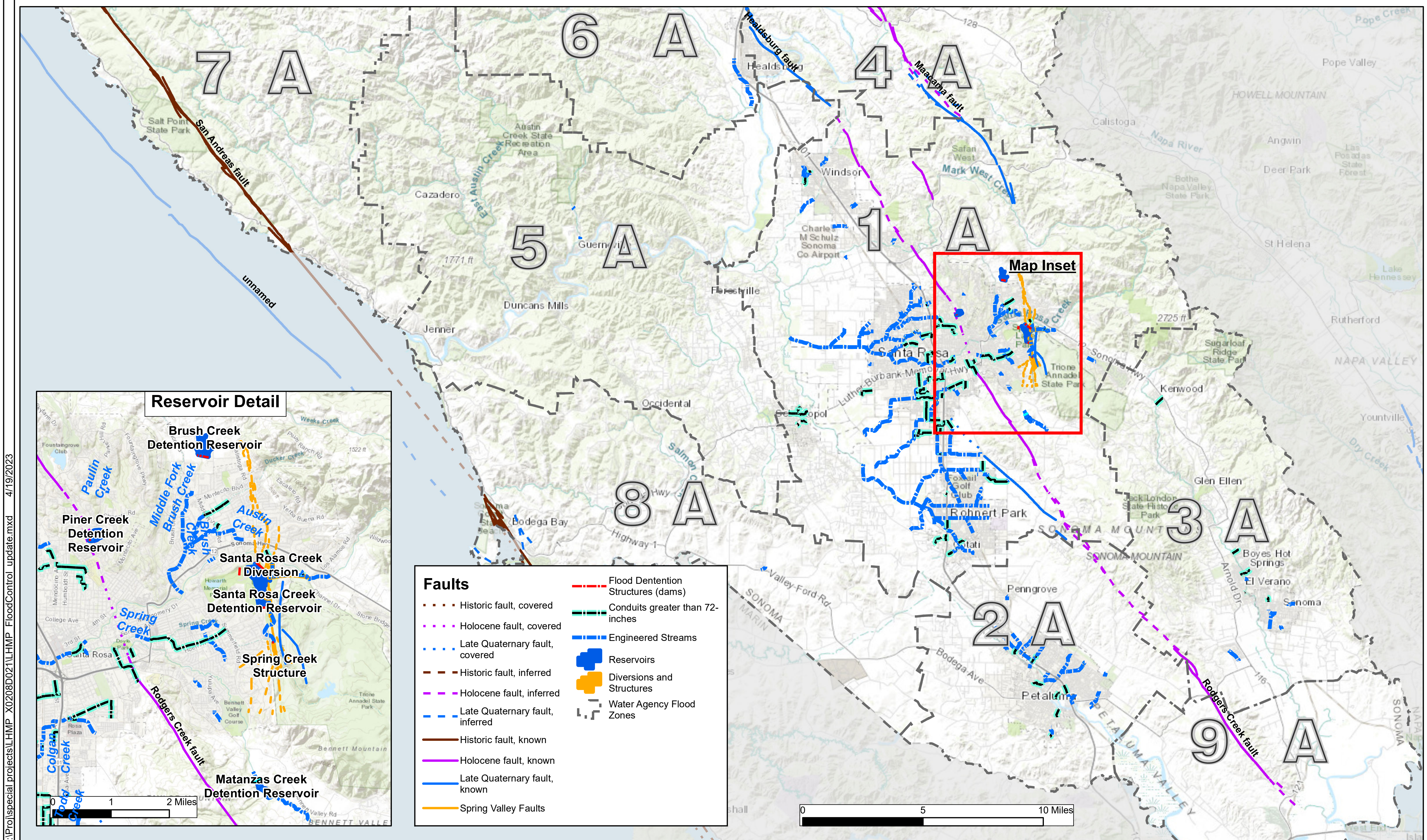
Figure 27



Sonoma Water LHMP

Flood Protection Infrastructures - Fault Hazard

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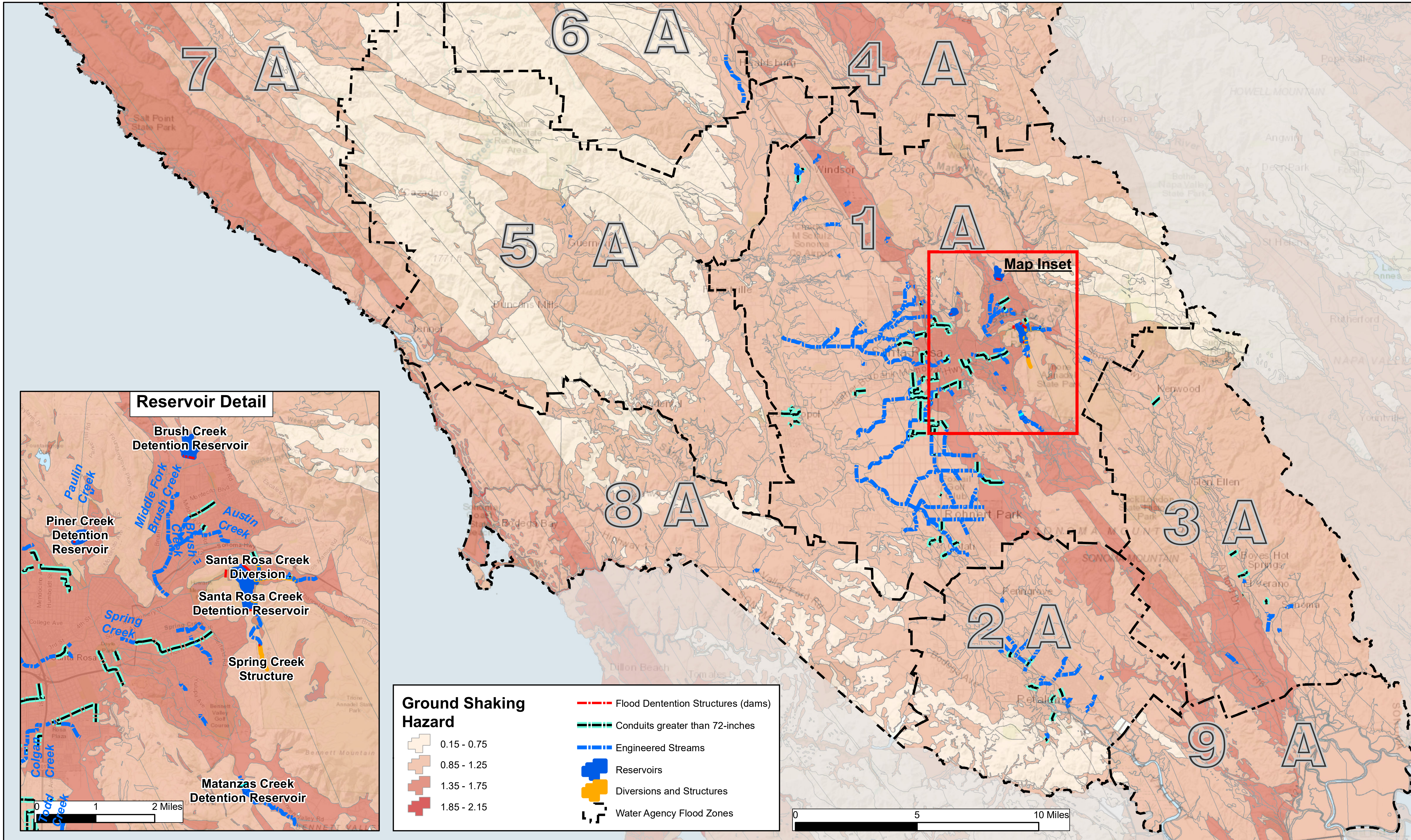
Figure 28



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Sonoma Water LHMP

Flood Protection Infrastructures - Ground Shaking Hazard

NORTH

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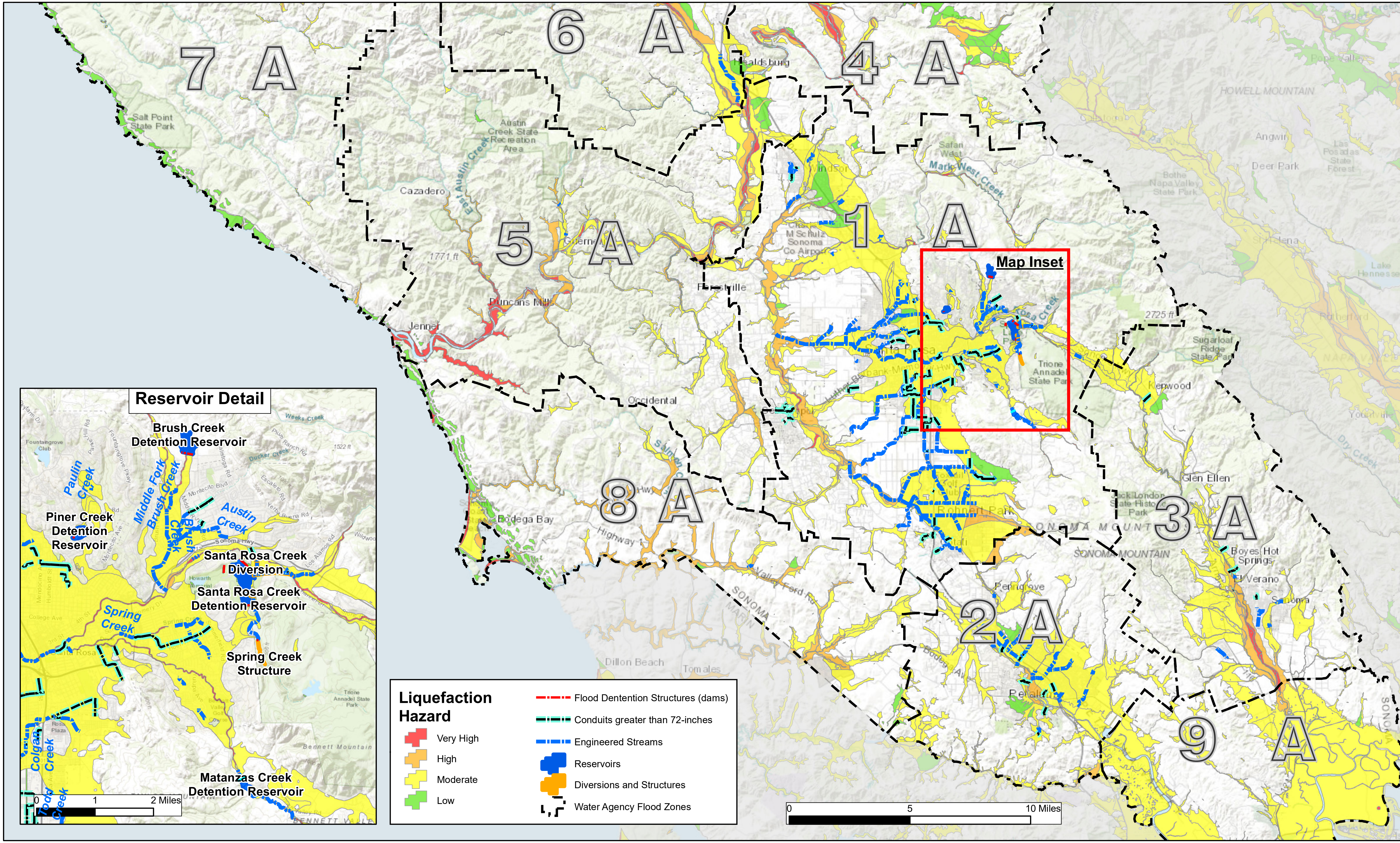
Figure 29



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Sonoma Water LHMP

Flood Protection Infrastructures - Liquefaction Hazard

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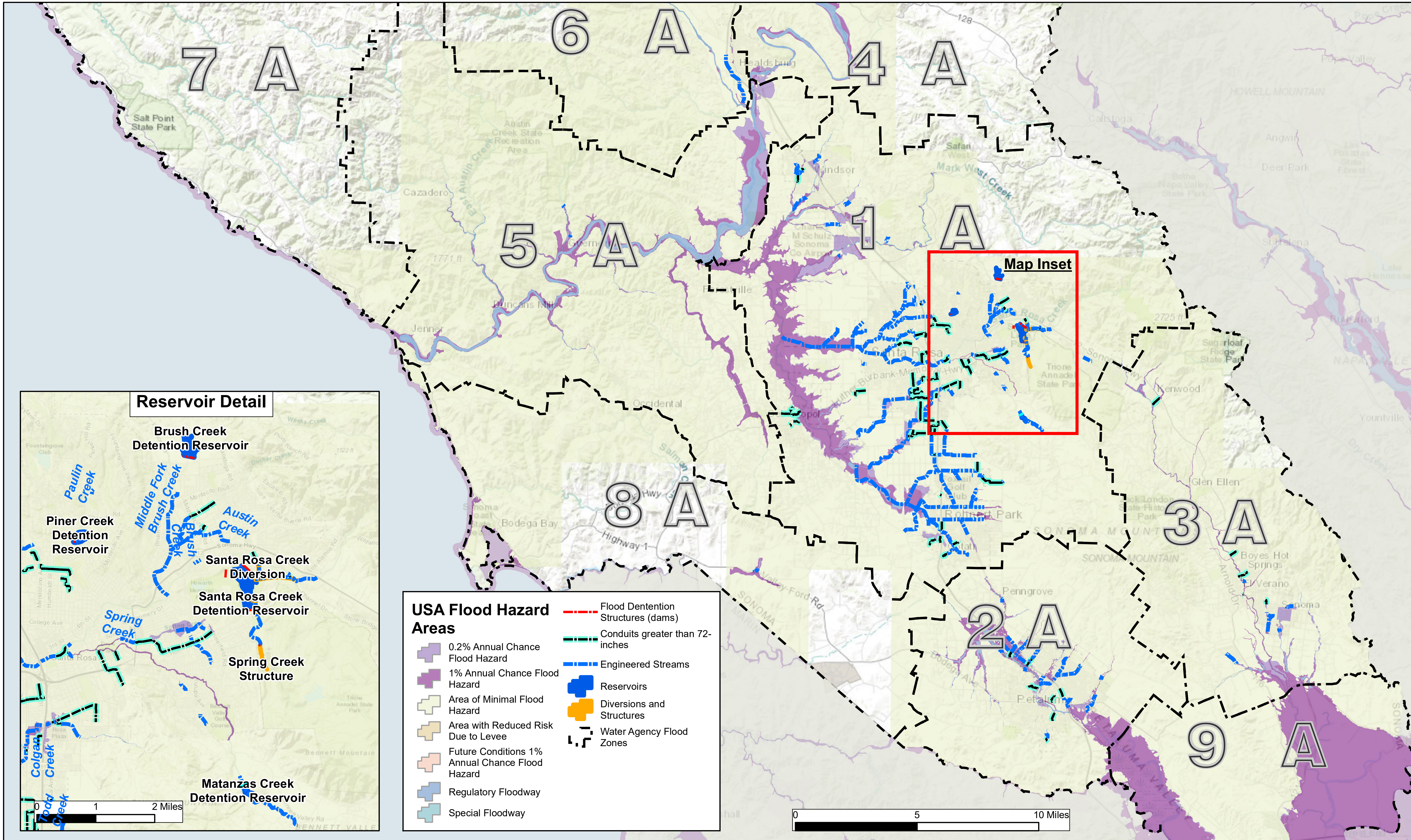
Figure 30



Sonoma Water LHMP

Flood Protection Infrastructures - Flood Hazard

NORTH

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Figure 31

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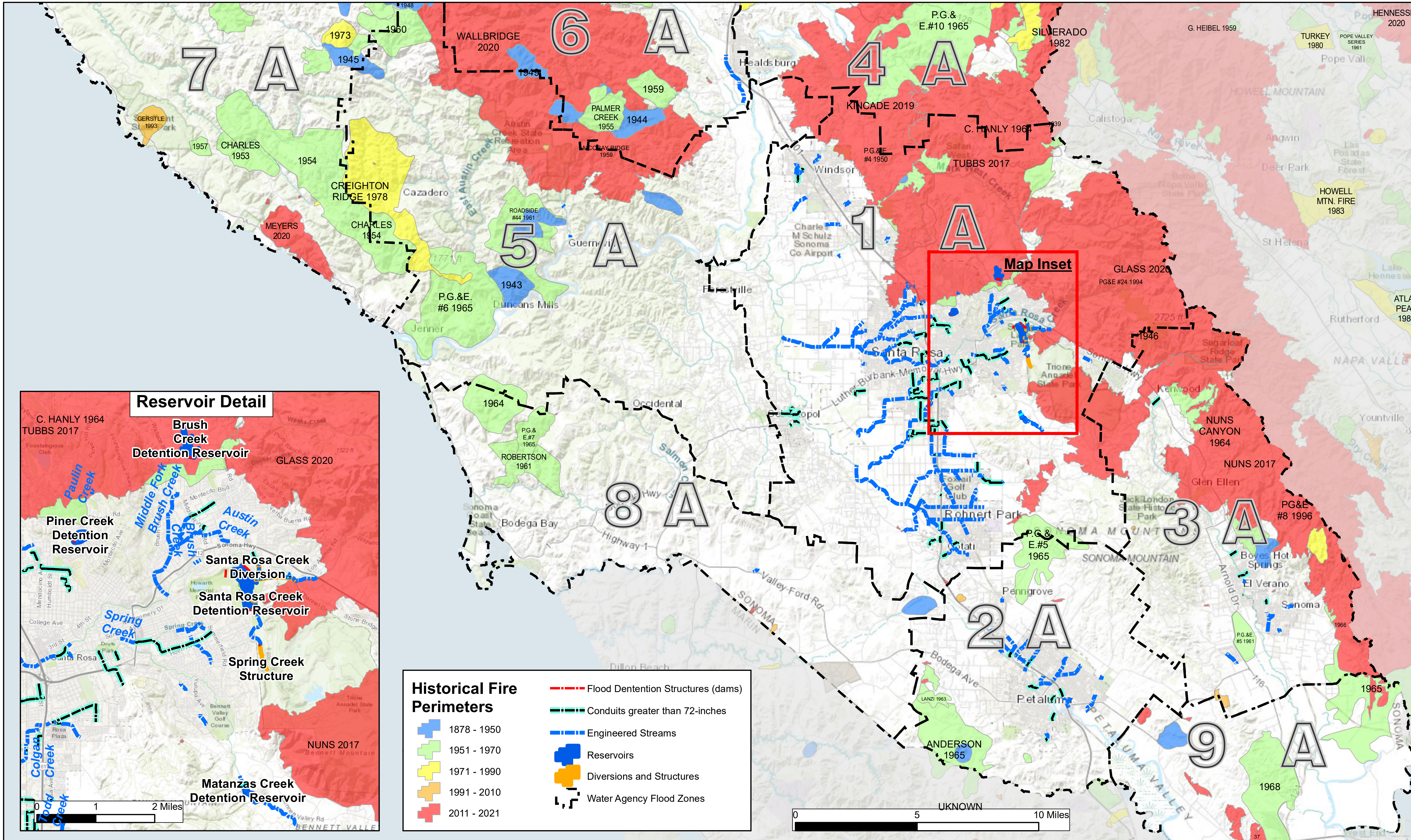

NORTH

Sonoma Water LHMP

Flood Protection Infrastructures - Historic Fire Hazard

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Figure 32

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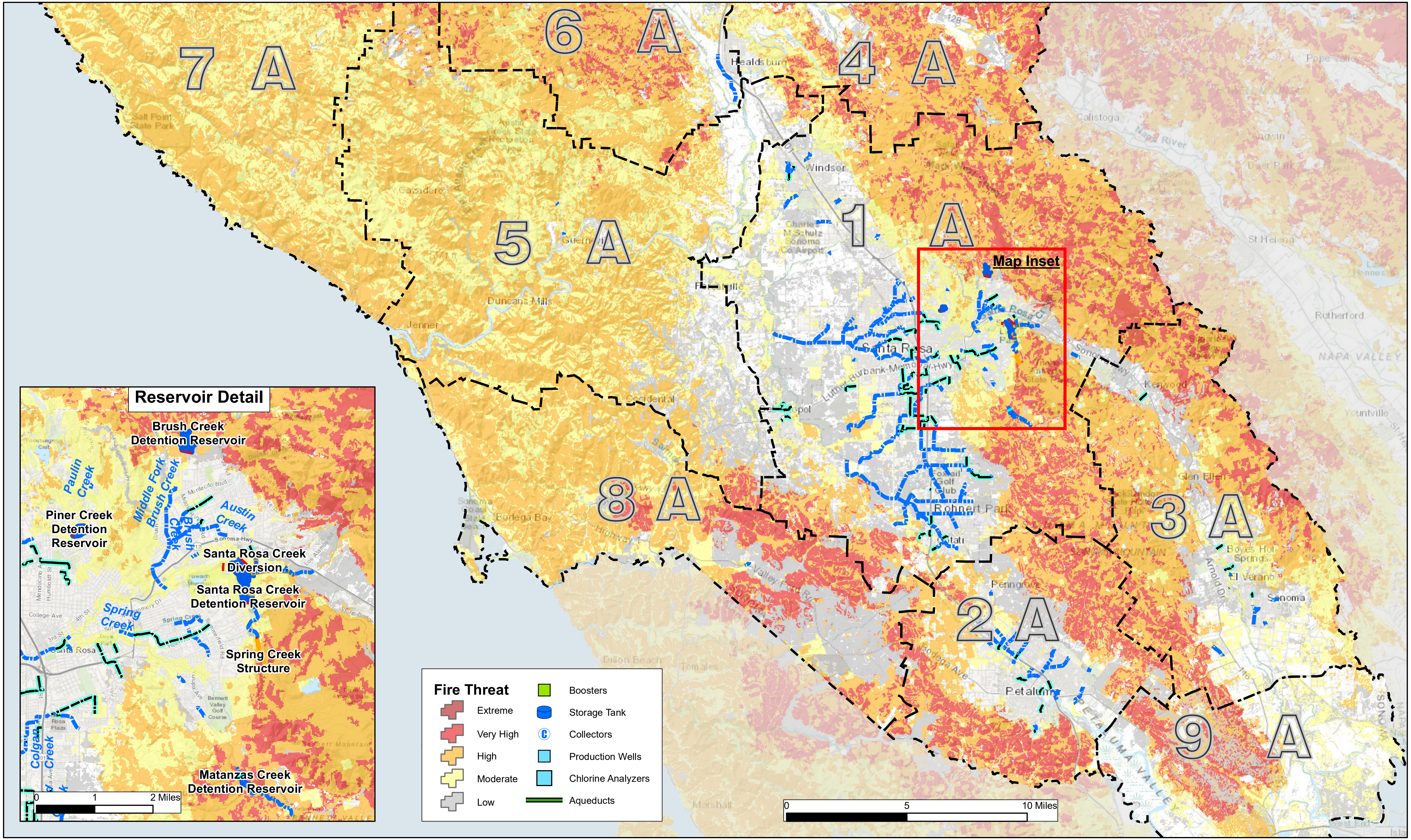

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Sonoma Water LHMP

Flood Protection Infrastructures - Fire Threat Hazard

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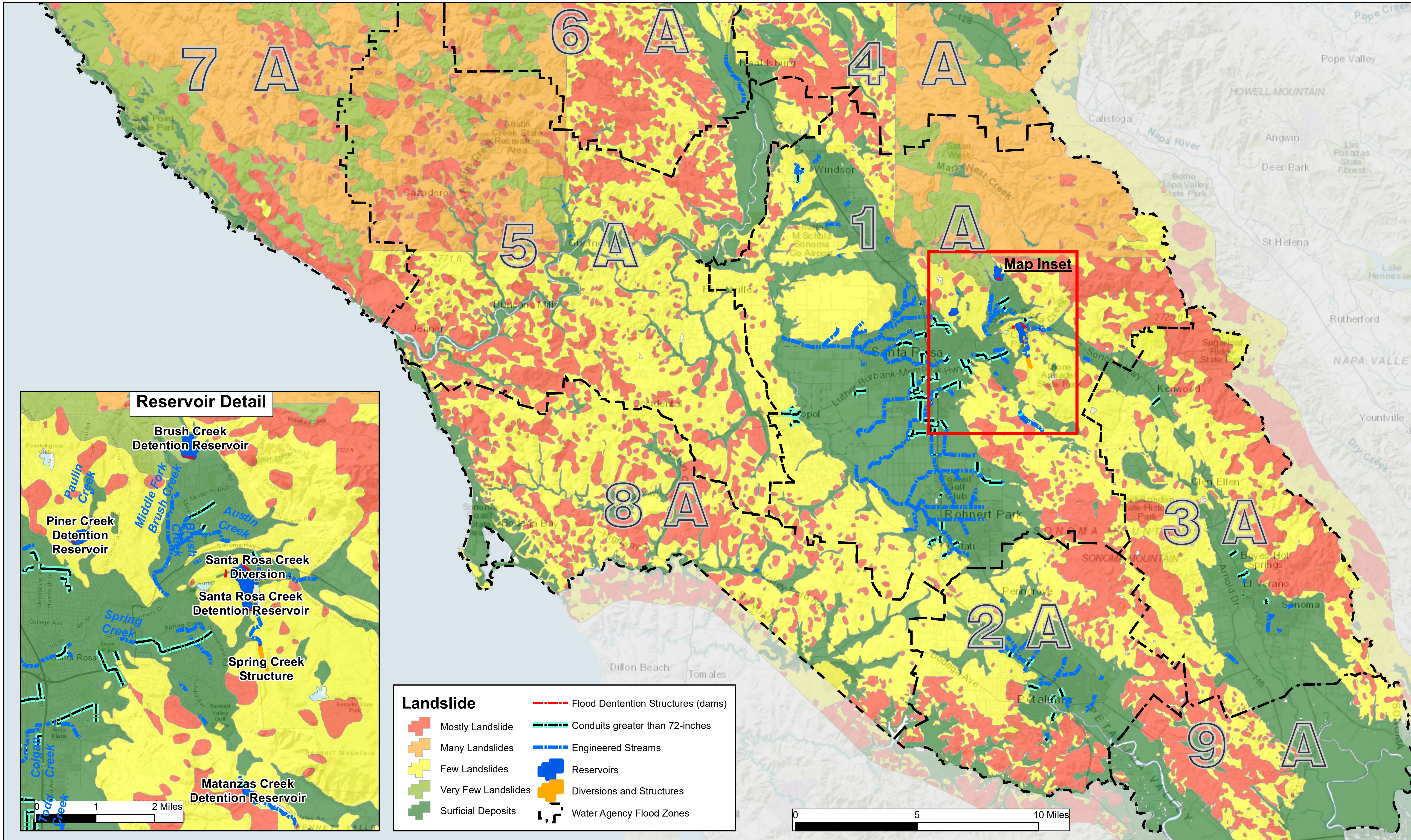
Figure 33



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Sonoma Water LHMP

Flood Protection Infrastructures - Landslide Hazard

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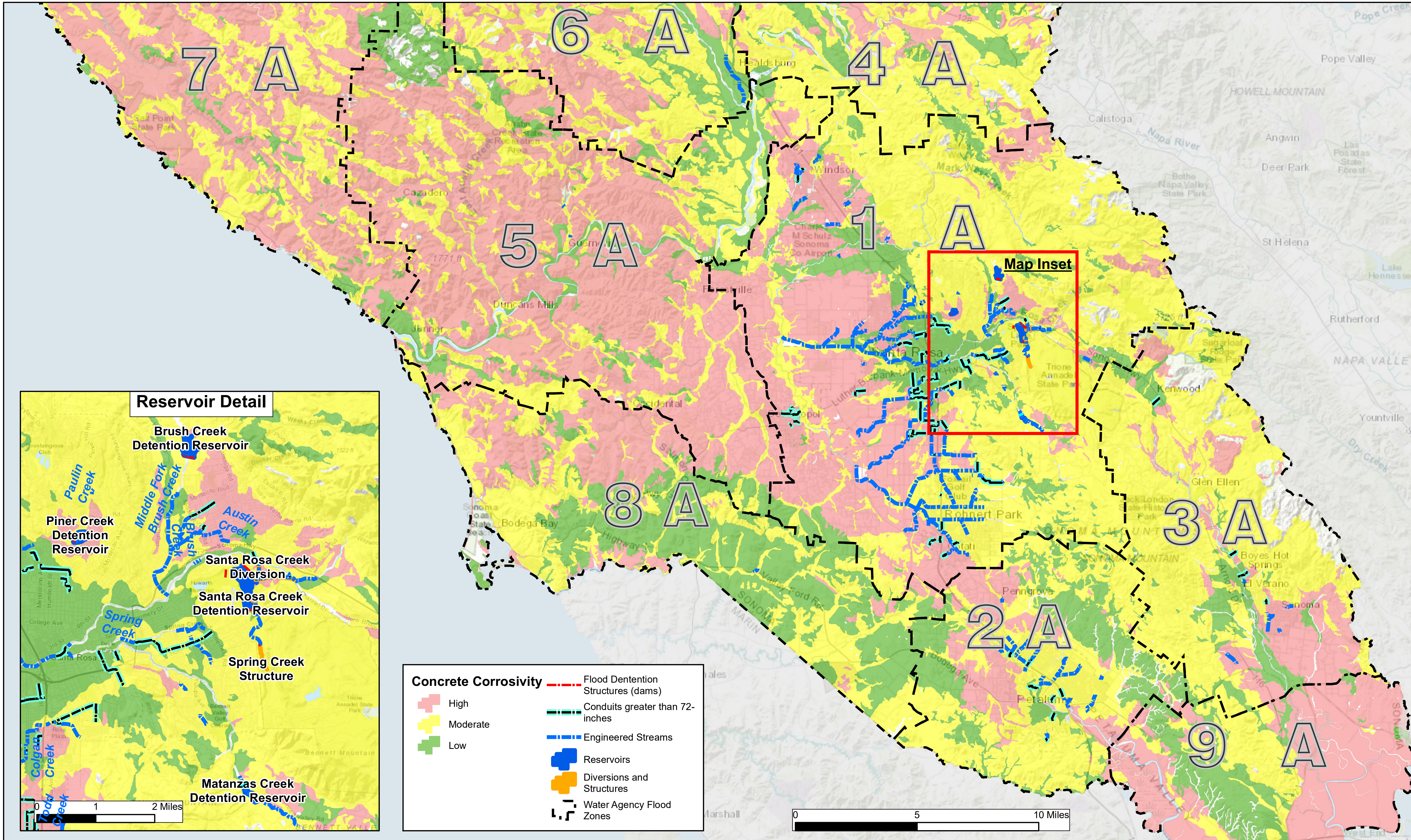
Figure 34



Sonoma Water LHMP

Flood Protection Infrastructures - Corrosive Soil - Concrete

NORTH

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Figure 35

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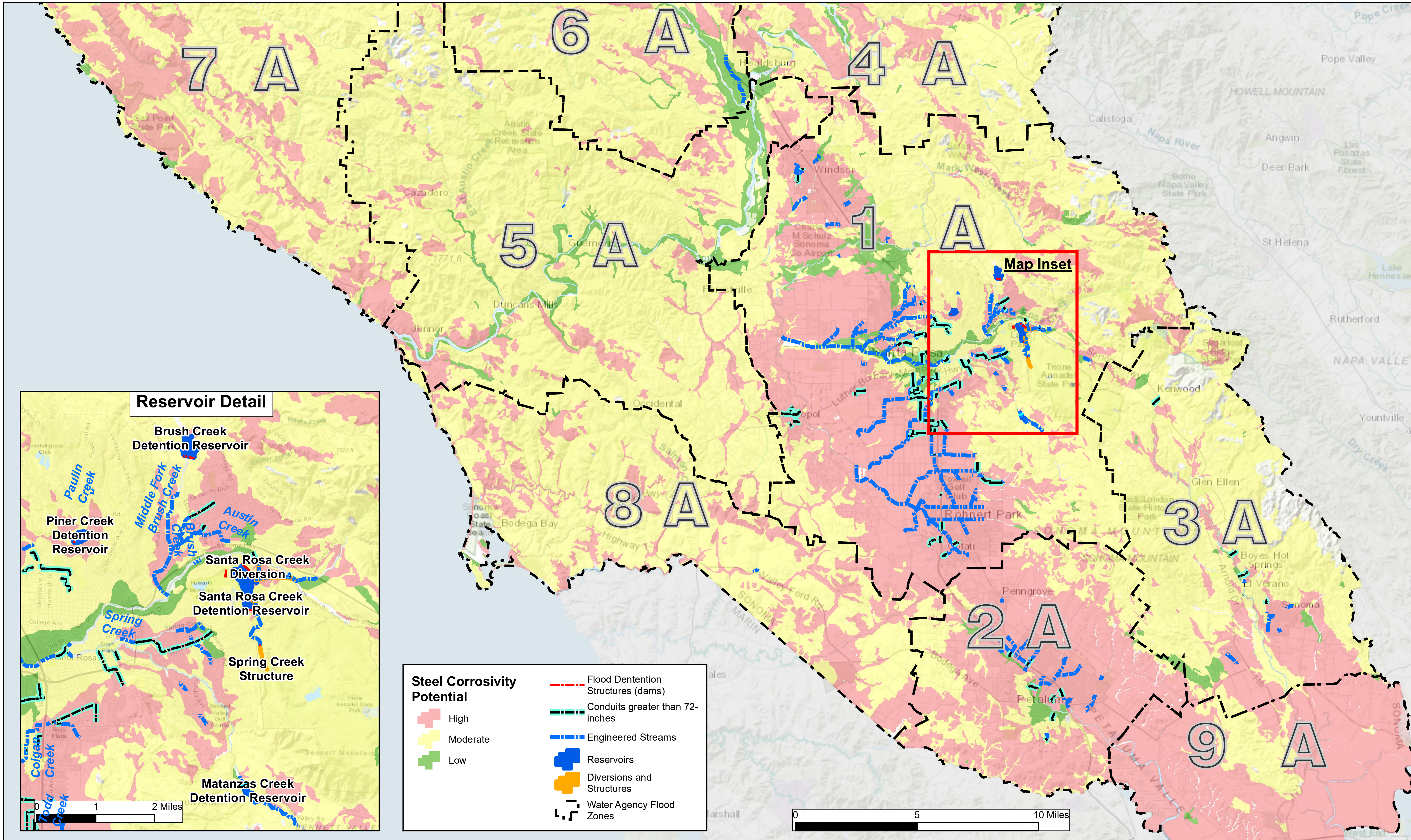

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Sonoma Water LHMP

Flood Protection Infrastructures - Corrosive Soil - Steel

NORTH

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Sonoma Water

Figure 36

Appendix F

Sonoma Water Organizational Chart

Sonoma County Water Agency
Position Allocations: 260

Updated: January 31, 2023

Water Agency General Manager

- 1 - Administrative Aide - Confidential

1 - WA Division Manager

Environmental Resources Division

Environmental Resources
- 2 – WA Environmental Resources Manager
- 4 – WA Principal Environmental Specialist
- 7 – WA Senior Environmental Specialist
- 6 – WA Environmental Specialist
- 4 – WA Resource Programs Technician

1 - WA Assistant General Manager

Emergency Management & Security Division
- 1 - Administrative Service Officer II
- 1 – Administrative Services Officer I
- 2 - Department Analyst
- 1 – Senior Office Assistant

Community and Government Affairs Division
- 1 – WA Community Affairs Manager and Ground Water Administrator

Water Education
- 1 – WA Principal Programs Specialist
- 2 – WA Senior Programs Specialist
- 2 – WA Programs Specialist

Community Affairs
- 1 – WA Principal Programs Specialist
- 2 – WA Senior Programs Specialist
- 2 – WA Programs Specialist

Administrative Services
1 - WA Division Manager

Risk Management
- 1 – Risk Management Analyst III
- 1 – Risk Management Analyst II

Human Resources & Administration
- 1 – Administrative Services Officer II

Recruiting, Training & Payroll
- 1 – Department Analyst
- 1 – Payroll Clerk
- 1 - Secretary
- 1 – Senior Office Assistant

Records Management/Clerical
- 1 – Department Analyst
- 1 – Administrative Aide
- 6 – Senior Office Assistant

Budgets/Accounting/Long Range Financial Planning
- 1 – Administrative Services Officer II

Grants and Funded Projects
- 2 – Administrative Service Officer I
- 1 – Department Analyst
- 2 – Accountant II
- 4 – WA Technical Writing Specialist
- 1 – Accounting Technician

Budgeting
- 2 – Administrative Services Officer I
- 1 – Accounting Technician

Accounting
- 1 – Accountant III
- 1 – Administrative Aide
- 1 – Accounting Technician
- 1 – Senior Account Clerk
- 2 – Account Clerk II

Engineering and Resource Planning
1 - WA Chief Engineer/Director of Groundwater Management

Engineering
- 2 – WA Deputy Chief Engineer

Energy Resources
- 1 – WA Principal Engineer
- 1 – WA Engineer
- 1 – Dpt. Program Manager

Survey/Right-of-Way
- 1 – WA Land Surveyor
- 1 – Licensed Land Surveyor
- 4 – WA Engineering Technician
- 1 – Supervising Right of Way Agent
- 1 – Right of Way Agent

Construction Management Contract Administration/ Inspection
- 1 – WA Principal Engineer
- 2 – WA Engineer
- 2 – WA Engineering Technician
- 1 – Project Specialist

Design Engineering
- 1 – WA Principal Engineer
- 6 – WA Engineer

Drafting/GIS
- 1 – WA GIS/CAD Coordinator
- 3 – WA GIS Analyst
- 2 – WA Engineering Technician

Operations Engineering
- 1 – WA Principal Engineer
- 5 – WA Engineer
- 1 – WA Engineering Technician

Electrical Engineering
- 1 – WA Principal Engineer
- 1 – WA Engineer

Resource Planning
- 1 – WA Principal Engineer
- 5 – WA Engineer
- 1 – WA Hydrogeologist

Groundwater Resources
- 1 – WA Principal Hydrogeologist
- 2 – WA Hydrogeologist

Technical Writing
- 1 – Technical Writing Manager
- 2 – WA Senior Technical Writing Specialist
- 4 – WA Technical Writing Specialist

Water Use Efficiency
- 1 – WA Principal Programs Specialist
- 2 – WA Senior Programs Specialist
- 2 – WA Program Specialist

Water/Wastewater Operations
1 - WA Assistant General Manager

1 – WA Operations & Maintenance Mgr.

Laboratory
- 1 – WA Coordinator
- 4 – WA Chemist
- 1 – WA Engineering Technician

Water/Wastewater Operations
- 3 – WA Coordinator
- 16 – WA Senior Plant Operator

Instrumentation/Electrician
- 1 – WA Coordinator*
- 3 – WA SR Electrician/Instrumentation Technician
- 4 – WA Electrician/Instrumentation Technician II
- 3 – WA SCADA Tech. Analyst

Computer Instrumentation / Applications Support
- 1 – Engineering Programming Manager
- 1 – Dept. Information Systems Manager
- 2 – Systems Software Analyst
- 1 – Senior Business Systems Analyst
- 2 – HS Systems and Programming Analyst
- 1 – Dept. Information Systems Coordinator
- 2 – Dept. Information Systems Specialist
- 1 – Dept. Information Systems Technician

Maintenance
1 - WA Assistant General Manager

1 – WA Operations & Maintenance Mgr.

Maintenance Mechanic Services
- 4 – WA Coordinator
- 6 – WA Lead Mechanic
- 21 – WA Mechanic
- 1 – Material/Equipment Specialist
- 1 – Lead Heavy Equipment Technician
- 1 – Heavy Equipment Technician
- 2 – Automotive Technician
- 1 – Department Analyst

Environmental Services Maintenance/Facilities
- 1 – WA Coordinator
- 2 – WA Lead Maintenance Worker
- 5 – WA Senior Maintenance Worker
- 2 – WA Maintenance Worker II
- 2 – Building Mechanic II
- 2 – Environmental Compliance Inspector
- 1 – Environmental Compliance Technician

Field Operations
- 1 – WA Coordinator
- 1 – WA Engineer
- 2 – WA Lead Maintenance Worker
- 1 – WA Vegetation Control Advisor
- 9 – WA Senior Maintenance Worker
- 1 – WA Maintenance Worker II

Appendix G

PLACEHOLDER

Adoption of LHMP by Board Resolution

Board Resolution Adopting the 2023 Sonoma County Water Agency Local Hazard Mitigation Plan