Sonoma Developmental Center
Existing Conditions Report
Hydrology and Site Infrastructure
Draft

Sherwood Design Engineers
January 8, 2018

SHERWOOD
DESIGN ENGINEERS

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ABBREVIATIONS

bgs	below ground surface
BMO's	Basin Management Objectives
BMP	Best Management Practice
cfs	cubic feet per second
CIP	Capital Improvement Plan
DDW	State Water Resources Control Board Division of Drinking Water
DODS	California Department of Water Resources Division of Dam Safety
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
HSG	Hydrologic Soils Group
LID	Low-Impact Development
M	million
MACL	maximum allowable contaminant level
MGD	million gallons per day
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
SCADA	Supervisory Control and Data Acquisition
SCWA	Sonoma County Water Agency
SDC	Sonoma Developmental Center
SGMA	Sustainable Groundwater Management Act
SVCSD	Sonoma Valley County Sewer District
USGS	United States Geological Service
VOMWD	Valley of the Moon Water District
WTP	Water Treatment Plant

LIST OF EXHIBITS

PHOTOS

1. Executive Summary

Sonoma Developmental Center is a large, substantially undeveloped area that lays across the Sonoma Valley from near Highway 12 to the east, across Sonoma Creek at about 175 ft elevation and well up the slope of the Sonoma Mountains to elevations above 900 ft. Much of the land is moderately sloped between 5% and 10% slope. Soils on the site are Hydrologic Group C and D, which have low to very low infiltration rates due to the presence of clay and silt. Although these soils are prone to erosion on steeper slopes. Much of the property has significant vegetation and humic material which will hold water and aid in slow infiltration. Transpiration may be a significant factor in the overall water balance due to the large number of mature trees and other vegetation.

Historic 100-year flood flow in Sonoma Creek, per FEMA model, is fully contained within the creek banks. Five hundred-year flows overtop the banks but flood only undeveloped areas near the creek. Impacts of climate change may significantly increase the occurrence of these flow levels, however, and more frequent, more extreme storms, combined with the potential of debris blockage at bridge crossings may override the low flood risk implied by the FEMA model. While rising water in the creek has not posed a hazard on the campus, surface runoff during storm events has impacted buildings due to grading and low finished floor elevations.

There are significant water sources on the SDC property, including springs, wells and creeks supported by an average annual rainfall (at Fern Lake) of 47.03 inches per year. The property has both appropriative and riparian water rights, several of which are grandfathered into modern water rights statutes, and provide ample water for any modest future development of the property. Asbury Creek and Hill Creek that run roughly along the north and south borders of the property respectively, provide water to the property via piped diversions at weir structures. Both diversion structures have been recently rebuilt and include weirs, gages and monitoring equipment. Water is diverted from these creeks into Fern Lake. Additional water from a group of seeps known as Roulette Springs is piped directly to the water treatment plant. Water is also pumped during winter from Sonoma Creek into Suttonfield Lake. Fern Lake and Suttonfield Lake provide 840 acre-feet of combined raw water storage, which is available to be treated for domestic water supply or managed as fire suppression stores. Of the four documented wells on the property, only the Camp Via well is still active. It supplies a separate water system at the Camp.

The raw water transmission system is in moderate to poor condition and will likely require replacement in the next 10-15 years. The system functions through a single 10-inch transmission line (ductile iron, but repairs have been made with PVC) that runs in both directions, depending upon system demands. Staff manually operate valves and pumps to shuttle water between storage locations. The pumphouse, located near Butler Building, has five pumps which can be used in various combinations, depending upon the transmission requirements. The pump house is in fair condition and the pumps have been well maintained.

The campus water treatment plant, originally built in the 1930's, can treat up to 1.8 million gallons per day (MGD), although it currently operates at about 0.2 MGD. This is the lowest flow rate at which the plant can effectively function; current demand is less than 0.2 MGD. The facility is licensed as a small community water system regulated by the State Water Resources Control Board Division of Drinking Water. The raw water quality is generally very good, having low turbidity and low levels of contaminants of concern. While the existing facility is old, it has been maintained and is functionally in full compliance with current regulations. A future owner should evaluate what, if any, upgrades are appropriate for the planned intended demand.

The treatment plant consists of a main building that houses the filtration units, controls system, chemical dosing and a small laboratory. The clarifier and sedimentation tank are outdoor units enclosed with large tents that provide functional protection from wind-blown contaminants. The plant uses alum and sodium hydroxide, stored in 5,000-gallon tanks outside with day tanks in the filter building. Chlorine is generated on site, also in the filter building. Routine laboratory tests are performed daily at the plant and more complex testing, such as bacteriological and metals analysis, is done at a commercial lab. Plant operations, and chemical dosing is controlled by a System Control and Data Acquisition (SCADA) system. The SCADA system was installed in 1995 and while it is due for an update, it and all plant controls are maintained through a third-party contract. The filter backwash system is supplied by gravity from a plant water tank on the knoll across the road from the plant, while the backwash discharge is settled in a series of recirculation tanks and once settled, returned to the headworks of the plant. Finished (treated) water is stored in two tanks with a combined capacity of 1.3 million gallons at the plant. Another 600,000 gallons of treated water is stored in the balance tanks above Suttonfield Lake.

Treated/domestic water is transmitted to the main campus distribution system in three 8-inch pipelines, which connect to the network near the Laundry and Goddard buildings. The condition of these transmission lines in unknown, but due to their age, are presumed to be near the end of their useful life. A 12-inch treated water transmission line, connecting near the intersection of Manzanita and Holt Roads, was installed to increase fire flow pressure in 1989 and is presumed to be in good condition. The water distribution system in the main campus consists of multiple interconnected systems, some of which are well beyond their useful life. These older pipelines are primarily built with asbestos cement pipe or cast-iron pipe with lead packing. A new main line system throughout the main campus was installed in 1995. New development should consider only this new portion of the system as viable and all laterals and older portions of the system as obsolete. The alignment of the new system may be appropriate for a future utility corridor. There is no separate non-potable system nor a separate fire water system on the campus.

The SDC has an agreement with the Sonoma Valley County Water Agency that the SVCWA will supply water to the SDC through an intertie connection located near the old dairy. However, this connection is not currently operable. The SDC also has an agreement with the Valley of the Moon Water District to provide water, on loan, to the District for emergency purposes via an intertie connection along Arnold Drive. This connection requires a portable pump be used to transfer the water.

The sanitary sewer collection system has not undergone regular cleaning, inspection or maintenance. The system was built in the 1920's and 30's using primarily vitrified clay and cast-iron pipe. Repairs have been made using PVC. Root intrusion has been the primary maintenance problem. The entire system is considered obsolete and in need of replacement for all new development. The sewage lift station near the farm was destroyed in the October 2017 fire. No functioning sewer system remains in the eastern portion of the property. The sewage lift station that serves Lux, Regamey and Emapran buildings was substantially damaged and only the pumps were salvageable. If these facilities are to be used in the future, they either need to be directly connected to the SCVWD or this lift station needs to be replaced.

The traditional piped/channelized storm drain collection system is beyond its useful life. In consideration of future development, more modern, environmentally conservative approaches to stormwater management should be employed that will enhance environmental functions, support groundwater levels and avoid sediment and contaminant loadings to the receiving streams. Such management practices are required by state and local regulations for new development. An analysis was performed considering topography, rainfall, vegetation, soil types and development type that identified the preferred locations of several types of stormwater management practices. These included:

1. Maintain upland retention and infiltration to reduce erosion and sediment transport;
2. Develop low-impact development (LID) measures within the main campus area for decentralized treatment and infiltration of stormwater; and
3. Wetland restoration and slow infiltration to groundwater in the eastern valley area of the property.

The condition of roads and sidewalks varies considerably within the main campus; much of it needs to be replaced or removed, depending upon plans for development. An analysis of the pervious versus impervious areas within the core campus area indicates that 74% of this area is impervious (roads, other paved areas and roofs). LID measures to remove a significant amount of impervious areas and replace this with pervious pavements, location-appropriate landscaping and native vegetation restoration will advance the goals of stormwater management, riparian and wildlife corridor protection and groundwater recharge potential.

The Sonoma Valley Groundwater Management Plan has identified 10 Basin Management Objectives aimed at moving the Valley toward sustainable groundwater condition. These include the intent to "identify and protect groundwater recharge areas and enhance the recharge of groundwater where appropriate". There are several opportunities to enhance groundwater recharge on this property.

On-site wastewater treatment could be reinstated at the SDC to relieve demand on the regional treatment facility and collection system, provide high-quality reclaimed water for non-potable uses (primarily agriculture) in the upper valley and provide a water source for wetland restoration and slow groundwater recharge in the eastern portion of the property.

2. Hydrology

2.1. Regional Hydrology

The Sonoma Valley is tucked between Sonoma Mountain to the west and the Mayacamas Range to the east. The mountain slopes are mostly undeveloped and wooded with numerous small seepages, springs and creeks. The slopes are moderate, primarily at less than 20% grade. The entire valley drains to Sonoma Creek, which discharges to the San Francisco Bay via Skaggs Island and the San Pablo Bay National Wildlife Refuge. The entire Sonoma Valley, ridge to ridge and from Mount Hood to the bay are all within the Sonoma Creek watershed.

The Sonoma Valley experiences significant variation in rainfall, with the higher elevations and northern reach of the valley receiving significantly greater precipitation. The National Weather Service Cooperative station data dating back to 1898 record annual rainfall between 11.34 and 63.45 inches with an average recorded annual rainfall of 29.4 inches in the town of Sonoma. Since 1953, the Sonoma Developmental Center has maintained a gage at Fern Lake on the northeastern slope of Sonoma Mountain. This location has experienced between 15.05 and 116.64 inches of rain during the (September 1 to August 31) year, with an average annual rainfall of 47.03 inches. Typically, the upper reaches of the watershed receive roughly 40-50% more rainfall than the valley floor. This precipitation drains to creeks, seeps into the soils, feeds the vegetation, recharges the groundwater, dissipates into the atmosphere through evaporation and transpiration, under saturated conditions, and seeps out of the ground to flow into streams and Sonoma Creek. These streams are the collectors in sub-watersheds that are determined by the topography over which the water flows. Exhibit 2.1 depicts the region highlighting the Sonoma Creek Watershed. Exhibit 2.2 presents an isohyetal map of the region indicating the variation of rainfall between the valley floor and higher altitudes.

Regionally, the Sonoma Valley depends heavily on groundwater for domestic and agricultural uses. Studies by the USGS and others have identified that groundwater pumping has increased significantly in recent years and that the Sonoma Valley is now experiencing declining groundwater levels and related concerns over groundwater quality as a result of potential seawater intrusion and geothermal upwelling. In response to these concerns, and well ahead of state mandated reporting by the Sustainable Groundwater Management Act, the Sonoma Valley Water Agency, local water districts and other local stakeholders developed a Groundwater Management Plan for the Sonoma Valley groundwater basin in 2007. This plan developed a set of Basin Management Objectives (BMO) to preserve, protect and manage groundwater resources in the region. Among these BMOs is one to identify, protect and enhance the recharge of groundwater where appropriate.

Regional water supply is discussed further in Section 3 of this report.

2.2. Site Conditions

2.2.1. Topography

The SDC property forms a swath across the Sonoma Valley and up the slope of the mountains on the western side. The eastern property boundary abuts state Forest Service property near Highway 12 at an elevation of approximately 400 feet. This eastern part of the site is undulating small hills with a valley that begins in the northeastern corner of the property and broadens as it slopes downward toward the south. Suttonfield Lake is a reservoir formed among the hills in the northeast corner of the site. These hills for a small ridge between the "Farm" area of the site to the east (at approximately 230 feet) and the eastern campus. The eastern campus (approx. elevation 200 feet) is a flat area between this low ridge and Sonoma Creek.

Sonoma Creek cuts across the midsection of the property with a water surface elevation at roughly 170 feet. West of the creek, the campus is flat for a few blocks of broad manicured lawns, including sports fields and a broad parade ground up to Sonoma Road. West of Sonoma Road, the grade increases as you continue across the rest of the main campus. By the time you reach Manzanita Street at elevation 250, the grade increases noticeably. Refer to Exhibit 2.3 Elevation for a map of the topography of the property. Roughly a third of the property is west of the main campus with slopes from 10% to well above 20%. Refer to Exhibit 2.4 for a slope analysis, which uses existing grades to identify different slope gradients on the site. The property reaches an elevation of approximately 900 feet and the surface elevation of Fern Lake is roughly 590 feet.

2.2.2. Soils

Soil properties, along with vegetation, slope, rainfall, development and pavement are a key consideration in understanding the site hydrology. In general, the soils found on the property are not very infiltrative, meaning that while water will percolate into the soils, it will do so quite slowly. Exhibit 2.5 depicts near surface soils found on the site, classified by Hydrologic Soil Group, a classification system developed by the Natural Resource Conservation Service to assess the runoff potential of soils. The dominant soil types found on the site are Group C and D, which have the highest runoff potential and low to very low infiltration rates because of the presence of clay or other properties that impede the movement of water within the soil. On steeper slopes, precipitation is likely to form surface runoff. In flat areas, surface water will tend to puddle. The primary way to improve infiltration in these soils is through vegetation and ponding. Vegetation acts to hold fine soils in place and reduce the energy of runoff. Ponding allows water to slowly infiltrate and provides a water source for the small components of the biosystem. Class C & D soils that are on steep slopes with poor vegetative cover are prone to soil erosion from the slopes and sedimentation of the water courses to which they discharge, creating an ecologically unstable condition. The natural vegetative cover and slowing the overland flow of runoff by encouraging upland ponding, help to maintain the ecological stability of the property.

Refer to the geotechnical report by PJC & Associates (2017) for a more in-depth discussion of the site geology, soils and geologically related concerns on the property.

2.2.3. Vegetation

The forested areas, which dominate the western part of the property, are heavily overgrown with a substantial amount of forest material (fuel) on this part of the property. This vegetation, however, as noted above, provides a significant "sponge" to retain water, reduce runoff, guard against soil erosion, supplement groundwater, and provide other ecological benefits discussed elsewhere in this report. Vegetation plays a significant role in the hydrologic cycle. Plant roots hold soil in place, break up soil and provide a path for water to infiltrate deeper into the ground, and take up water into the plant stem. Plant growth, especially the leaves of a plant, release water into the atmosphere. This transpiration may be a significant factor in the overall water balance. Between the humic matter on the ground and the growing vegetation, a thriving forest, grassland, wetland, or other vegetated environment is a critical factor in assessing the hydrologic balance on the property. The significant number of mature trees on the property, whether in the forest or planted in the main campus area, similarly provide significant hydrologic benefits.

While an environmental assessment of the eastern part of the property, after the recent fire, will help identify the status of vegetation, a mild but damp 2017-18 winter will support a regrowth of native grasses that will encourage wetland habitat and avert potential erosion. Exhibit 2.6 depicts the (pre-fire) vegetation map of the property. Note that the area of the fire includes an area where favorable wetland vegetation formerly thrived. However, reestablishment of native wetland habitat will require management by seeding, planting, and removing nonnative plants.

2.3. Site Hydrology

2.3.1. Historical Rainfall

As mentioned above, rainfall on the SDC property tends to be higher than that experienced at the National Weather Service gage a few miles away, but at lower elevation. Annual precipitation recorded at Fern Lake is 15.05 inches to 116.04 inches, with an annual average precipitation of 47.03 inches. Although no historical rain gages have been maintained at the far eastern part of the property, it is likely that that area experiences less rainfall than at Fern Lake and sees similar precipitation as that found at the Sonoma gage.

2.3.2. Flood level

Sonoma Creek, in the reach within the SDC property, runs through a natural channel that is wide and deep enough to contain the 100-year storm. While there are numerous bridges and utilities crossing the creek that could become blocked by trees or other flood debris being caught in an undercrossing, barring a blocked undercrossing, even in a 500-year storm, only the banks near the creek where there are no buildings would be expected to be inundated. Exhibit 2.7 depicts the FEMA flood zone for the 100-year and 500-year storm event. It is likely that in the foreseeable future, what we currently consider as a 100-year storm will be downgraded, as we develop tools to assess the impacts of climate change and incorporate new climate assessments into flood forecasting. However, given the topography, the risk of flooding on the SDC campus from Sonoma Creek is remote. The greater concern is existing finished floor elevations and site drainage from surface runoff. Improvements to surface runoff during major wet weather events will reduce the risk of stormwater at building entrances. This concern is discussed in greater detail under Section 6.1.

2.3.3. Creeks and Watersheds

Sonoma Creek, the primary watercourse through the Sonoma Valley and the drain for the Sonoma Creek watershed, bisects the SDC property. All on-site storm drainage flows to Sonoma Creek. Two major tributary creeks frame the western part of the property: Asbury Creek to the north and Hill Creek to the south. (On some maps and documents, Hill Creek is also referred to as Mill Creek.) Part of Butler Canyon Creek cuts across the far eastern corner of the property. Numerous smaller, seasonal, unnamed water courses and seeps are also found on the property. The property has significant available surface and near-surface water availability. Exhibit 2.8 shows these creeks and their watersheds. SDC maintains water diversion systems on Hill and Asbury creeks that provide most of the water supply for the campus. See the section on water supply for details on the water supply system.

An analysis performed by the Sonoma Valley Water Agency in 2015 using historical data from the nearest stream gage on Sonoma Creek at Agua Caliente (about 2 miles downstream) and the rainfall data from the Sonoma gage identified base flows in Sonoma Creek to be approximately 0.7 cubic feet per second (cfs), as the average flow in September (driest month) has been 0.73 cfs. The reach of Sonoma Creek that flows through SDC has typically been a "gaining" stream, meaning that more water drains or weeps into the creek than is infiltrated into the ground from the water flowing in the creek. This indicates surplus near-surface water availability on the property during much of the year.

2.3.4. Groundwater resources

Although groundwater is found in all soil types on the SDC property, groundwater resources within SDC property are predominantly found within Sonoma Volcanics geologic formations and are most evident in the form of seeps and springs west of Fern Lake. There are four wells on the property:

- The Camp Via well, roughly half a mile west and uphill from Fern Lake;
- The Suttonfield well at the southwest edge of Suttonfield Lake;
- The Dairy well near the intersection of Sunset and Dairy Roads; and
- The Soccer Field well opposite residence #150 at the end of John Mesa Rd.

The Camp Via well has been used to supply water to the Camp, a 5-acre outdoor recreational facility for the residents of SDC. This well is developed to 195 feet below ground surface (bgs) and draws from groundwater between 75 and 195 feet deep. At the time of its development, the yield of this well was 20 gallons per minute (gpm) with a drawdown of 35 feet. This well and its water supply system is designated as a transient noncommunity water system. It is used locally only and not piped to other parts of the property.

The Suttonfield Well is a water supply well developed to 890 feet bgs and draws from between 570 and 870 feet. At the time of its development, its yield was recorded as 300 gpm. (No drawdown was recorded.) No record of current yield is available; however, as yield tends to decline over time, it is likely the current yield is lower than 300 gpm. This well was taken out of use because of temperature and mineral content.

The Dairy well, in front of the old dairy has been closed with a brick dome. No information has been identified with regard to the quantity and quality of the water from this well, nor is it known why it was closed.

Records indicate that the Soccer Field well was used for irrigation of the playing fields in the southeast corner of the property until recent years and offer no mention that the well has been capped, plugged or abandoned. However, when staff went out to locate the well for this report, it could not be positively identified. Near where it was believed to be was a small pile of rock and concrete rubble, which may be all that remains of it. At the intersection of Dairy and John Mesa Roads, there are still two concrete pads where storage tanks used to be.

These four wells are located on Exhibit 3.1.

2.3.5. Geothermal resources

The California Division of Mines and Geology has investigated the geothermal potential on the property and concluded that there may be higher temperature groundwater northwest of the Eastside Fault zone in the easternmost area of the property. This conclusion seems to be borne out by the somewhat elevated temperatures found in the Suttonfield well. In 1982, a private contractor performed a geothermal investigation, including drilling a 1,400-foot-deep exploratory well. The results at this exploratory well were apparently inadequate to warrant further investment because the well was never used. It was abandoned and plugged in 1987. However, it should be noted that this well was drilled quite some distance from the area the CDMG identified as most promising for geothermal exploitation.

2.4. Impacts of Climatic Variation

As local climate conditions change in the future, we can expect the extremes in the weather to become more frequent. More intense rain events and droughts are likely to become more common. The notion of a 10-year storm or a 100-year storm should be reconsidered because we are likely to see peak flood stages for what is now considered a 10-year event happen with statistically greater frequency than every 10 years. What this will mean for the project site is that short-burst intense rainfall will result in higher than normal runoff, less groundwater replenishment, more soil erosion, and increased sediment transport into the creeks. Supporting the creation of a robust environment that will be able to withstand or rebound from frequent extreme weather events will include tactics that preserve vegetation and retain water on steeper parts of the site. Slowing runoff encourages infiltration, which will support vegetation growth, which will, in turn, help retain soils.

2.5. Constraints and Opportunities

2.5.1. Water Rights

The SDC holds several specific water rights including both riparian and appropriative rights and rights that were held before 1914 when the state water rights legislation was enacted. It is the regulation of these rights that governs how much water can be diverted from watercourses and how that water can be used. While the pre-1914 riparian rights do not permit storage of water, the SDC has secured additional appropriative rights to store water for beneficial use. In this manner, the facility can secure adequate stores of water to provide reliable year-round domestic water for all uses at the property, to compensate for drought, and to provide substantial storage for fire suppression. The SDC has an agreement with the Valley of the Moon Water District (VOMWD) to provide emergency water for fire protection or other emergency conditions. The water system also has a direct connection to the Sonoma County Water Agency in the event the SDC needs to supplement their water supply, such as if they need to perform maintenance on the water treatment plant (WTP). It is expected that the SDC has ample rights to continue to divert water and to store water for beneficial use for future moderate density development of the property, including domestic, irrigation and fire suppression requirements.

2.5.2. Minimum stream flows and wildlife corridors

As is noted elsewhere in this document, the property boasts a critical wildlife corridor between the Sonoma Mountains and the Mayacamas Range. A host of animals are dependent upon the wild riparian corridors, fed by the local streams, within and adjacent to the SDC property and passage across the valley. The property hosts a pinch point in this wildlife corridor where it "necks" down near Arnold Drive. Sustainable ecological balance and biodiversity requires that this corridor and the riparian habitat that supports it be protected.

2.5.3. Groundwater management plan

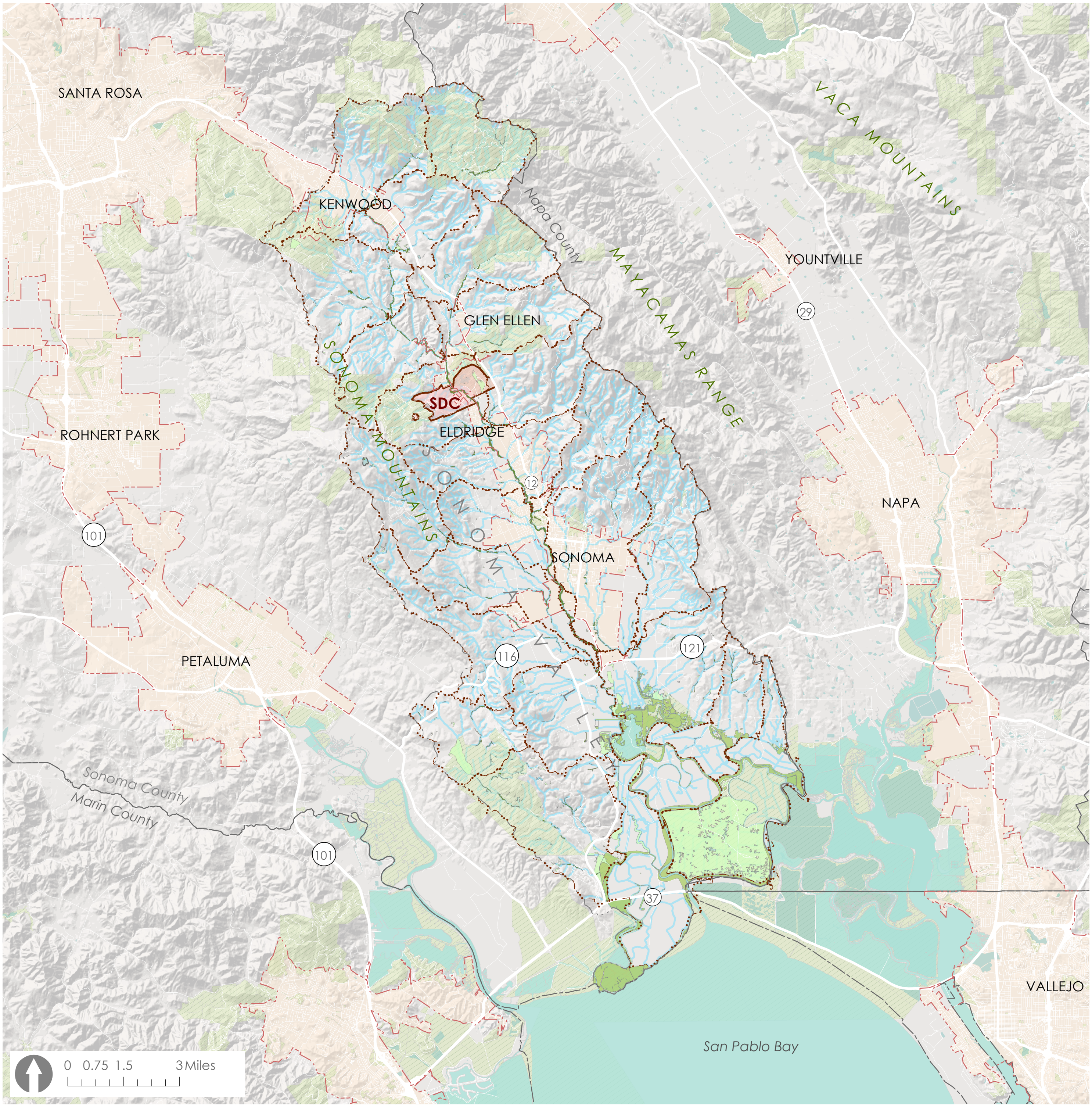
The valley's groundwater management plan presents both opportunities and constraints. The region as a whole has seen dropping groundwater levels over the last few decades as demand, particularly in the southern part of the valley, has increased and groundwater supplies have been overdrawn beyond their capacity for natural recharge. The Sonoma Valley Groundwater Management Plan has identified ten Basin Management Objectives (BMO's) aimed at managing the valley's groundwater to achieve a sustainable condition. These BMOs include the intent to "identify and protect groundwater recharge areas and enhance the recharge of groundwater where appropriate." The property could represent a significant opportunity to recharge groundwater upgradient in the groundwater basin for improved regional groundwater sustainability. Water to be recharged could be surplus water from the current water supplies on the property. Another source of recharge water could be developed by construction of an on-site wastewater treatment plant that would provide relief to the local collection and transmission system and provide a source of reclaimed water in the northern part of the valley. Or recharge water could be a blend of various source waters. A treatment plant located near the Junior Farm could provide source water for the restoration of wetlands in the area most suited to recharge and where historic hydrologic elements may provide a conducive environment to a restored native habitat. Refer to later sections of this report for a discussion on the groundwater infiltration opportunities on the SDC properties. Refer to the report on the ecology of the property, prepared by Prunuske and Chatham, Inc., for additional discussion on the potential for wetland restoration on site.

2.5.4. Resilient Best Management Practices (BMPs)

Best management practices (BMP) that are designed to provide robust environmental services in the face of climate change are ideal for implementing along with any development at the SDC. Such measures may include protecting and restoring the riparian zone along the major creeks, maximizing the upland retention of stormwater, and infiltrating or recharging stormwater to the groundwater. Inclusion of resilient BMPs can be expected to require lower long-term costs than what would be associated with repair and expansion of traditional or structural control measures that resist the flow of natural systems. Resilient BMPs are discussed further under Section 6.2.

Exhibit 2.1

REGIONAL WATERSHED HYDROLOGY

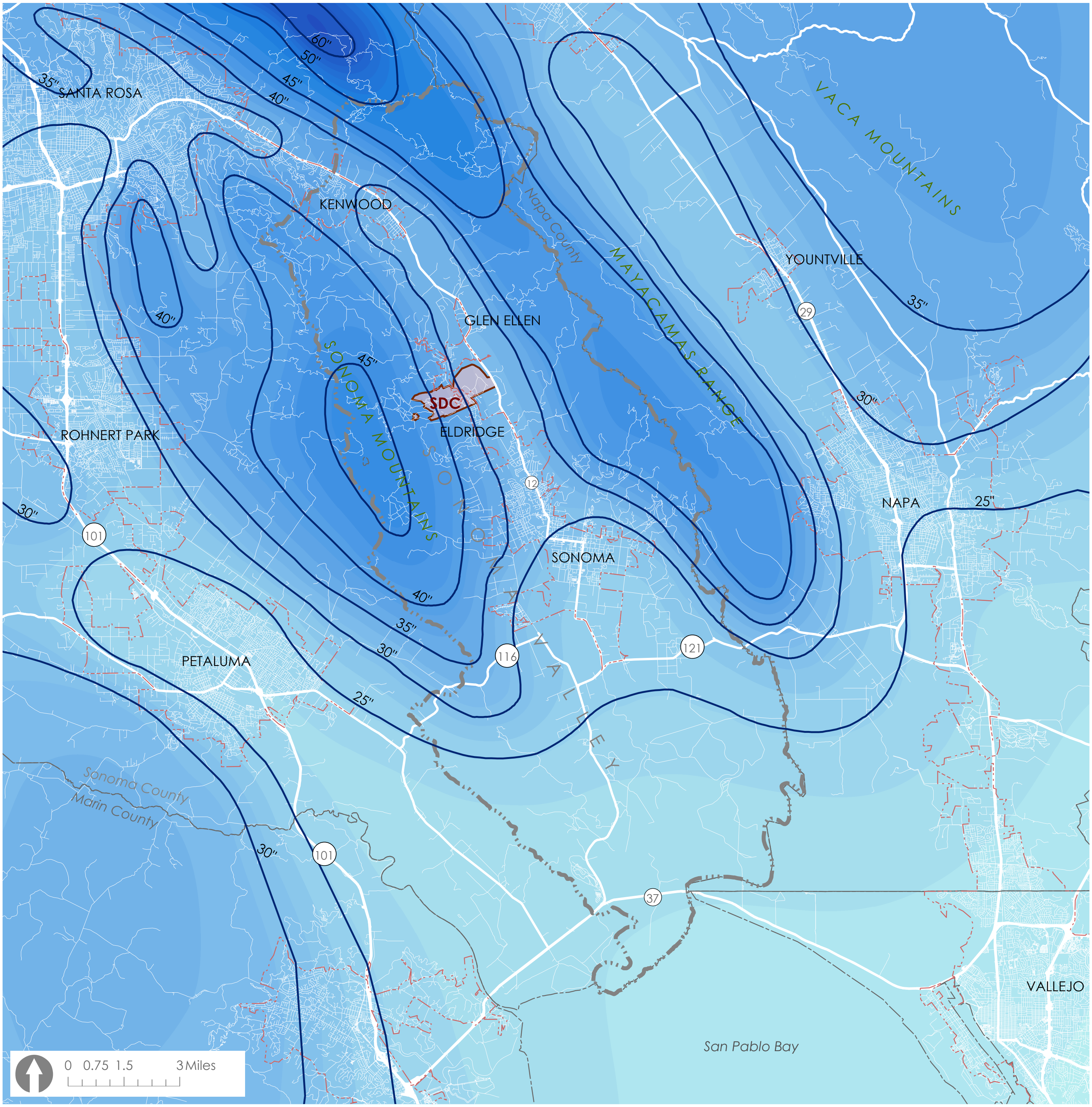


Sonoma Creek Micro-Watersheds
Sonoma Creek Watershed
County Boundary
SDC Property
Water
Public and Protected Lands
Streams
Urbanized Areas
Freshwater Herbaceous Wetland
Tidal Salt Marsh
Woody Riparian

Sources:
USGS, US Census Bureau, California Geoportal, GreenInfo Network, Sonoma Ecology Center, Sonoma County Water Agency, Sonoma County Agricultural Preservation and Open Space District, Sonoma County Vegetation Mapping and LiDAR Program, San Francisco Estuary Institute

Exhibit 2.2

RAINFALL



Sonoma Creek Watershed

County Boundary

SDC Property

ISOHYETAL
(Inches)

20"

30"

40"

50"

60"

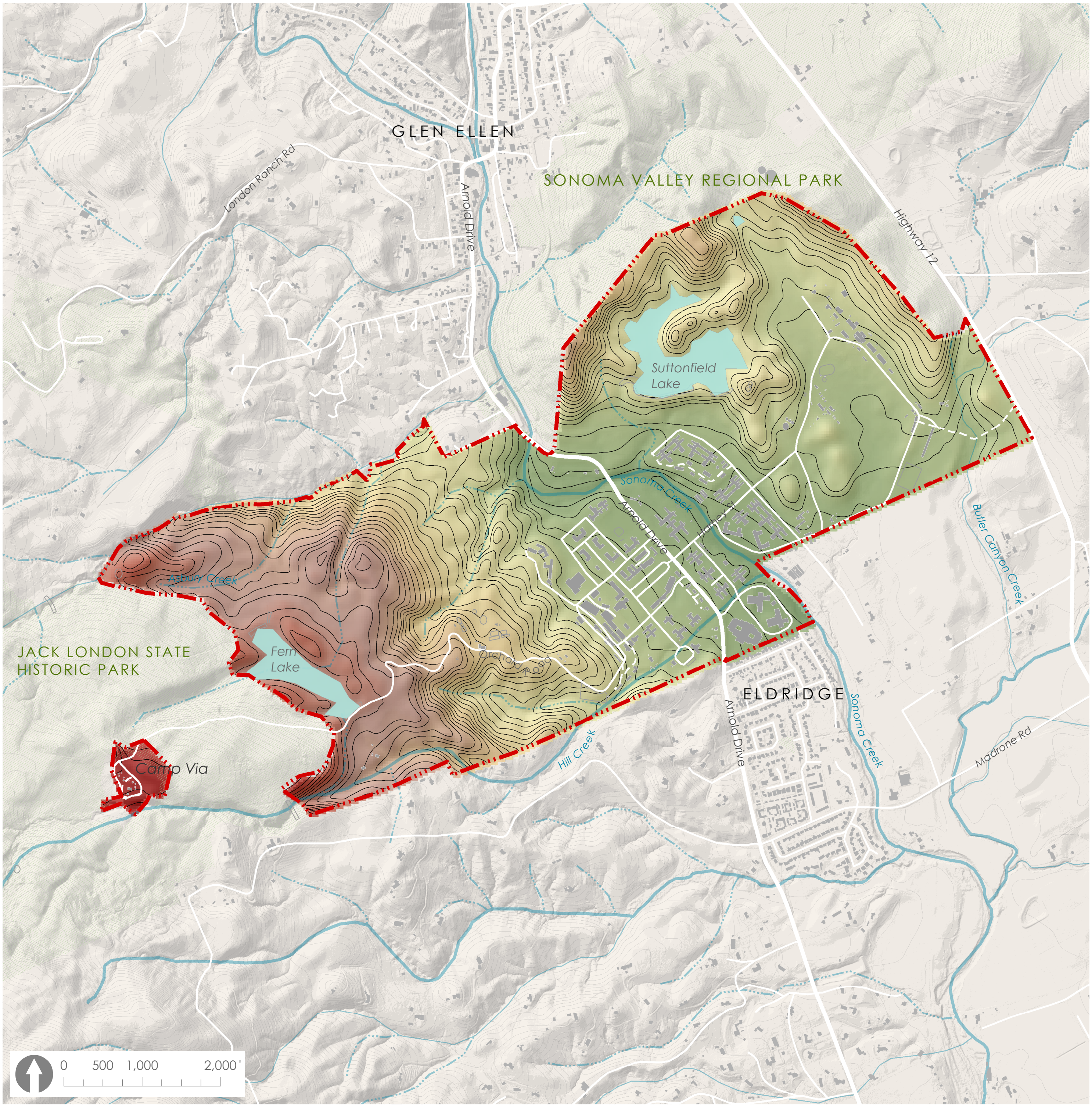
70"

80"

Sources:
USGS, US Census Bureau, California Geoportal, GreenInfo Network, Sonoma Ecology Center. Sonoma County, Sonoma County Water Agency

Exhibit 2.3

TOPOGRAPHY



SDC Property line

Lakes

Ephemeral Streams

Perennial Streams

Intermittent Streams

On-Site Contours (5m)

Protected and Public Lands

Elevation

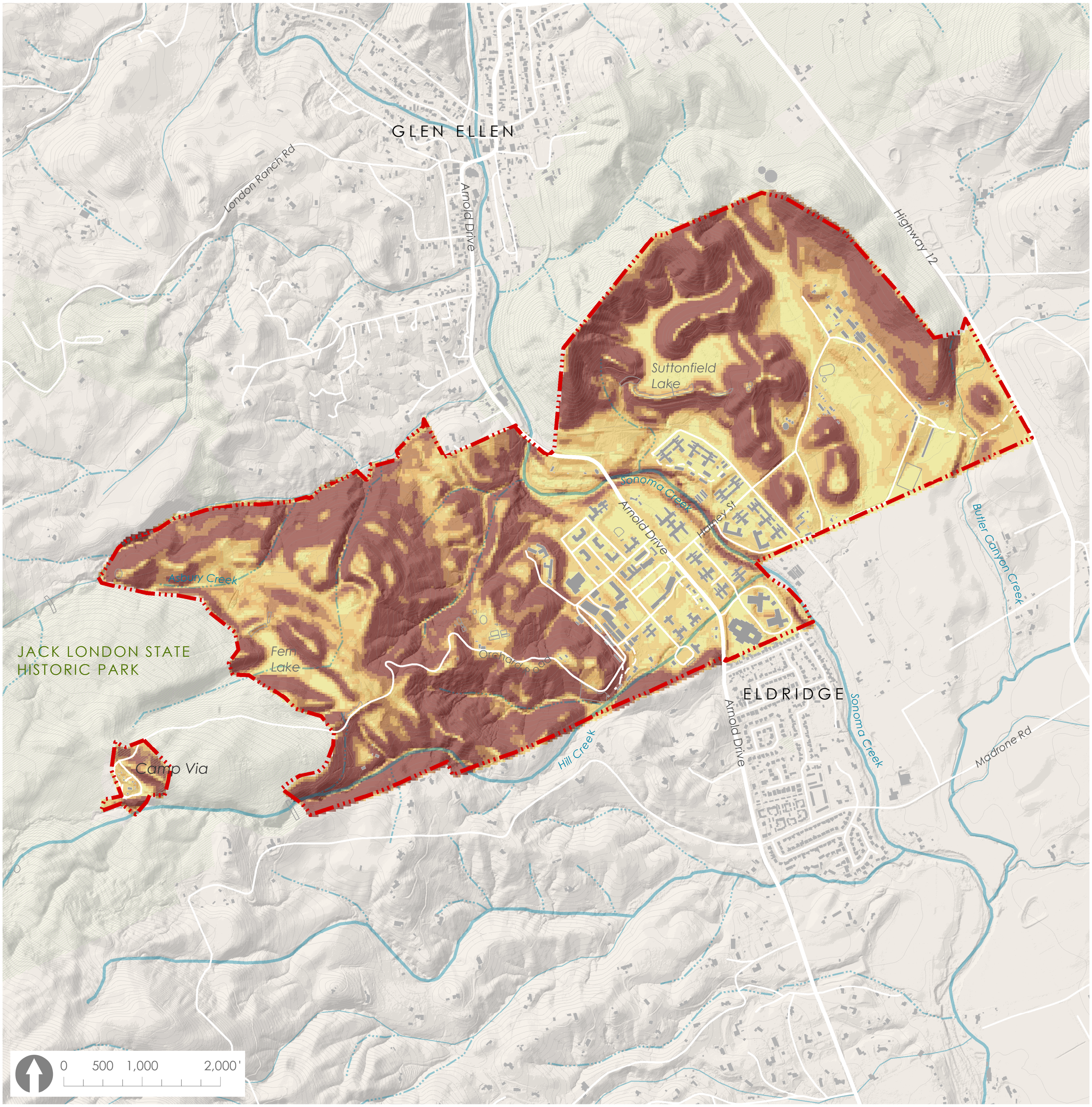
High : 243

Low : 57

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

Exhibit 2.4

SLOPE ANALYSIS



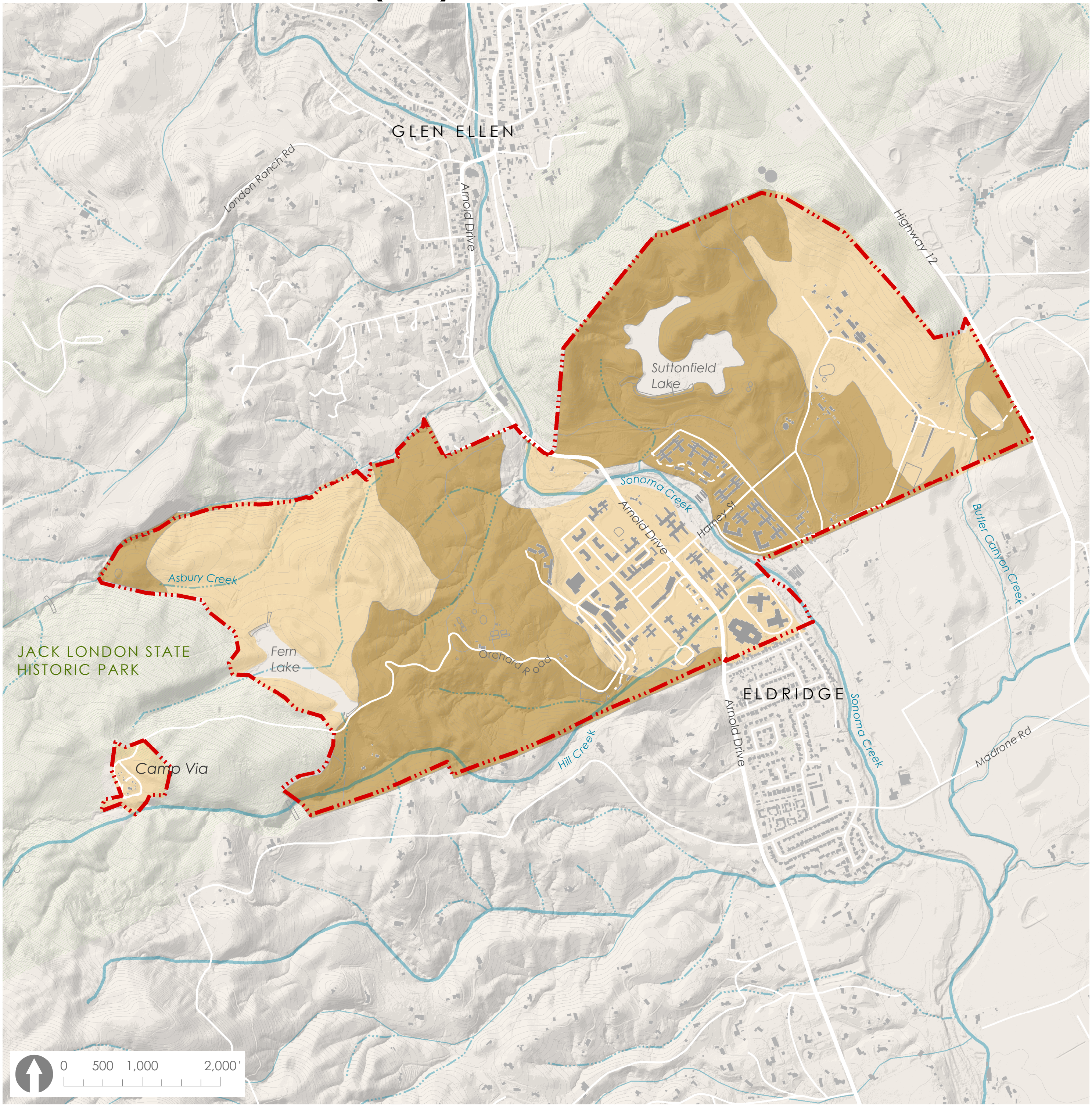
SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands

0 - 2.9%
3 - 5.9%
6 - 7.9%
8 - 10%
< 10%

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

Exhibit 2.5

HYDROLOGIC SOILS GROUP (HSG) SOIL CLASSIFICATION



SDC Property line

Ephemeral Streams

Perennial Streams

Intermittent Streams

Protected and Public Lands

Soils (HSG)

HSG

C

D

HSG DEFINITION

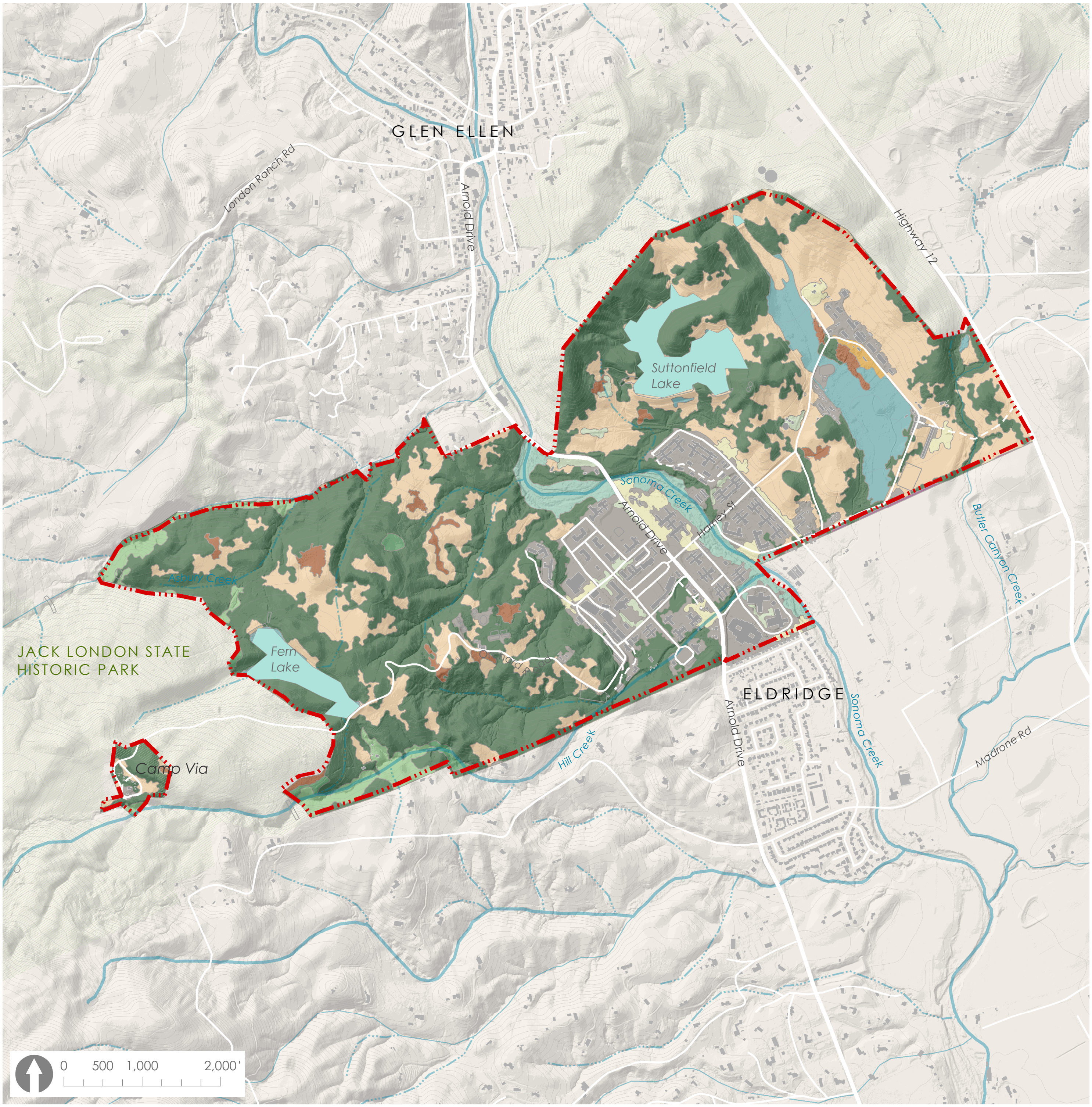
• Group C
Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

• Group D
Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Source
USGS, GreenInfo Network, Sonoma Ecology Center

Exhibit 2.6

VEGETATION



Lakes
SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands

DEVELOPED
Agriculture
Barren and Sparsely Vegetated
Developed

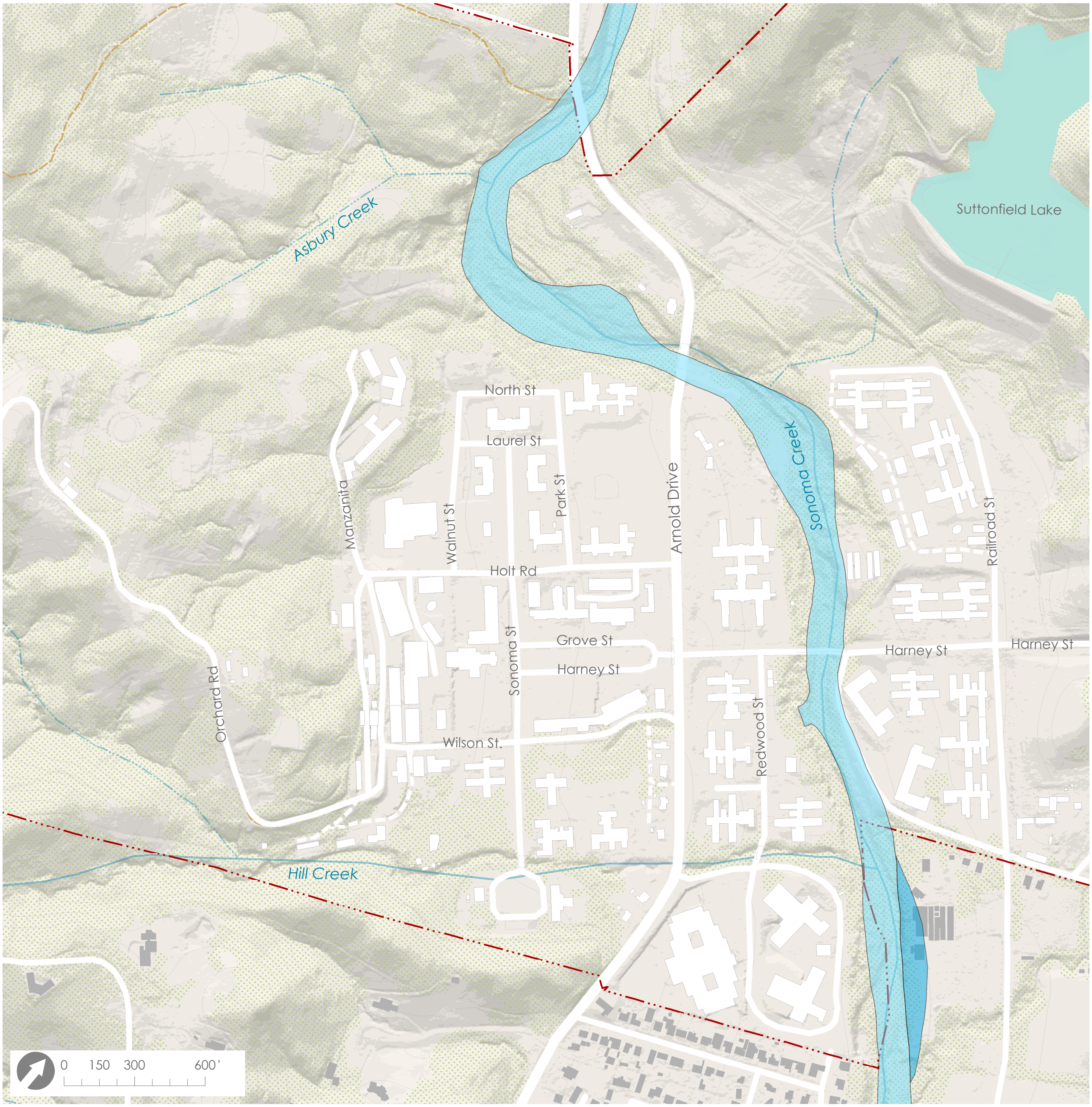
HERBACEOUS
Shrub
Herbaceous
Riparian Forest
Herbaceous Wetland

FOREST
Hardwood Forest
Mixed Conifer and Hardwood Forest
Conifer Forest
Forest Sliver
Non-native Forest

Source
USGS, GreenInfo Network, Sonoma Ecology Center, Sonoma Veg Map: Sonoma County Vegetation Mapping & LiDAR Program

Exhibit 2.7

FEMA FLOOD MAP-100 & 500 YEAR FLOOD ZONE



SDC Property
Trails
Lakes
Ephemeral Streams
Perennial Streams
Intermittent Streams
Native Forest
100 - Year Flood
500 - Year Flood

Source
USGS, GreenInfo Network,
Sonoma Ecology Center,
FEMA

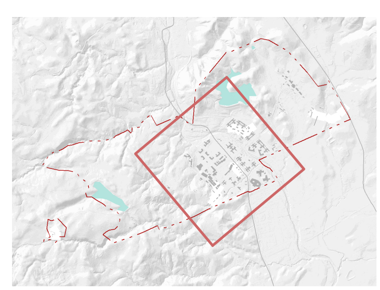
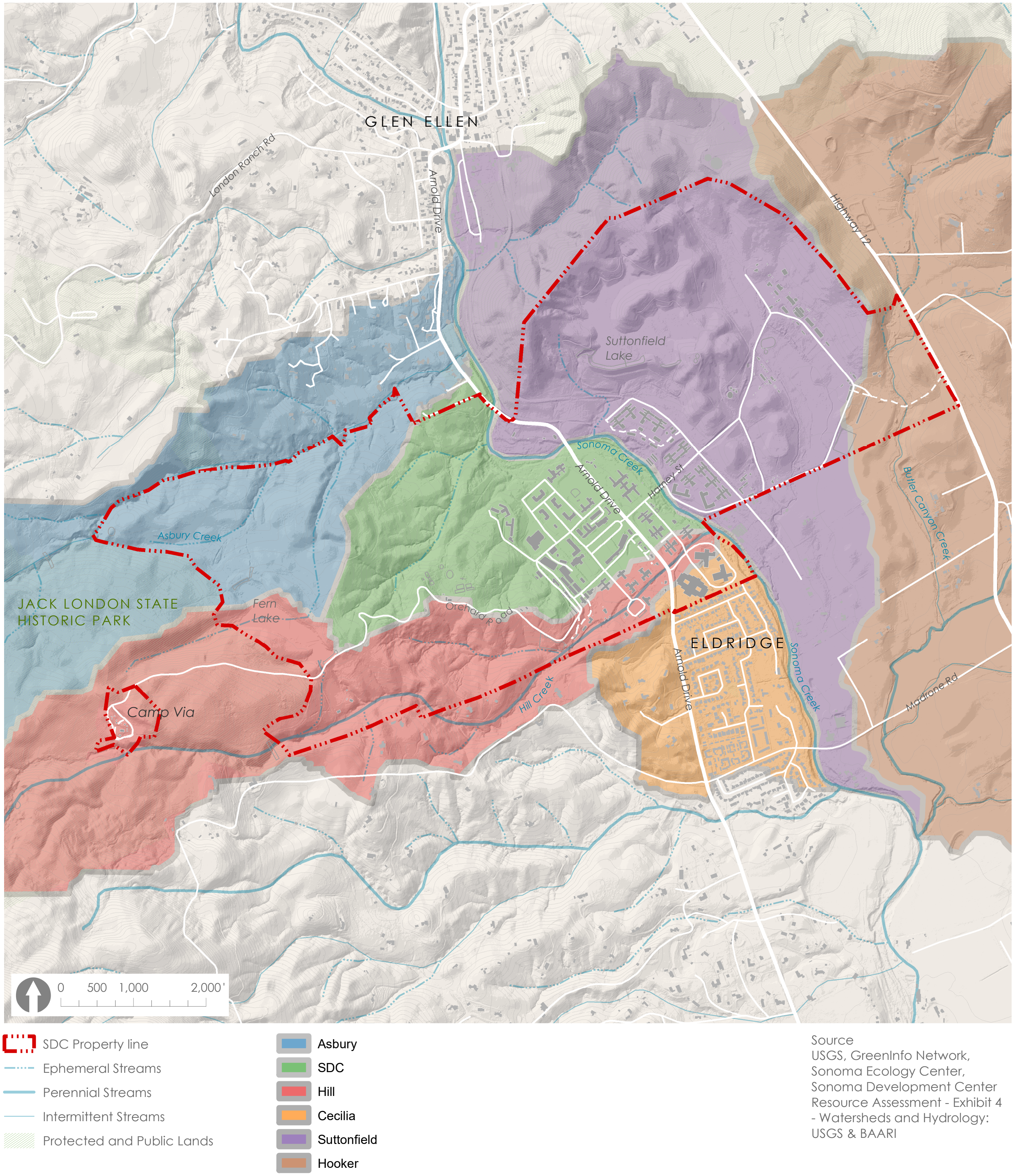


Exhibit 2.8

SUB-WATERSHEDS



Source
USGS, GreenInfo Network, Sonoma Ecology Center, Sonoma Development Center Resource Assessment - Exhibit 4 - Watersheds and Hydrology: USGS & BAARI

3. Water Supply System

The SDC has an extensive and elaborate raw water collection system that includes wet weather in-stream diversions with storage in man-made reservoirs; collection of spring water; raw water transfer and transmission lines that are primarily managed by gravity flow; and bidirectional flow in transmission lines by use of valves, a primary pump station capable of pumping in either direction, storage tanks located at appropriate hydraulic grades, and a booster pump. Almost all the water for domestic and irrigation use is obtained on site through three surface water diversions on the eastern slope of the Sonoma Mountains. Approximately 60% of the SDC water supply is drawn from Asbury Creek, approximately 30% is drawn from a diversion on Hill Creek, and 10% is drawn from a collection of springs and seeps known as Roulette Springs. Other less significant water sources include a diversion from Sonoma Creek and a number of wells in the remote parts of the property.

A representational layout of the collection system is shown on Exhibit 3.1. Raw water is diverted from Hill and Asbury creeks by gravity to Fern Lake and is pumped from Sonoma Creek to Suttonfield Lake. A small tributary referred to as "Unnamed Creek" flows directly into Suttonfield Lake. A 10-inch raw water transfer line is designed to be operated in either direction. It enables operators to transfer water from Fern Lake to Suttonfield Lake by gravity or in the reverse direction by pumping. The same pumps are used for the majority of the raw water transfers on the property, including from Sonoma Creek to Suttonfield, from Suttonfield Lake and Sonoma Creek to the Water Treatment Plant. A separate pump station transfers water from the 25,000-gallon break tank below the Water Treatment Plant to Fern Lake.

3.1. Surface water diversions

3.1.1. Asbury Diversion

The Asbury Creek diversion is the oldest developed water on the property, having been in use since at least the1880's. The diversion structure consists of a weir built across the creek with an orifice at its base sized to guarantee that the mandated 0.9 cfs will be released through the orifice before water can be diverted. Boards must be placed manually to detain creek flow to a depth that it can be diverted. Metering and flow recording equipment is installed at the diversion.

In 2002, a large parcel of land was deeded to the adjacent Jack London State Park. The Asbury Diversion is located at the northwestern most edge of the property on a small spur of the property that retains the diversion structure within the SDC property at about 660 feet elevation. SDC maintains the diversion structure and the associated rights and reports operational data to state regulators. To maintain sustainable riparian habitat, SDC is limited to only withdraw up to 1 cfs of water from the Asbury diversion provided a minimum of 0.9 cfs flows downstream. The SDC water manager maintains logs of the flow conditions and reports back to the National Marine Fisheries Service (NMFS).

The old diversion structure was damaged in heavy storms in 2006 and was redesigned and constructed in 2011. It includes a low-head dam, adjustable weir, and a bypass flow structure to ensure that water is only diverted once at least the required 0.9 cfs streamflow passes the structure. It is also equipped with gage and metering equipment.

Photo 1: Asbury Data Recorders

Diverted water is transmitted to Fern Lake via a 24-inch pipeline that transitions to an open channel for the final +/-500 feet. The diversion is generally only possible between November and May, or significantly less in years of very high (because the lakes are full) or very low (because there is not sufficient streamflow) rainfall. Although water is reported to flow in the creek year-round, summer flows typically drop to 0.5 cfs or less.

Photo 2: Asbury Diversion. Note the small pipe opening in the weir wall designed to allow 0.9 cfs stream flow to bypass diversion.

3.1.2.Hill Diversion

The Hill Creek Diversion is at approximately 600 feet elevation on Hill Creek southwest of Fern Lake. Originally built in 1904, this diversion structure was also severely damaged in

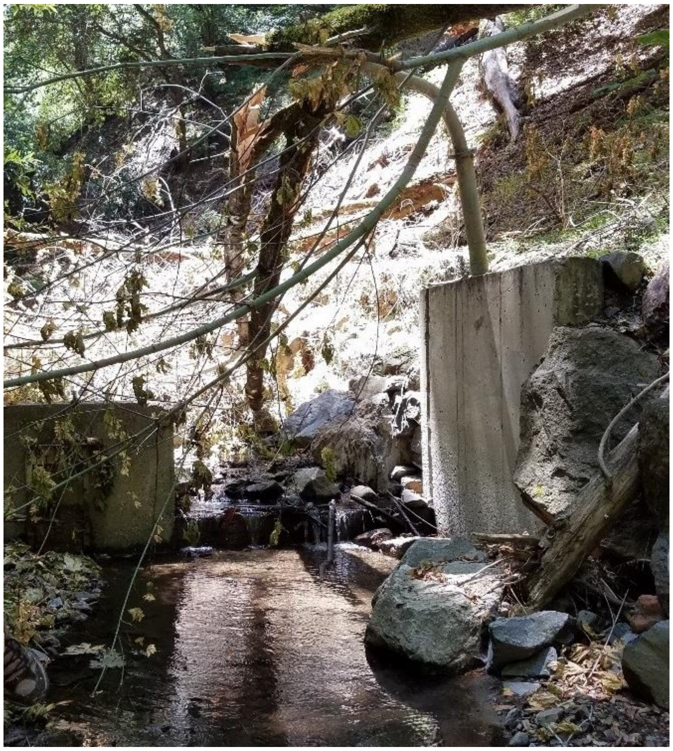


Photo 4: Hill Creek Diversion.

Photo 3: Hill Creek Pipeline.

Photos of the Hill Creek diversion weir and the diverted water pipeline over the culvert that carries the streamflow.

the 2006 storms and was reconstructed in 2007. The constructed diversion includes gabion revetment, cemented riprap, and an 18-inch steel pipeline on concrete piers across a deep ravine carrying the diverted flow. The pipeline transitions to an open channel for the last +/-50 feet of the run. The permit for the Hill Creek diversion does not require maintenance of a prescribed minimum stream flow — the SDC is allowed to take as much water from this location as they want. The constraint at this location is that although the creek does flow year-round, at low flows, infiltration exceeds streamflow in the area just above the diversion weir leaving no surface water at the diversion itself. Therefore, it is only possible to divert water when flows are above this naturally limiting low flow condition. Although there are no reporting requirements at this location, the flow is metered and SDC maintains records of creek and diversion flows.

3.1.3.Roulette Springs

The Roulette Springs collection box was developed in 1897 and provides water year-round. Rather than a discrete spring, it consists of several seeps and springs in a boggy forest area where a simple leaky collection box has been set in a depression and a collection pipe laid into it. The fact that it leaks ensures that some (although unmeasured) volume of streamflow bypasses the collection pipe to maintain a riparian condition. According to SDC personnel, diversions from Roulette Springs typically flow at about 80 gpm during the summer and at 120 gpm in the winter, providing a potential of about 1,200 acre-feet per year. Water from the diversion is transferred to the water treatment plant by a 3-inch steel pipe.

3.1.4.Sonoma Creek diversion

SDC maintains their rights to draw water from Sonoma Creek primarily to ensure that they maintain their storage of raw water through the dry season, ensuring adequate water supplies during drought and times of high fire threat. In years of average rainfall and normal lake levels, they run the pumps for a month each winter, sending 1 million gallons per day (mgd) of water to Suttonfield Lake, to ensure that they keep the Lakes full for fire protection through the summer. The diversion sump, 6 feet x 6 feet x 14 feet deep, is located at the west edge of the creek just below the pump house.

Licensed withdrawal from Sonoma Creek is limited by stream flow, time of year and storage limitations. The withdrawal rate is limited to 1,657 gallons per minute (2.39 mgd) with a storage limitation of 525 acre-feet. Thirty days at 1 mgd with no discharge from the lake would provide 92 acre-feet of stored water. So their typical withdrawal is well within licensed limits, and they have the flexibility to increase withdrawals if conditions warrant doing so.

3.2. Groundwater sources

There are two active and two abandoned water supply wells on the property. None are connected to the domestic water system that serves the main campus.

3.2.1.Camp Via well

As mentioned in Section 2.3.4, where depth and yield is described, this well provides water to Camp Via at sufficient yield for its intended use. It appears to be fully operational and regularly maintained. This well is not connected to the main campus water system; however, there is a small distribution system with nine delivery points. The water at Camp Via is not treated but is disinfected by sodium hypochlorite injected into the system as it enters the distribution system.

3.2.2.Suttonfield well

The Suttonfield well is located in the field approximately 100 feet east of Railroad Road and 500 feet south of Suttonfield Lake. The proximity of the Eastside Fault appears to impact the water temperature and quality, because upwelling of highly mineralized water would explain the elevated arsenic and boron levels in the well water. Because of these quality issues, the well has been capped and is no longer in use.

3.2.3.Dairy well

Previous studies reference a shallow water supply well located near the Dairy (SCWA, 2015) or near the chicken barn (URS, 2016). There appear to be no records of this well with respect to its production rates, water quality, when this well was developed, how deep it is, etc. This well has a brick dome-like cap with a steel lid and appears to have

Photo 5: Dairy Well (after the fire).

been a dug well from which water was drawn with buckets. It is likely that this well has not been capped or plugged. See Photo 5.

3.2.4. Soccer field well

Previous studies reference a shallow water supply well used to water the soccer fields in the eastern part of the property. Field investigation was unable to precisely locate this well, but it is believed to have been located across from (the former) Residence 150. Water from this well was piped to two above ground storage tanks. Today only the concrete pads on which the tanks used to stand remain.

3.3. Raw water storage

3.3.1. Fern Lake

Fern Lake is located on the western edge of the property. It was originally created with the construction of the south dam in 1910. That dam was later raised and a north dam constructed to increase its capacity to its present day volume of 240 acre-feet. The spillway is located on the north dam at an elevation of 590 feet. The lake is approximately 28 feet deep when full. The dam has had a slow leak for many years (at about 5 gpm). The leak is monitored and has not been observed to change over time. The dams are inspected annually by the California Department of Water Resources Division of Dam Safety (DODS) and maintained regularly by the SDC staff. The dam is 40 feet high and 300 feet long. The outlet structure for Fern Lake is a 10-inch vertical pipe with three service intakes at different levels.

Photo 6: Intake at Fern Lake.

3.3.2.Suttonfield Lake

Suttonfield Lake is located on the northeastern part of the property. Several popular maps depict Suttonfield Lake as part of the adjacent Sonoma Valley Regional Park, and it is considered by some to be a "hidden gem" for recreational purposes. However, most recreational uses, such as swimming, are prohibited for water quality, safety, and liability reasons.

This reservoir was initially constructed in 1938 and was increased to its present volume of 600 acre-feet in the 1950's. The earthen dam, constructed in two segments, is 76 feet high and 965 feet long. The spillway is at the western edge of the lake at an elevation of 291 feet. The lake is 62.5 feet deep when full. Like Fern Lake, it is inspected annually by DODS.

Suttonfield Lake is supplied by gravity from Fern Lake via a 10-inch transmission line. It also receives direct flow from the "unnamed creek", but no flow data is available for this small tributary. Water pumped from Sonoma Creek is stored in Suttonfield Lake as described in Section 3.1.4 above. Suttonfield Lake is used as storage for the SDC's domestic water use, irrigation and fire protection. The outlet structure is an octagonal concrete tower with two service inlets at different elevations.

3.4. Raw Water Transmission System

3.4.1. Raw water pump station

The raw water pump station on the southwest bank of the creek houses five pumps of varying capacity: two horizontal pumps (40- and a 50-horsepower (hp) and three vertical pumps (two 50 hp and one 25 hp). By operating appropriate valves, water can be pumped from or to Suttonfield Lake up to the water treatment plant. This flexibility in the use of a single pump station and transmission pipeline allows operators to manage the system to maximize storage capacity and maintain circulation in the system to maintain low bacterial levels of the stored water. Near the Pressure Break Tank at the WTP, there is a 5-hp booster pump that enables operators to transfer water from the WTP area to Fern Lake. While the pump house is old, the pump station and the pumps appear to be in well-maintained condition.

3.4.2.Raw water transmission

The raw water transmission line is a single 10-inch ductile iron (DI) pipeline. Joints in the original pipeline were packed with lead and oakum. Over the years, some sections of the pipe have been repaired and replaced with PVC. The pipeline is designed to flow in either direction by manually opening and closing several valves and pumping in the reverse (uphill) direction.

The approximate routing of the raw water transmission line is shown on Exhibit 3.1 and conveys water by gravity from Fern Lake to the Pressure Break Tank adjacent to the WTP. The break tank is a partially buried 25,000-gallon covered concrete tank under the trees near the recirculation water storage. This tank is necessary to relieve the pressure in the system before transmission to the lower part of the property.

From the WTP/break tank area, the pipeline is routed near the northern edge of the property, skirting around the core campus area to Sonoma Creek and south along the west bank of Sonoma Creek to the pump station. It then continues south to the bridge at Harney Drive where it crosses Sonoma Creek and is routed north along the Creek, around the north side of the east campus where there is a tee connection to Suttonfield Well. It then runs up the dam slope to the Suttonfield Lake intake structure. As noted above, by operation of the pumps and valves, water can be moved in either direction to and from any of the previously described storage facilities.

3.5. Water Treatment Plant

The Water Treatment Plant is at approximately 434 feet elevation west of the main campus. The facility was originally built in the1930’s and expanded in 1950 with the construction of four more rapid sand filter beds (for a total of six) and provision of 300,000 gallons of treated water storage. In 1992, chemical systems were added. In 1995 a SCADA system was installed and treated water storage increased with the erection of the 1M-gallon tank. The plant is fed and functions by gravity, with pumps being used only to backwash the filters and incidental services such as chemical dosing.

The design capacity of the water treatment plant is 1.8 mgd and is licensed as a small community water system. Water quality is regulated by the State Water Resources Control Board Division of Drinking Water (DDW). A bird's-eye view of the treatment plant site is provided in Exhibit 3.2.

3.5.1.Intake & Pre-Treatment

The water treatment plant receives water from Fern Lake via a 3-inch and a 6-inch-diameter pipeline and from Roulette Springs via a 3-diameter pipeline. The intake structure is a rectangular concrete tank of approximately 500-gallon capacity. Inlet pipes discharge above the free water surface at elevation 434 feet. Chlorine injection for pre-treatment and alum dosing is done at the tank's outlet, low on the tank. Until recently, the facility used an in-line static mixer between the intake box and the flocculation tank, which required a minimum flow of 200 gpm. This unit was switched out in the fall of 2017 with a flash mixer, and the facility is able to operate at lower flow rate—currently at 150 gpm (216,000 gpd—a reduction of about 72,000 gpd). The ability to operate at this lower production rate to serve a lower service demand at the property translates to savings in operation costs.

3.5.2.Flocculation Tank

The flocculation tank (or clarifier) is an open circular treatment unit that brings the water up through the middle of the tank and out across the unit in a slow mix that facilitates flocculation, a process by which the alum causes the small particulate matter in the water to clump large enough to settle out. The Floc Tank is housed inside a metal building and is the gating equipment in this system with respect to the plant capacity. Because of the size and way it operates, it is only possible to operate the treatment plant at flows up to 1,250 gpm. Because of low demand currently at SDC, the plant is operated at its minimum capacity, even though demand is below this minimum production rate.

3.5.3.Sedimentation

After the Floc Tank, the water passes through the 75,000-gallon Sedimentation Tank where water flows from one end of the tank to the other and as it moves, remaining particulate matter drops out. The clear water flows across a weir to a trough and is piped to the rapid sand filters. The Sedimentation Tank was built in the 50's before regulations and permitting of water treatment plants and was built uncovered, outdoors. Because of current requirements, it must now be covered, and this has been accomplished with a large arched tent-style enclosure.

3.5.4.Filtration

Six rapid sand filtration units operate in parallel to polish the treated water. These units were completely refurbished within the last 1 to 2 years and provided with five grades of fresh media. The finished water is chlorinated, and the pH adjusted before being transferred to the treated water storage and distribution system.

3.5.5.Backwash System

There is a 65,000-gallon plant water tank on the top of the knoll across the road from the WTP site. This tank is filled with treated water and used to backwash the filters. The dirty backwash water is transferred to the recirculation basins just down the slope from the

WTP. The dirty water is allowed to settle in the first tank, then water is drawn off the top of the first tank and transferred to the second tank where it is allowed to settle again. Water is drawn off the top of the second tank and transferred to the intake structure for treatment.

3.5.6.Chemical Systems and Control Systems

Bulk chemical storage is located on the WTP grounds near the parking area, across from the main building, within a common containment berm. There are two 5,000-gallon tanks, one each for storage of sodium hydroxide (NaOH) and alum. Day tanks are located inside the main building where the filter units and chemical-feed systems are located. The facility manufactures its own chlorine with an on-site chlorine generator that uses common salt in solution to generate sodium hypochlorite (NaOCl). Salt is purchased in 50-lb sacks and stored on pallets near the day tanks. The alum is used as the flocculating agent. Chlorine is used as a disinfecting agent and sodium hydroxide is used to adjust the pH of the finished water to limit corrosion within the distribution network and prevent a resultant elevation in the mineral content in the water. The facility was designed to be able to use polymer to aid in the sedimentation process, but the turbidity and solids content of the raw water is very low, and polymer has never been used.

The SDC has a service contract with Telstar who comes out quarterly to check on all the chemical feed, monitoring and control systems. As a result, all the feed and injection systems, monitoring, alarm and control systems are well-maintained.

3.5.7.Supervisory Control and Data Acquisition (SCADA) system

The SCADA system and computer are dated but the SCADA system is regularly serviced, as mentioned above, and is primarily used for its alarm function. When any component in the system reaches a set trigger point, it automatically dials the operator's cell phone. He carries his cell phone with him 24/7. Several of the alarm functions also automatically shut down the treatment plant as a precaution. Since there is only one operator, he needs to be immediately responsive to the alarms. Within the past year, a computer failure (rather than a plant failure) triggered the SCADA to shut down the plant. The SCADA system is capable of running the backwash system, but the operator prefers to perform that operation manually. The SCADA system also manages the continuous monitoring of chlorine and turbidity levels in the finished water.

3.5.8.Treated water storage

There are two treated water storage tanks adjacent to the WTP; a 1-million-gallon tank and a 300,000-gallon tank. They are located at approximately 400 feet (ground elevation).

3.6. Water Quality

Raw water quality on the site is quite good, as might be expected from water sources where the watershed is as protected as it is at SDC and where the water supply is so abundant. There are some naturally occurring minerals that, when found in drinking water at high concentrations, pose a problem. A few of them, notably arsenic and nitrate are found on the SDC property. Other constituents of concern include asbestos, primarily because of the prevalence of old asbestos cement pipe in the distribution system, and bacteria, which is always of concern in surface water. The WTP is equipped with a laboratory and tests for a wide range of constituents as prescribed by their license with DDW. To date, arsenic and nitrates have been found to be below the maximum allowable contaminant level (MACL); asbestos has not been found; and all raw water is disinfected to kill bacteria both through pre-treatment and prior to storage and distribution of all treated water. In addition, water clarity is described by turbidity and is measured in Nephelometric Turbidity Units (NTU) that determines the concentration of suspended particles in a water sample by measuring how much light scatters when shined through the sample. Typically, a raw water sample taken at the WTP is about 1 NTU, which meets treated water standards. After treatment, water at the SDC is around 0.02 NTU.

The SDC collects samples daily for analysis at the laboratory located at the WTP as follows:

- Raw Water as sampled at the intake mixing box
    - temperature
    - pH
    - alkalinity
    - turbidity
    - chlorine
    - backwash return turbidity

- Data collected daily on process and chemical addition
    - backflush blowdown (in minutes)
    - alum tank level
    - alum set
    - NaOH tank level
    - NaOH Set
    - hypochlorite %
    - hypochlorite pump #1 set
    - hypochlorite pump #2 set

- Process water taken exiting the sedimentation tank
    - pH
    - chlorine
    - turbidity

- Treated water effluent taken at the end of the treatment train at the WTP:
    - temperature
    - pH
    - alkalinity
    - total dissolved solids (TDS)
    - conductivity
    - turbidity
    - hardness
    - calcium
    - chloride
    - saturation index
    - adjusted pH
    - free and total chlorine (taken morning and evening)

- Data collected daily on process and chemical addition
  - backflush blowdown (in minutes)
  - alum tank level
  - alum set
  - NaOH tank level
  - NaOH Set
  - hypochlorite %
  - hypochlorite pump #1 set
  - hypochlorite pump #2 set

Additional sampling for testing at an off-site certified laboratory is conducted biweekly for bacteria and metals.

3.7. Treated water transmission and system pressure

3.7.1. Treated water transmission lines

There are three 8-inch transmission lines that carry water from the treated water storage tanks at the WTP to the main campus to feed the domestic water distribution system. In 1989 a 12-inch line was constructed to augment the existing transmission system to increase the fire flow capacity of the system.

3.7.2. Domestic water balance tanks

Two 300,000-gallon Welded-steel treated water tanks are located on the knoll south of Suttonfield Lake. These tanks are balance tanks for the gravity-fed water distribution system on the main campus. They function not only to store treated water, but also to maintain a constant pressure in the distribution network and to dampen potential fluctuation in the system pressure. They are located at elevation 370 (ground surface).

3.7.3. Fire flow

Sonoma County (Hereon County) currently adheres to the 2016 Edition of the California Fire Code with specific amendments as adopted by County Ordinance 6184. It is through this ordinance; the county takes exception or extends the requirements to specific sections of the code. For site development, the Table B105.1(2) of the California Fire Code provides a schedule of the required site fire flow based on the several factors including building square footage based on fire-code criteria and building construction type per California Building Code designation. Sonoma County Fire has adopted Table B105.1(2) without any revisions or exceptions.

The code also provides for a reduction of the reported fire flows per B105.1(2) if the building is equipped with a sprinkler system. The reduction in site fire flow is up to 75% for nonresidential development and final reduction at the discretion of the Fire Department official.

There are exceptions to the required flows. For multistory buildings, of Type 1A and Type 1B construction the code determines the fire flow based on the three largest successive floors, and for parking structures based on the largest floor rather than total building square footage for other types of construction. It should also be noted that said fire flow shall be provided to a building site with a minimum residual pressure of 20 psi in the water main network.

Based on this criterion, the Fire Hydrant Flow tests carried out by JC Chang & Associates (JCCA) at various locations of the site were reviewed for their results, location on site and potential associated implications. In addition to the site readings, the JCCA data also reported the projected fire flow at the residual pressure of 20 psi. For all tests except for Test #1, this resulted in favorable flows of 2,182 gallons per minute or higher. It should be noted, Test #2, read the flow at the same hydrant but took the pressure off a different hydrant resulting in more favorable reading. From both test results it is possible to deduce that Test #1 was off a hydrant connected to a smaller line or different line than that of the hydrant test off Test #2. This may also point to necessary upgrades depending on final layout of future development. All other hydrant tests resulted in favorable conditions ranging in flow rates of 2,182 to 3,330 gallons per minute. Assuming an approval of 50% reduction (typically more common than the maximum 75%) in fire flows for future development this can be correlated to a flow rate range of 4,300 to 6,600 gallons per minute of the reported values in Table B105.1 (2). This represents a broad range in potential square footage for future buildings.

During site planning for future development, placement of future building including criteria described earlier such as construction type and square footage, should be compared against the reported values. Placement of buildings will also better describe the need for potential improvements to meet both fire flow demand and length of time as required by fire code.

It should also be noted that in 1989 when the 12-inch domestic water line from the treatment plant was installed, the fire hydrant numbering system was changed, and the historical maps of the water system indicate a numbering system no longer in use. However, it appears that J. C. Chang used the old numbering system for these tests.

3.8. Constraints and opportunities

3.8.1. Phased upgrades

As noted above, the water treatment plant has been carefully maintained over the years. While industry standard practice would have implemented structural upgrades to the WTP over the years, the SDC has maintained the plant commendably and it is still a functioning system that meets state regulations in treatment, monitoring and operations. The filter units have recently been rehabilitated and it will be possible for a new owner or operator to take over the treatment plant without being required to immediately implement significant capital improvements. It is advisable to develop an operations, maintenance and capital improvement plan (CIP) that identifies exactly what improvements will be appropriate, with an anticipated schedule that these improvements will be necessary, once the operational capacity of the plant, based on the owner's long-term plan for operations of the plant is determined.

3.8.2. Operations and Maintenance Responsibilities

Current operations of the entire water system, from source to treatment plant operations, laboratory sampling and testing, management of storage and transmission and transmission of treated water to the distribution system, appear to be conducted by one person with irregular support from an intern and a former (retired) operator. Continuation of management of the system at such a low staffing level by a new owner-operator is unlikely. A minimum of three full-time staff should be expected.

A new owner may not be interested in taking on the responsibility of the extensive water supply, treatment and distribution systems on the property. It is expected that an independent operator can be hired on a long-term operations contract to operate the treatment plant and manage the water supply system. It is also reasonable to assume that should a new owner choose, a contract that included long-term lease or ownership of the treatment plant and water supply system along with the operations and supply of treated water to the campus. This operator could be a commercial for-profit firm or a public agency such as the Valley of the Moon Water District.

3.8.3.Rates fees and capital costs

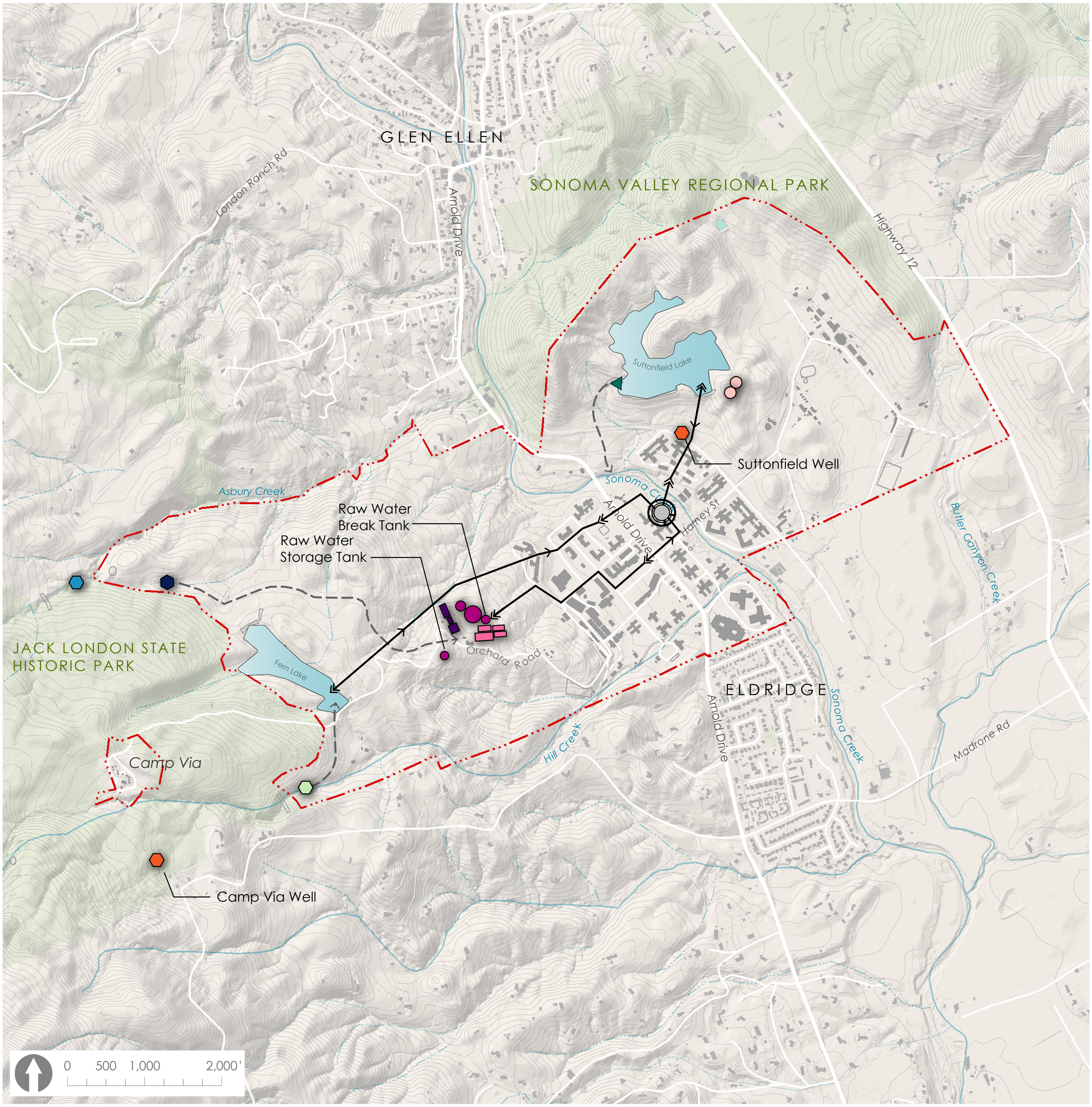
Regardless of whether the new owner of the property operates the system or contracts that out, a means will need to be clearly identified to pay for the system and its operations. Salaries, operation of the facilities, maintenance, chemicals, and funding for capital improvements will need to be primarily paid for by water rates and connection fees. It is expected that these rates will likely be higher than those for nearby neighborhoods to build up a CIP base. If state funding could be made available to support a CIP, it may encourage more interest in taking over the responsibility of this system.

3.8.4.Abundance of water

The abundance of water on this property is extremely attractive to local and regional water purveyors, local environmentalists, farmers and vineyard owners. There is tremendous opportunity here, given the local water demands, to successfully improve infiltration to groundwater, support healthy riparian habitat, provide additional resources for domestic water and fire protection, reduce local groundwater extraction, and possibly improve downstream surface and groundwater quantity and quality. Clearly not all of these goals will be met by the water resources on the SDC property, but an important aspect of the next phase of this study will be to examine these opportunities in depth and provide a clear understanding of the costs and benefits of these different water use opportunities.

Exhibit 3.1

SITE HYDRAULICS



SDC Property line
Lakes
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Land
Hill Diversion
Asbury Creek Diversion
Roulette Springs Diversion

Gravity Flow
Raw Water Transmission (to flow in either direction depending on pumping)
Water Treatment Plant (Designed for 1.8 Million Gallons Day)
Treated Water Storage (1.35 Million Gallons)
Recirculating Water Storage
Balancing Tanks (2 x 350,000 Gallons)
Spillway into Drainage Ditch
Sonoma Creek Pump Station
Well

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

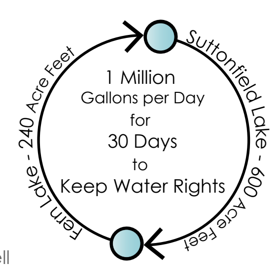


Exhibit 3.2: **WATER TREATMENT PLANT**

4. Water Distribution System

The domestic water distribution system at the SDC is complicated for several reasons: double piping—there are parallel pipes in the system that are cross connected in many places (see below on historical dual piped system); age—much of the original piped system is still in use and is prone to failure from corrosion, stress on the pipe from earth movement and tree roots, etc.; and it is a complex, single-pressure-zone system that is currently underutilized presenting efficient operations and maintenance challenges.

4.1. Historical Dual-Piped System

A practice that is just becoming common now, dual plumbing, was the norm at SDC until the mid-1970's. Buildings were double-plumbed to use non-potable water for toilet flushing. Most of the campus had a non-potable pipe system running in parallel to the domestic water distribution system, providing low-cost water for irrigation and reducing the demand for treated water. Because of concerns about potential cross-contamination and concerns over possible resident error or accident with non-potable water, the dual-water system was discontinued. The existing double-pipe system on the campus was not abandoned but was intentionally interconnected, allowing treated water to flow through several parallel pipes. This system was unusual but did allow maintenance crews ease of making repairs or performing other tasks without inconveniencing residents. In the attached Exhibit 4.1, you can see that there are two or more parallel water lines that appear to all be serving the same purpose: increasing flow to buildings without having to install a larger pipe. While with the double pipe system it is easy to make repairs without inconveniencing users because of all the valves and double piping, it also poses different maintenance challenges in that there are a lot more joints, valves, and fittings that could break or leak.

4.2. System integrity

Originally constructed 60 to 100 years ago, the water distribution system has experienced numerous repairs and is now a patchwork of pipe materials. Most of the water mains were built with asbestos-cement (A/C, also called transite) pipe and laterals with galvanized pipe. Additionally, welded-steel or ductile iron pipe has been used as a material of choice for transmission lines and in some areas, cast-iron pipe has been used for water supply. While A/C pipe is quite durable if undisturbed, it is brittle. In soft or unstable soils or near mature trees, breaks will occur. Galvanized and cast-iron pipe will rust over time. These older pipes are very much at the end of their useful life. Over the years, many repairs have been made, usually using PVC pipe to repair the damaged section of pipe. In 1995, a new water main was installed in the main campus with C-900 pipe (PVC pressure pipe). This relatively new water main is 22 years old and should have at least another 50 years of life left in it. Exhibit 4.1 highlights the new water main, which is considered as in good condition. Everything else is considered obsolete.

4.3. System operations and limiting conditions

The water distribution system at SDC operates entirely by gravity—without pumps. Pressure in the system is maintained because at the east and west end of the main campus area, pressure is balanced by the free water surface in the storage tanks—the two storage tanks at the WTP and the two balance tanks near Suttonfield Lake—making the whole system operate in a single pressure zone at very low operating cost. What makes the system a challenge is that the distribution network is anything but elegant and includes huge system losses in terms of pressure and flow caused by the redundancies in the system. Pressure loss is primarily attributable to two conditions: friction and leakages. Friction losses increase at every fitting, valve and bend in the pipe and a component of friction loss is related to flow velocity, pipe diameter and length and type of pipe. Older, rougher pipe material generates larger friction losses. For the SDC system where very old, rough pipes are encountered with smaller diameter multiple pipes dominate, the friction losses are going to be large. Additionally, the same parameters lead to significant losses through leakages. These leaks may be small but numerous and will be very difficult to detect. Only when there is a major pipe break can the staff quickly identify the location of a leak and take corrective action. Smaller leaks can continue for years without being identified and corrected.

4.4. Domestic water system capacity

The complexity of the water distribution system, expectation of significant system losses, age and condition of the system present substantial challenges to system modeling. The value that can be derived from such modeling would be an understanding of the capacity of the system for future development uses. However, because the system is in such deteriorated condition, and replacement is recommended, there is little value to be derived from modeling.

What can be said about the water system capacity is that the system as designed should be able to produce and distribute to the core campus and beyond 1.8 MGD of potable water, enough to support a resident population in the neighborhood of 6,600 people. However, because of its present condition, the system is most likely unable to support flows at this level and has not done so for many years.

4.5. Sonoma County Water Agency and Valley of the Moon Water District Tie-ins

SDC has had an agreement with the SCWA since 1964 to supply water to the facility in the event the on-site water system is unable to do so. SDC maintains a 6–inch metered connection to the Sonoma Aqueduct, which runs through the eastern part of the property. The SCWA was able to provide domestic water to the property in the past when the WTP was undergoing upgrades. However, the connection point is fitted with a double check-valve backflow prevention system that SDC staff have identified as having failed. When the valve is opened, water from the SDC flows into the SCWA line (rather than water flowing into the SDC line) because the pressure in the SDC line is greater than in the SCWA line and the backflow preventer doesn't work. Until the backflow preventer is replaced, the only way SCWA can provide emergency water to the SDC is if the SDC system is drained down and valves closed from the balance tanks and the treatment plant.

SDC also has an agreement with the Valley of the Moon Water District (VOMWD) to provide water to the VOMWD in times of emergency. The agreement stipulates that any water supplied is a loan and must be repaid in kind. VOMWD maintains a 6–inch metered connection to the SDC treated water line in Arnold Drive. Transfers into the VOMWD requires a 20-hp portable pump to transfer water at the stipulated maximum rate of 0.5 gpm.

4.6. Constraints and Opportunities

4.6.1. Utility Corridor

The "new" water main through the main campus discussed above might be able to provide appropriate routing for a future "utility corridor". A utility corridor is a concept in planning campus or district-wide utility systems that will minimize the footprint of utility systems while maximizing the ease of maintaining those systems. It also plans out pipe and utility routings to avoid future building footprints, thereby reducing costs of future construction. Because the utility systems at the SDC campus are, by and large, at the end of their useful life and in need of replacement, the site provides an exceptional opportunity to plan for future development by creating utility corridors. These corridors may be actual tunnels with utility pipes installed inside, precast concrete ditches that house a bank of utilities that can be accessed by lifting a cover, or simply by planning where buried utilities will be installed along a common route and locating them with minimum clearance between them. Whichever type of corridor will be most cost-effective for the future SDC development will be determined in the next phase of this project when alternative development scenarios are considered. Efficient corridor layouts will be considered at that time in conjunction with where future utilities will be required and how they can be constructed over time, phased with related building construction, but planned in advance.

See Exhibit 4.2 for the extent of this new water main.

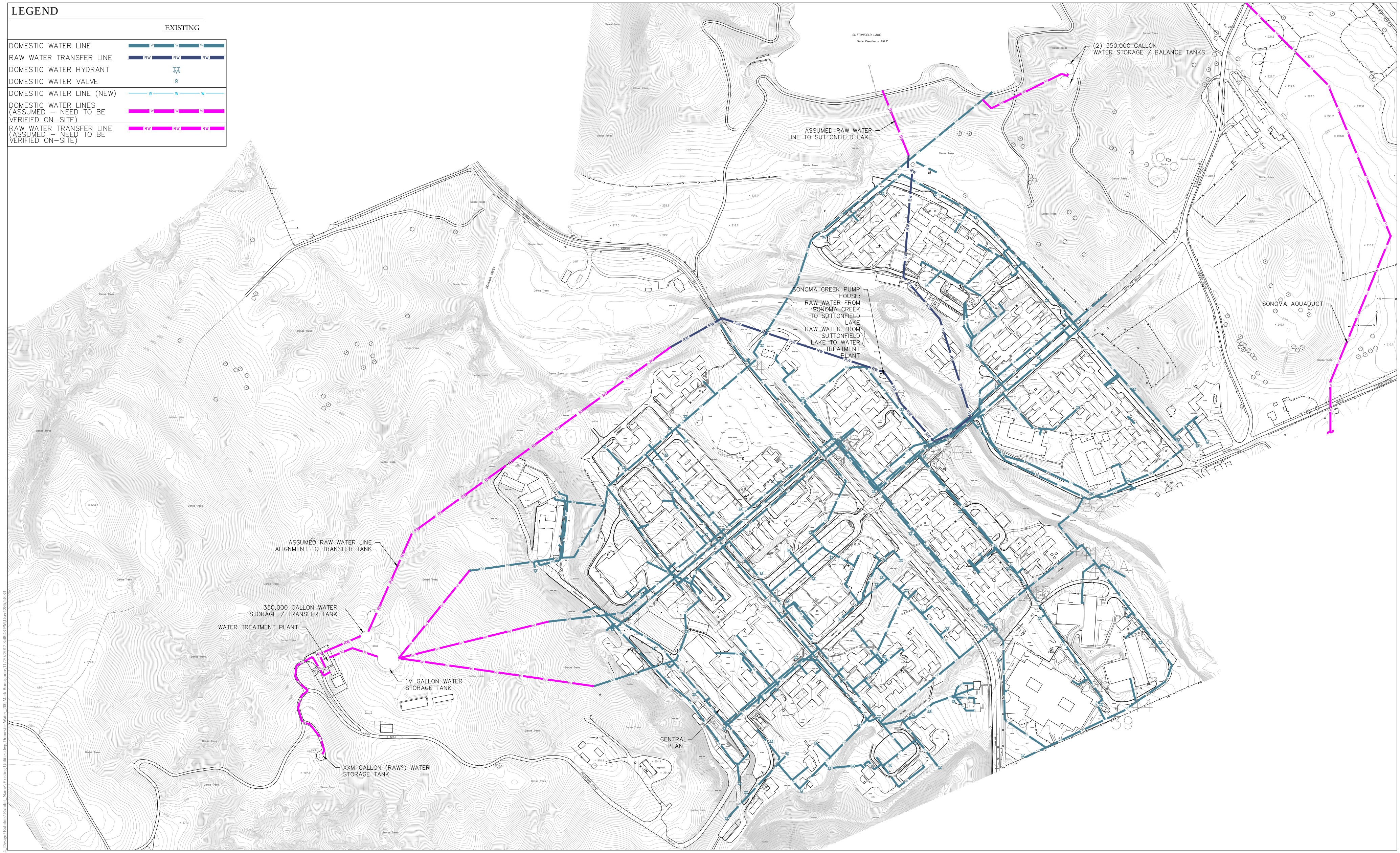


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Exhibit 4.1: **WATER SYSTEM MAP**

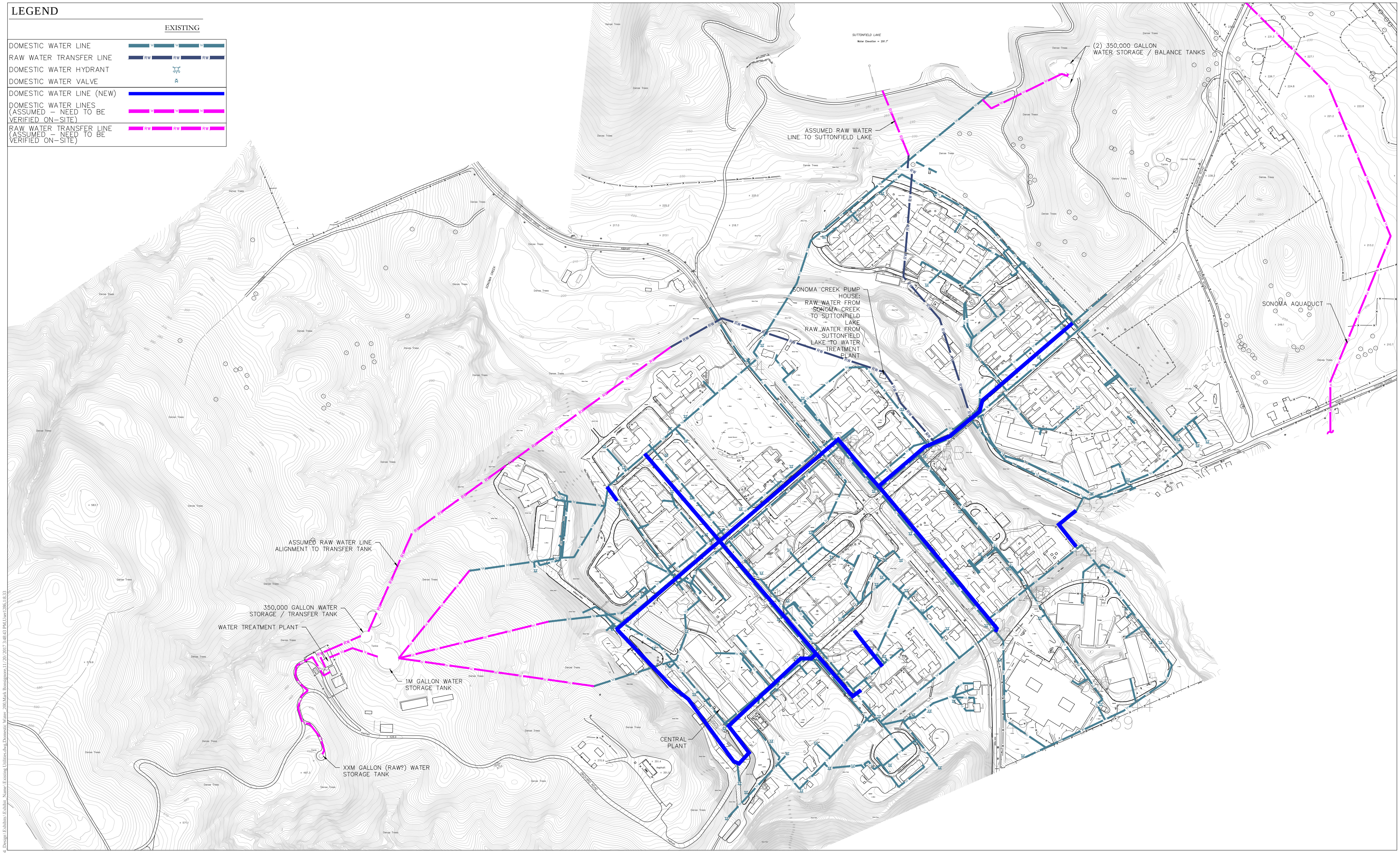

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Exhibit 4.2: **WATER DISTRIBUTION CONSTRAINTS MAP**

5. Sanitary Sewer System

5.1. Sewer Collection System Description

The sanitary sewer collection system is reported by SDC facilities staff to consist of primarily vitrified clay pipe for the sewer mains and cast iron for the laterals. However, much of the system was built in the 1920's and 30's and there have been numerous failures and blockages over the years. Staff have attributed the blockages to be caused primarily by root intrusion. Much of the cast-iron pipe has rusted through. Repairs on the system have been made as required, normally with PVC replacing damaged pipe sections. The system should be cleaned and inspected regularly, but the SDC has not had sufficient staff to do so as a part of the regular maintenance schedule. Although most of the PVC sections are probably in fairly good condition, because of the patchwork nature of the system, the entire system is considered to be obsolete and in need of replacement. Refer to Exhibit 5.1 for a map of the sewer system. How much of the system should be replaced will depend upon the extent of future development. If the property is developed in a manner that concentrates the built environment within a smaller footprint than the current facilities at the core campus, then the extent of new sewer lines needed may be significantly reduced. Because the entire system is considered to be obsolete, the system was not modeled for this study.

5.2. Sewage Lift Stations

The system operates via gravity flow for all but a small section of the system. There is a lift station located between the south side of Sonoma Creek and Traxler Road across from the Johnson-Ordahl Building. This station was completely refurbished a year ago. Unfortunately, it suffered severe damage during the fires in October. The building was not in the path of the fire but was so close to the fire line that it spontaneously burst into flames inside the building. The pumps were submerged and survived, but the building itself (basically a metal shed) is seriously damaged and the wiring, controls and associated components were all destroyed. The SDC performed immediate repairs to get the pumps operational, but the pump station needs to be reconstructed if sewage will continue to be collected from the Regamey and Emparan and Lux buildings.

The pump station moves sewage up to the SDC SSMH #3.2-4 via a 6–inch diameter SDR 35 PVC pipe. From MH 3.2-4, it flows by gravity to the main collection station and bar screen at Harney and the south side of Sonoma Creek.

All sewage at SDC flows to the main collection point located at the southwest side of Harney Avenue west of Sonoma Creek. At this point, the sewage flows through the bar screen to remove trash and debris that may have entered the system upstream before going through the meter to be discharged to MH #99 of the Sonoma Valley County Sanitation District (SVCSD) main sewer line in Redwood Street just south of Harney Avenue. The bar screen has been recently repaired, but it is a 1970's model Jeffrey unit that needs to be replaced. A recent estimate to replace it was $125,000. The remaining components of this station include a concrete in-line venturi flow gage, a monitoring meter that is barely readable because the unit is slowly burning out, and a sampling unit inside an old gutted refrigerator. As with many components at SDC, the maintenance staff have done a good job of keeping everything operable, but this station needs to be upgraded in the near future.

There was a second sewage lift station in the east campus that handled all the sewage from the Sunrise campus and Junior Farm areas. This lift station was destroyed in the fires in October. Since the buildings it served are either destroyed or not in service at this time, no interim measures have been taken to replace it.

5.3. Abandoned WWTP

There are remnants of an abandoned Wastewater Treatment Plant near the north side of the intersection of Harney and Sunrise. Previously, SDC operated this plant to process sewage from the property, but there are no records of the operations, type of treatment, disposal of sludge, or any other data, probably because wastewater treatment was a wholly unregulated enterprise at that time. In 1954, the treatment plant was shut down and abandoned and all sewage thereafter was discharged into the county sewer trunk line and treated off site.

5.4. Constraints and Opportunities

5.4.1.Condition

Although the SDC staff have managed to keep the system functioning, and have implemented necessary repairs, the sewage collection system is beyond its useful life and in generally deteriorated condition. New development on the property will require a functioning sewage collection system that has at least 30 to 50 years of useful life and require operations and maintenance costs to be commensurate with a system that does not require immediate capital outlay. An expectation that the entire collection system requires replacement is not unreasonable. If future development will be more clustered (smaller overall footprint) than the current campus, a less extensive replacement system would be required. Refer to Section 4.5.1 for a discussion on opportunities to develop utilities for efficient cost, maintenance and use of space in utility corridors. While gravity systems such as sewer lines do not neatly conform to the constraints imposed by utility tunnels and trenches, they can be considered in the design of utility corridors for efficient routing and long-term development planning. Phasing the construction of a new sewer system is a reasonable approach to mitigate the capital costs required.

5.4.2.Opportunity to provide on-site wastewater treatment and reuse or recharge

An opportunity that may be worth further study is to consider construction of an on-site wastewater treatment plant in the east side of the property. Such a facility could be built to treat SDC wastewater only or it could be built either in partnership with, or entirely by, the SVCSD to provide sewage treatment of SDC flows and flows from the nearby upstream community. Treated effluent from the plant could then be used in the area in the east campus to restore wetland habitat and infiltrate water into the groundwater. (See Section 6.2.3 for a description of why this area is preferred for restoration of wetland habitat.) Excess water could be used for irrigation and sold to adjacent agricultural landowners for irrigation. It is unknown at this time what impacts a project to infiltrate significant amount of water into the groundwater might have on areas further downstream that currently exhibit declining water levels and deteriorated water quality. Further study is required to identify the most appropriate means to infiltrate water at this point in the valley.

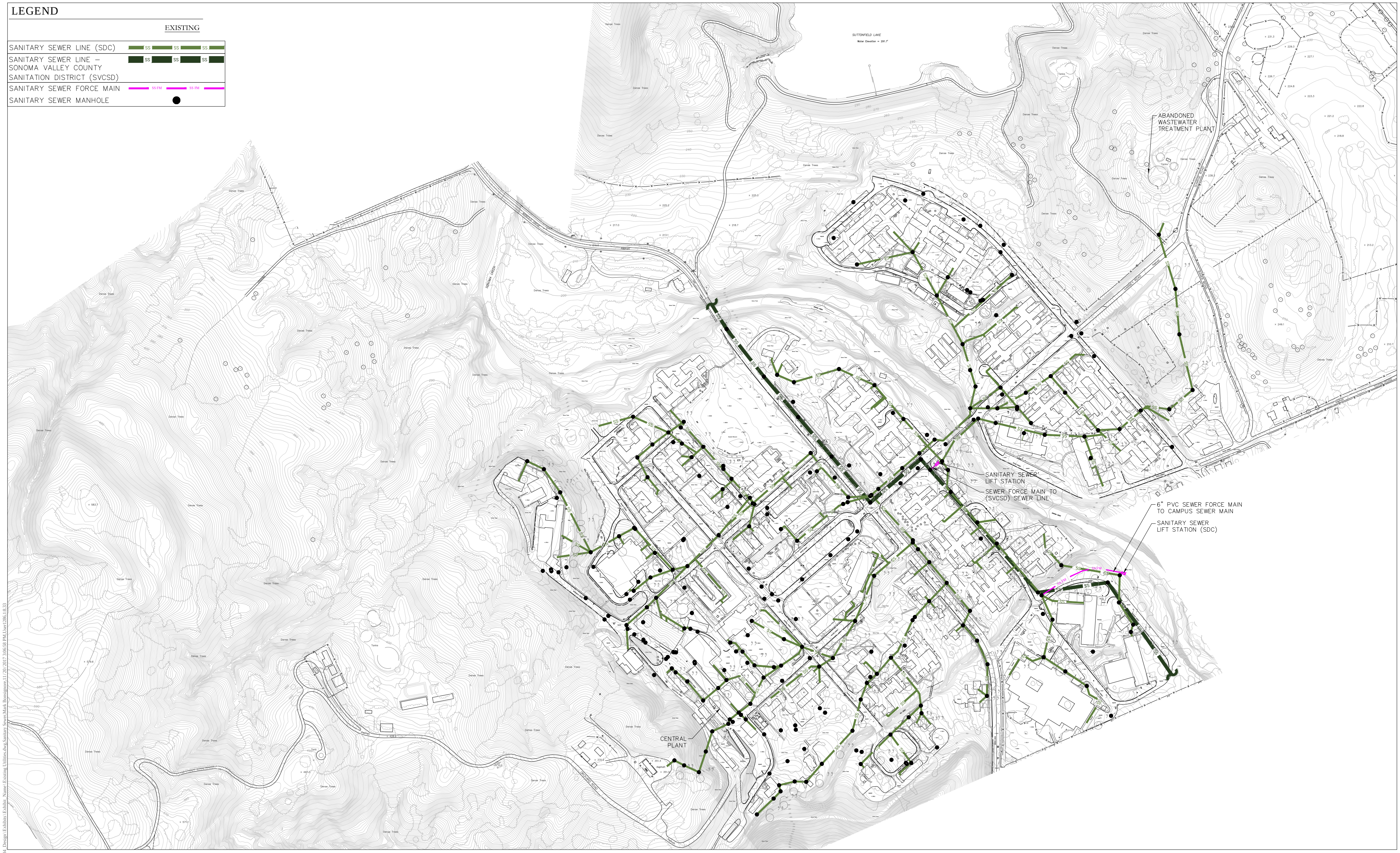

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Exhibit 5.1: **MAP OF SANITARY SEWER SYSTEM**

6. Storm Drainage

6.1. System description

Traditional stormwater management strategy that was the norm through the 1970's strove to get stormwater into a pipe and off site as quickly as possible. No treatment of stormwater was done before being discharged to local water bodies. This approach to stormwater management is evident at SDC in the rock-lined and concrete-lined roadside channels, stormwater inlets and buried pipelines that transfer the stormwater quickly from buildings and developed areas to discharge directly into the local creeks.

Modern strategies of stormwater management aim to work with nature rather than to fight against its more destructive tendencies by including groundwater infiltration, maintenance of sustainable riparian corridors, mitigation of peak storm flows to reduce erosion and flood risks, surface level conveyance with energy dissipation amidst appropriately vegetation, rocks, swales, and basins, reduction of heat island effect created by large areas of paved surfaces and related means of creating a more sustainable, natural and aesthetically pleasant built environment.

There are a few noteworthy aspects of the property that provide high quality stormwater management services, such as broad landscaped areas, large trees, and the creeks that have been allowed to retain their natural riparian functions. However, the high ratio of paved areas that drain directly to a piped and channelized storm drain system in the main campus area will need substantial modification to meet current stormwater management requirements.

On the steeper slopes of the property, soil erosion and slippage are concerns. On the main campus, the piped storm drain system has been, for the most part, left to function with little operations or maintenance intervention. Catch basins and gutters have been cleaned when they clog, but otherwise, facilities staff have not had to do very much to just let the stormwater system drain to the creeks.

Facilities staff do not report that there is a problem with drainage during large events. However, several buildings experience water incursion, which is most likely due to inadequate grading around buildings, thresholds and finished-floor elevations originally constructed too low, or inadequate foundation drainage, rather than because of localized flooding problems.

Like other piped infrastructure on the property, the storm drain system was primarily built in the 1920's to 30's and much of the built facilities and pipes are near the end of their useful life. It has been reported that some slip-lining was done in the 1990's in a rehabilitation effort. However, according to SDC staff, no part of the storm drain system was slip-lined.

The existing system does not meet current requirements for on-site stormwater management. There is no mechanism to prevent discharge of pollutants to the creeks or to reduce peak flow discharges from the system to avoid scouring of creek beds and downstream flooding. These issues will need to be addressed with redevelopment of the property.

Refer to Exhibit 6.1 for a map of the existing storm drain system.

6.2. Constraints and Opportunities

New development at the SDC will need to meet current stormwater regulations that primarily focus on water quality and hydromodification (stormwater runoff rates). Given the campus context, stormwater management at the SDC should be considered at two complementary scales: one focused at the building cluster scale (the scale at which future phased redevelopment efforts would most likely be focused) and the other at the campus scale. By using a two-pronged approach, stormwater management can be managed as the campus exists today, and as it is developed over time. The constraints and opportunities discussed below adhere to this approach to meet the needs of the changing campus in a sustainable manner, which adheres to regulatory requirements and aids with the phasing strategy of new structures while also ensuring a healthy ecology and reducing operations and maintenance burdens. Fundamental in consideration of opportunities and constraints is the ability to integrate many low-impact development systems. The term low-impact development (LID) refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater to protect water quality and associated aquatic habitat.

6.2.1.Implement LID measures to manage stormwater

Low-Impact Development (LID) is a type of stormwater BMP that prioritizes natural systems. The EPA defines stormwater BMPs as "methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources." Traditional methods of closed drainage collection and centralized detention areas act to remove stormwater runoff from the site in the quickest and most efficient manner possible. LID takes a different approach, one that looks at stormwater as an asset to be retained in an effort to mimic the natural hydrologic cycle. These decentralized stormwater collection networks may also be designed to retain stormwater for reuse as irrigation or other purposes. The implementation of LID techniques can include benefits such as greatly improving the quality of stormwater runoff, restoring the infiltration of water to the aquifer, eliminating costs associated with conventional drainage systems, and reducing development impacts such as erosion and flooding. An added benefit is the integration of BMPs to manage stormwater while at the same time improving the natural aesthetic of the campus. The following LID best practices should be followed for future development:

- Assess the site's topography, soils, vegetation and natural drainage for integration of LID techniques to minimize the future development footprint.
- Assess native vegetation and soils for placement of LID facilities.
- Assess primary BMP function: water quantity, quality, infiltration, and conveyance to meet Regional Water Quality Control Board (RWQCB) and county requirements.
- Minimize and manage stormwater at the source to promote treatment and infiltration
- Minimize areas of impervious surfaces such as parking lots, driveways, courtyards and roof tops, using permeable pavements and green roofs to maximize evapotranspiration and allow infiltration of precipitation into the soils.
- Manage runoff by disconnecting the impervious surfaces from one another, and directing runoff to LID features such as vegetated swales, planters, rain gardens and pervious pavement.
- Preserve existing trees and plant new trees in coordination with development.
- Avoid compaction of soils in areas of the site that will not have structure.
- Minimize surface parking areas through the use of structured parking.

- Provide micro-detention in landscape areas (self-retaining areas).

Stormwater runoff should be collected throughout the site and transported, mostly through surface conveyance, to LID water-quality treatment areas. These areas will act to evapotranspire, infiltrate and remove contaminants from the water by one or more means of settlement, filtration or bioremediation. Overflow volumes will be released to the campus scale storm drain network that leads to the local creeks.

6.2.2.Develop Best Management Practices Specific to SDC

Although there are many potential ways to manage stormwater on a site, final selection should be specific to the context of the site. At the SDC, it will be important to develop a Stormwater BMP toolkit, matching density-appropriate techniques to functional objectives. In simple terms this means prioritizing different stormwater BMPs (strategies) throughout the campus depending on the existing and proposed conditions. The BMPs can be simply categorized by primary function: water quality, infiltration, water quantity, and conveyance. At the SDC, priority should be given based on primary importance:

1. Water Quality, to protect aquatic and groundwater resources.
2. Infiltration, to recharge the local groundwater and regional aquifers.
3. Water Quantity, to manage naturally occurring runoff events caused by the site's low infiltrating soils without an increase in erosion due to higher velocities.
4. Conveyance, to direct stormwater to water quality treatment areas or discharge points without nonerosive velocities that cause additional erosion or flooding, especially the alluvial sand and gravel deposits along Sonoma Creek.

The Stormwater BMP Matrix shown below in Exhibits 6.2 through 6.5 help convey the goals of various BMP technologies and how their form and function may change depending on the site. The BMPs are primarily categorized by function, in order of importance of the different functions within the boundaries of the SDC.

6.2.3.Opportunities for Local Infiltration

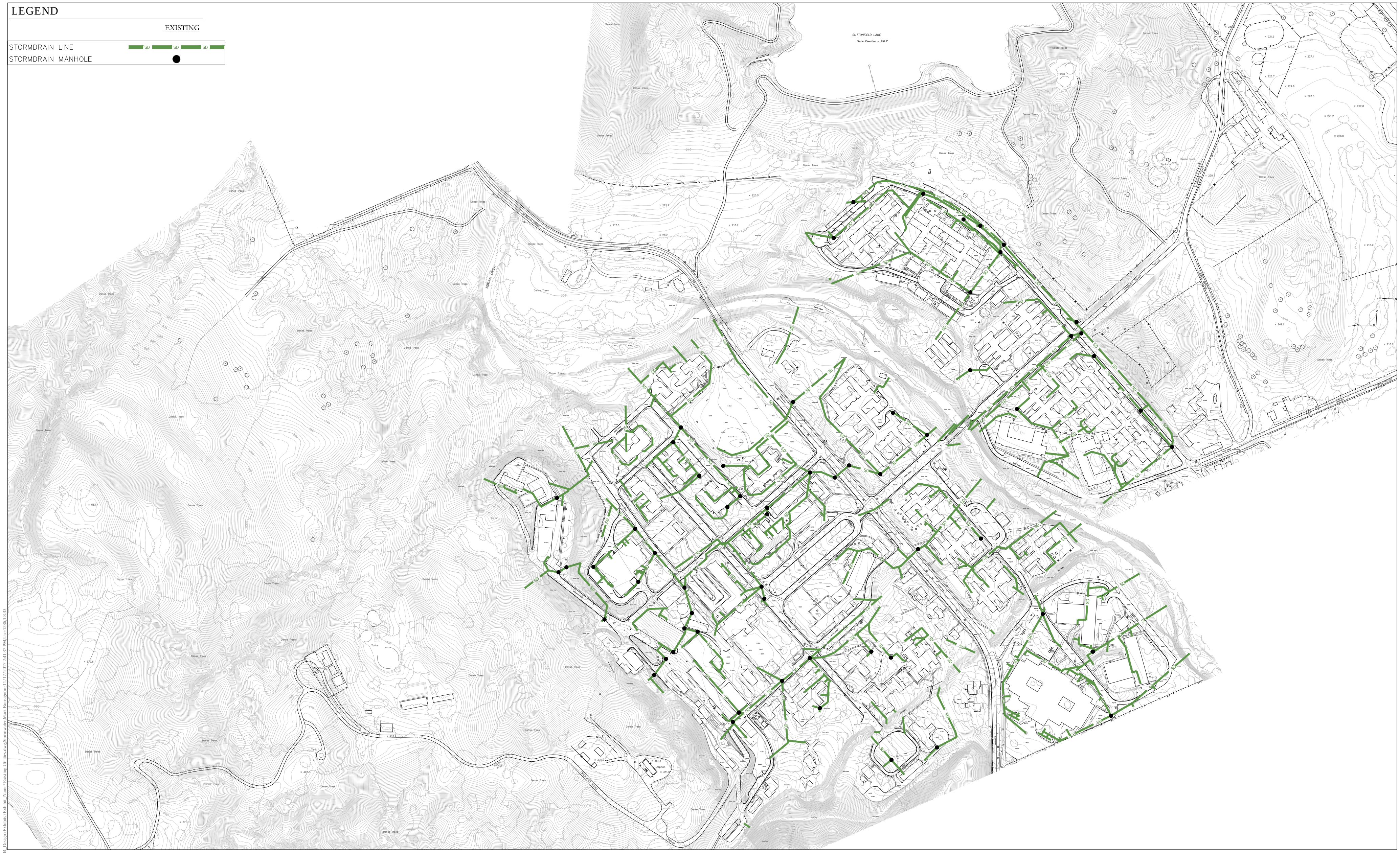
The infiltration potential has been analyzed on-site as a way to further refine plan-based selection criteria related to green infrastructure and stormwater management. A weighted analysis was performed considering the relative impact to infiltration of specific known physical and hydrological conditions of the property. The analysis included three primary elements that are major factors in the determination of the relative infiltration versus runoff for rainfall events:

- Infiltration: Slope Steepness
- USGS Soil Survey
- Sonoma County Vegetation Mapping & Lidar Program's vegetation survey (Sonoma Veg Map)

Exhibit 6.6 demonstrates the process involved in analysis of the potential infiltration on the property to derive optimal locations for development of appropriate BMPs that involve infiltration. Each of these three studies were layered to find the overlapping areas on the property with the highest infiltration potential. Figure 6.6d defines the process and weighted values that were assigned to relevant attributes to achieve the final result in the form of a single map.

The Infiltration Potential Analysis Map (see Exhibit 6.7) translates this analysis into physical space, providing a relative comparison of infiltration analysis to inform decisions about placement of green infrastructure and stormwater management facilities.

Opportunities include: areas in lowlands adjacent to wetlands and significant vegetation would be viewed as highly sought after for infiltrating surface water and using BMP installations. For these areas, development would need to prioritize slow infiltration and be pursued with caution and sensitivity. An area with significant slopes and spottier chaparral vegetation would be viewed as less appropriate for water detention and infiltration and would be better served by using permaculture techniques like contour swales.



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STORM DRAINAGE

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November 2017

Exhibit 6.1: **MAP OF STORM DRAIN SYSTEM**

FUNCTION	FOREST & UNDEVELOPED	FARMLAND	BUILDING SITES	PAVED SURFACES

INFILTRATION

Landscape Buffers

Vegetated buffer zones adjacent to roadways and paths that allow for shallow unconcentrated runoff infiltration.

Vegetated Infiltration Basin

Vegetative infiltration basin are stormwater facilities that treat and infiltrate stormwater into the groundwater aquifer.

Permeable Pavement

Porous pavement is a permeable pavement surface with a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. Runoff is thereby infiltrated directly into the soil.

Bioretention

Bioretention is a up-land water quality and water quantity control practice that uses the chemical, biological and physical properties of plants, microbes and soils for removal of pollutants from storm water runoff.

Exhibit 6.2: **BEST MANAGEMENT PRACTICES-INFILTRATION**

FUNCTION	FOREST & UNDEVELOPED	FARMLAND	BUILDING SITES	PAVED AREAS
WATER QUALITY				

Green Roof

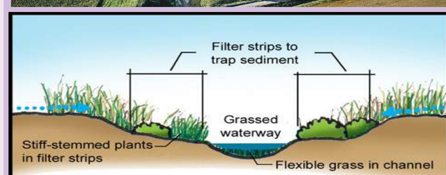
Green roofs, also known as vegetated roof covers, eco-roofs or nature roofs, are multi-beneficial structural components that help to mitigate the effects of urbanization on water quality by filtering, absorbing or detaining rainfall. They are constructed of a lightweight soil media, underlain by a drainage layer, and a high quality impermeable membrane that protects the building structure. The soil is planted with a specialized mix of plants that can thrive in the harsh, dry, high temperature conditions of the roof and tolerate short periods of inundation from storm events.

Natural Buffer Zone

Large uncultivated landscapes which provide separation between development zones and natural resources such as wetlands, streams, ponds, and coastlines.

Filter Strip

Narrower strips of often manicured landscape providing filtration of sheet flow prior to discharge to resource areas.



Urban Gardens

Gardens located in pockets throughout urban hardscapes provide opportunities for runoff to be filtered and contaminants removed prior to entering the concentrated stormwater collection system.

Vegetated Streetscapes

The addition of pockets or strip of vegetation within or adjacent to existing or future streetscapes provide a means for runoff to re-enter the acquifer. These spaces also provide filtration of street runoff and ultimate uptake of contaminants by the vegetation.

Exhibit 6.3: **BEST MANAGEMENT PRACTICES-WATER QUALITY**

FUNCTION	FOREST & UNDEVELOPED	FARMLAND	BUILDING SITES	PAVED AREAS

WATER QUANTITY

Constructed Wetland

Constructed wetlands are an alternative to traditional detention ponds by providing valuable habitat and water quality improvement in addition to the detention of increased stormwater runoff resulting from development.

Urban Flood Plain

Surface runoff from urban hardscapes can be directed toward non priority spaces which are planned and designed for the temporary storage of stormwater flows.

Contour Swales

Contour swales are an important tool for irrigating landscapes, mitigating stormwater runoff, and reducing erosion. Retaining rainwater on the landscape can be an efficient way to improve soil quality, slowing and spreading valuable moisture.

Cultivated Wet Pond

Wet ponds are used where the conditions do not provide an opportunity for a constructed wetland, while still creating opportunities for habitat development, water quality improvement and temporary detention of stormwater runoff.

Vegetated Flood Plain

Flood plains can be integrated with parks, playing fields or unmanaged landscapes. Larger storm events should be directed to non priority vegetated landscapes for temporary detention.

Exhibit 6.4: **BEST MANAGEMENT PRACTICES-WATER QUANTITIY**

FUNCTION	FOREST & UNDEVELOPED	FARMLAND	BUILDING SITES	PAVED AREAS
CONVEYANCE				

Forest & Undeveloped

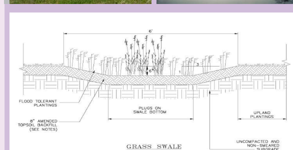
Creek Restoration

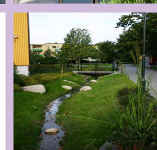
Creek restoration provides a natural way to improve the environmental health of a river or stream - restoring the hydrologic functions related to biodiversity, flood managment, and landscape growth.

Farmland

Naturalized Channel

Natural channel is a meandering, vegetated watercourse with natural banks and buffered from development zones by large uncultivated landscapes.





Building Sites

Community Swale

Community swales are similar in size to a natural swale, but more linear in design to conform with the adjacent development zones. i.e. walkways, roadways and buildings.

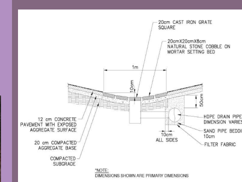
Urban Channel

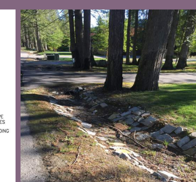
Urban channels are narrow vegetated or stone lined conveyances framed by vertical stone or concrete banks abutting cultivated landscapes or hardscapes.

Paved Areas

Road Swale

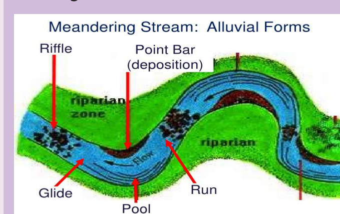
Road swales are shallow paved or stone lined water courses integral with a vehicular or pedestrian circulation route. These conveyances often include intermittent inlets and are underlain by a collection pipe.





Riffle Pools

Connected landscapes which provide retention of runoff by integrating intermittent vertical drops and daming in a watercourse. The retained runoff is then allowed to infiltrate into the groundwater table.



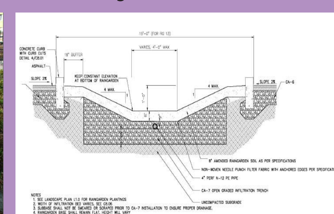
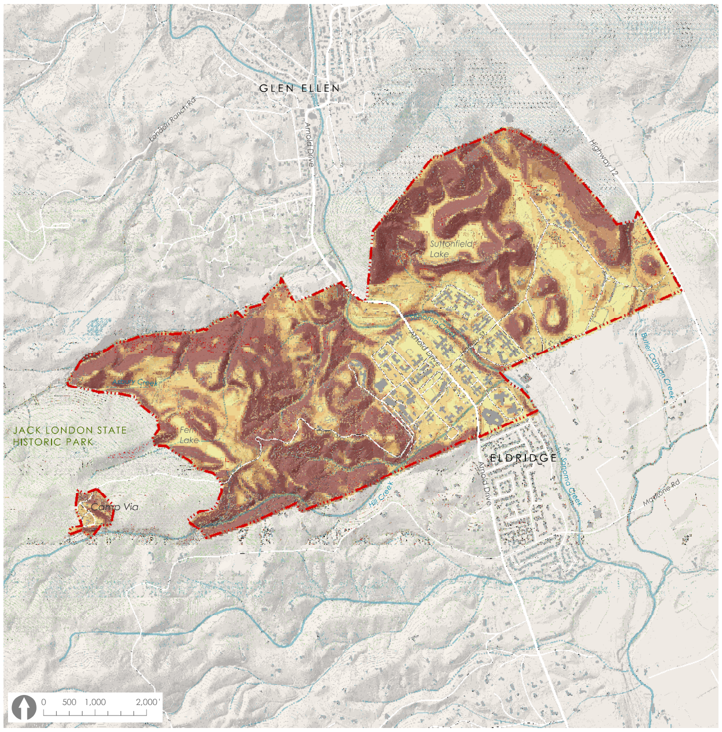


Exhibit 6.5: **BEST MANAGEMENT PRACTICES-CONVEYANCE**

Exhibit 6.6a

INFILTRATION: SLOPE STEEPNESS



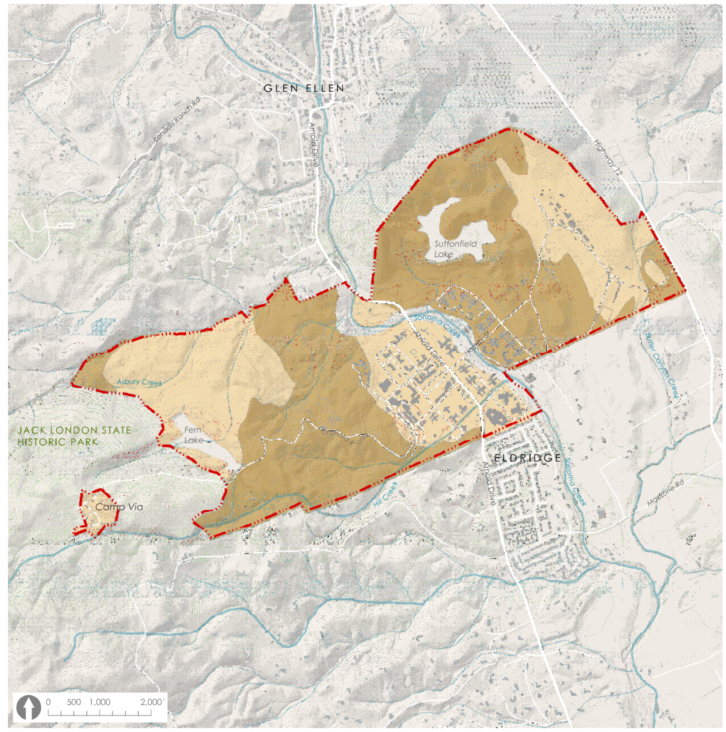
SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands

0 - 2.9%
3 - 5.9%
6 - 7.9%
8 - 10%
< 10%

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

Exhibit 6.6b

INFILTRATION: USGS SOIL SURVEY



SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands

Soils (HSG)

HSG

C
D

HSG DEFINITION

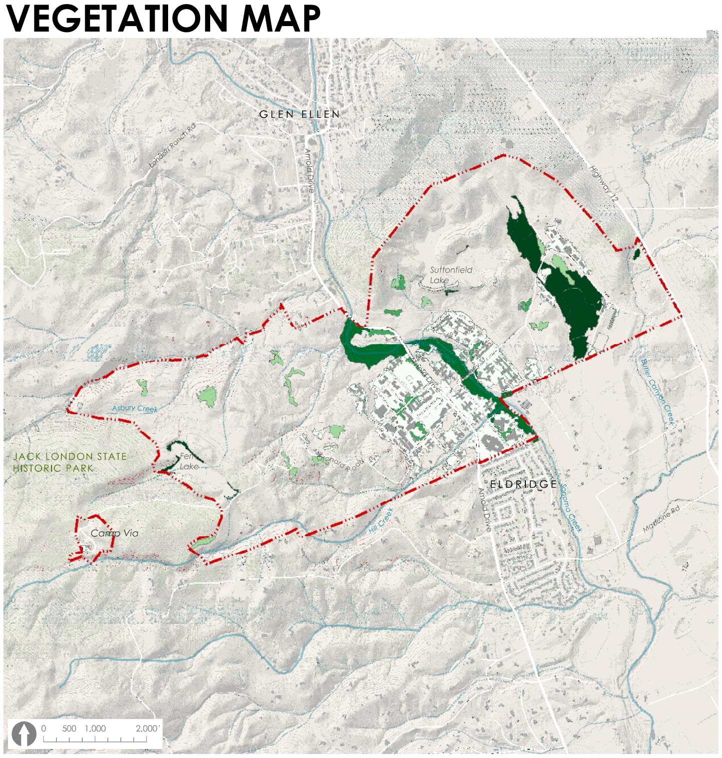
• Group C
Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

• Group D
Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

Exhibit6.6c

INFILTRATION: SONOMA COUNTY VEGETATION MAP



SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands

VEGETATION

Herbaceous Wetland
Riparian Forest
Forest
Herbaceous Shrub
Developed

Source
USGS, GreenInfo Network,
Sonoma Ecology Center,
Sonoma Veg Map - Sonoma
County Vegetation Mapping
& LiDAR Program

Exhibit 6.6d

INFILTRATION: PHYSICAL AND HYDROLOGICAL CONSIDERATIONS

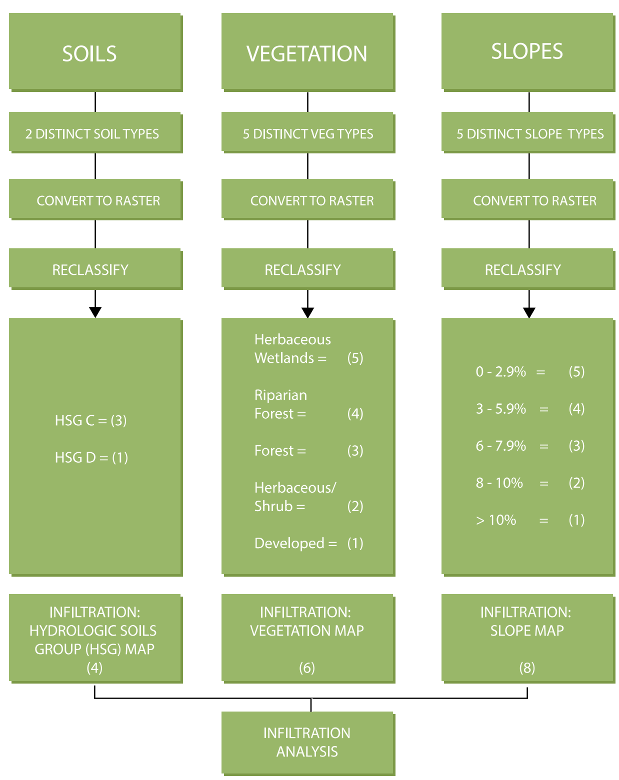
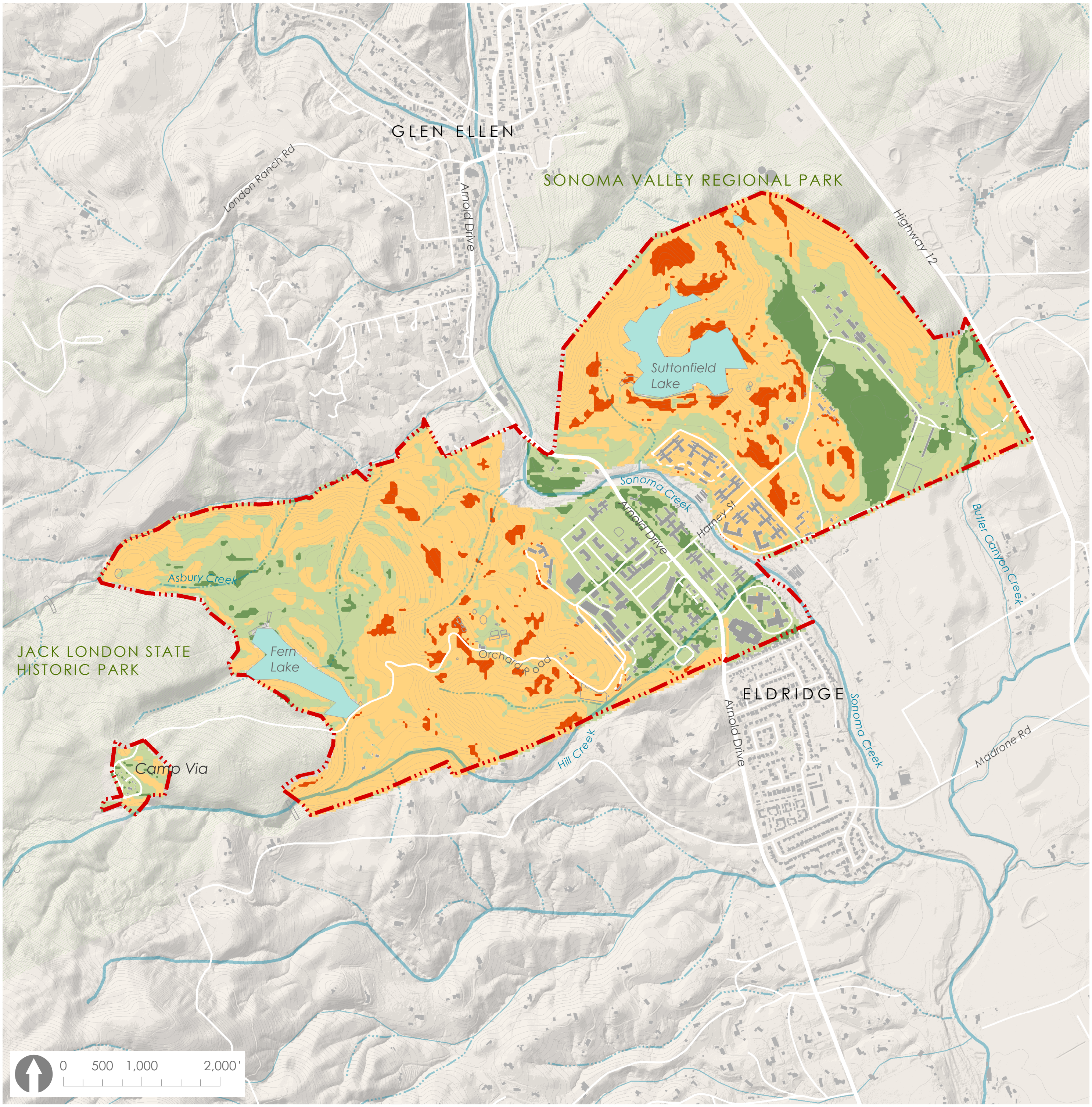


Exhibit 6.7

INFILTRATION POTENTIAL ANALYSIS



SDC Property line
Ephemeral Streams
Perennial Streams
Intermittent Streams
Protected and Public Lands
Not Suitable for Infiltration
Prefered Area for Native Woodland, Slow Infiltration & Soil Retention
Best Suited for Small, Decentralized Stormwater Management Practices
Best Suited for Centralized Infiltration Practices & Wetland Restoration

Source
USGS, GreenInfo Network,
Sonoma Ecology Center,
Sonoma County Vegetation
Mapping & LIDAR Program

7. Roads and paved areas

7.1. Existing facilities and condition

Most of the main campus is laid out with two-lane streets with parking on both sides, and concrete curb, gutter and sidewalks. Most buildings have a significant amount of parking and paved service area around them. Although the main campus buildings are widely spaced with broad lawns between them, the ample paving around the buildings provides a higher than average percentage of impervious pavement within the developed areas. Roadways are paved with asphalt and condition of these roads varies from excellent to very poor. Pedestrian paths throughout the main campus are concrete and form sidewalks along the streets (usually both sides) and primary paths of travel between buildings. Most of the sidewalks have modest to severe issues from minor cracks to broken and uneven pavement. In a number of locations, sidewalks have cracked at the control joints, and adjacent slabs are significantly out of alignment posing extreme tripping hazards. Refer to Exhibit 7.1 for a high-level analysis of the current condition of roads, curbs and sidewalks in the main campus area.

A high-level analysis of the core campus area reveals three-quarters of the core campus presents an impervious surface resulting in a significant amount of untreated surface runoff to the creeks. Calculated impervious area within the core campus area was estimated using Lidar data as provided by the Sonoma Veg Map (Exhibit 7.2) as follows:

Pervious area (landscaped or natural vegetation)		48 acres	26%
Building footprint (roof area)	26 acres		14%
Paved roads	84 acres		46%
Other impervious surfaces (parking/service/other areas	25 acres		14%
Total impervious area		135 acres	74%

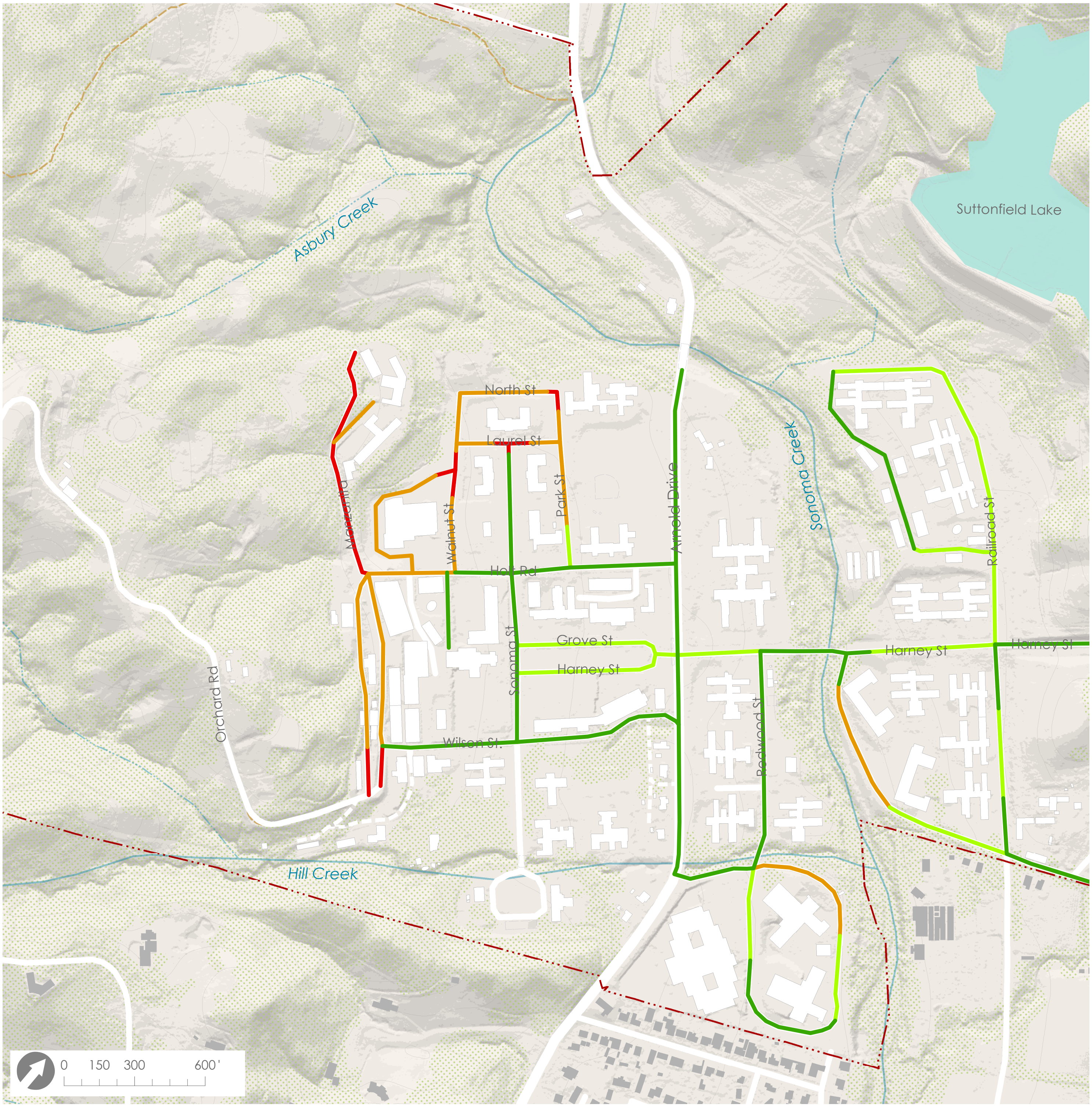
7.2. Constraints and Opportunities

7.2.1.Low-Impact Development (LID)

What the above information reveals is that there is significant room for implementation of Low-Impact Development techniques to improve stormwater management in the core campus area. Reduction of street width, provision of curb cuts that allow surface runoff to drain to adjacent landscaped bioretention areas, provision of pervious pavement where appropriate and other measures as discussed in Section 6.2 above will significantly improve the quality of stormwater discharged from the property while slowing the release of stormwater to local creeks, reducing the risk of flooding and soil erosion.

Exhibit 7.1

ROAD CONDITION



SDC Property
Trails
Lakes
Ephemeral Streams
Perennial Streams
Intermittent Streams
Native Forest

PAVEMENT CONDITIONS

Excellent
Good
Maintenance
Distressed

Source
USGS, GreenInfo Network,
Sonoma Ecology Center

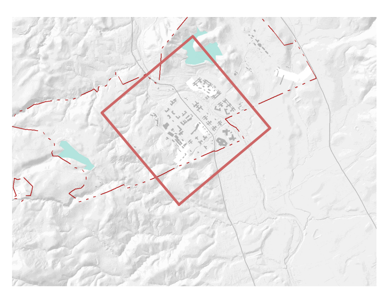
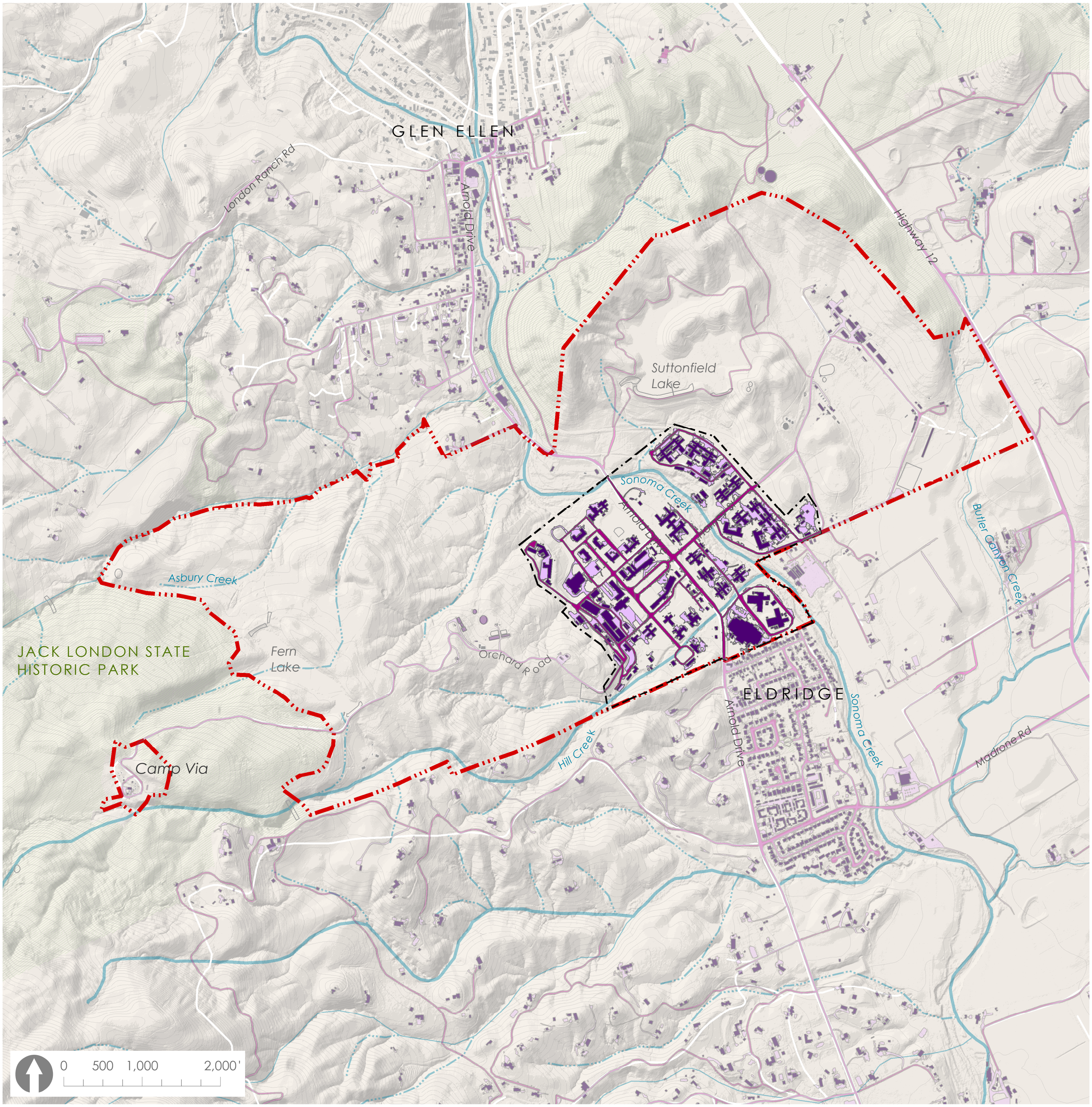


Exhibit 7.2

IMPERVIOUS AREA



SDC Property line

Ephemeral Streams

Perennial Streams

Intermittent Streams

Protected and Public Lands

Impervious Study Area

Buildings

Other Impervious

Paved Roads

IMPERVIOUS STUDY AREA

Total Impervious Area:
5,878,894.96 Sq. Ft.
134.96 Acres

Buildings:
1,146,178.04 Sq. Ft
26.31 Acres
20%

Other Impervious:
1,083,903.38 Sq. Ft
24.88 Acres
18%

Paved Roads:
3,648,813.54 Sq.Ft.
83.77 Acres
62%

Source
USGS, GreenInfo Network, Sonoma Ecology Center, Sonoma Veg Map - Sonoma County Vegetation Mapping & LiDAR Program