# Operational Management Manual

## of the

# San Bernardino Valley Water Conservation District

**November 2017 Update**

OPERATIONAL MANAGEMENT MANUAL

FOR THE
DETERMINATION
OF
WATER RECHARGE/OPERATIONAL
PROCEDURES

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NOVEMBER 2017

## History of Revisions

<u>Summary of Revisions/Additions</u>

July 1992:

- Initial Adoption by Board of Directors

March 1994:

- Revised Operational Management Manual to conform of the State of California Water Code, Division 21, Water Conservation Districts, Sections 75500 To 75624, Ground Water Charge

September 2012:

- Revised Operational Management Manual to update procedures and methods to reflect those that are currently used
- To note changes in operations with the completion of the Seven Oaks Dam

November 2017:

- Revised Operational Management Manual to update procedures and methods to reflect those that are going to be required by the Wash Plan HCP
- Update acquired equipment
- Update status on projects in the area of the District's operations
- Update with aggressive recharge activities
- Update with other non-spreading activities

## Acknowledgements

The 2017 Operational Management Manual was prepared by Katelyn Scholte with review by Daniel Cozad, Manuel Colunga and Richard Corneille. The assistance of Jennifer Zhou, Ryan DeLeon, and Tommy Purvis is also acknowledged in the preparation and the production of this Manual.

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## Definitions

Acre Feet (AF): A unit of volume equal to the volume of a sheet of water one acre in area and one foot in depth. Also equal to 43,560 cubic feet.

Aquifer: An underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.

Arizona Crossing: A type of road crossing that allows a waterway to run over a road. Man-made Arizona crossings include culverts that allow water to pass through a paved roadway. The Arizona crossing allows for low-level water to overflow directly onto a road. When water levels rise, the water will pass over the road, but not frequently enough to impede traffic.

Berm: A level space, shelf, or raised mound constructed through the piling of sand, dirt and/or rock. Berms can serve as boarders, barriers between two areas, or diversions/blockages to control flows of water.

Borrow Pit: Pit resulting from the construction of the Seven Oaks Dam. Material constantly being taken form the site such as rock, dirt, and clay led to the name of Borrow Pit. Santa Ana basins one, two, and three are located at the east end of the borrow pit. A limited of water can also be spread in the west end of the borrow pit.

Canal: Small, main made ditches and tunnels used to carry water from one basin to another.

Channel: Larger natural waterways which feed the canals and basins. The two main channels are the Santa Ana River Channel and the Mill Creek Channel.

Conduit: A pipe or tube through which water is able to flow through.

Cubic Feet per Second (cfs): The Standard English unit for measuring volumetric flow rate. Equivalent to a volume of 1 cubic foot flowing every second.

Culvert: A structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side. Normally embedded in the soil underneath the obstruction, a culvert can be made with a pipe, reinforced concrete or other material.

Diversion Structure: Any type of man-made structure that is used to divert water from a river around a site or a portion of the river flow to a desired location. Usually utilizes some type of sluice gate.

Eastern Branch Extension Phase 2 Pipeline (EBX II): Approximately three miles of large diameter pipeline which conveys SWP water from Valley District's Foothill pipeline near Cone Camp Road to a reservoir south of the Santa Ana River Wash in the Mentone Area. A pump station then conveys water from the reservoir in Mentone to the existing Crafton Hills Pump Station.

Groundwater Recharge: Groundwater recharge of deep percolation is a hydrologic process where water moves downward from surface water to groundwater. Water is collected into basins and through percolation, enters aquifers underneath the soil.

Inland Feeder Pipeline: A 44 mile long water conveyance system owned by the Metropolitan Water District of Southern California. It connects the California State Water Project to the Colorado River

Aqueduct and Diamond Valley Lake. The system is designed to increase the reliability of Southern California's water supply, while minimizing the impact on the San Francisco Bay/Sacramento–San Joaquin River Delta environment in Northern California.

Miner’s Inch: Originating during the Gold Rush, a miner’s inch is the quantity of water which discharges through a square inch of opening under a prescribed head. The number of miner’s inches is equal to the area of the opening in square inches. The SBVWCD uses miner’s inches when taking weir measurements for the daily flow report. In southern California a miner’s inch equals 0.020 cfs.

Overflow: A structure comprised of a stack of wooden boards inside of a metal railing located on the inner bank of spreading basins. The structure is designed to allow water to pass over the top and into a canal when the water level in a basin reaches a specific height. This allows basins to only receive water once the previous one is filled to the desired level. The overflow can be adjusted by adding or removing boards to the structure.

Parshall Flume: A hydraulic metering device used for measuring the volumetric flow rate of surface waters and irrigation flows. The Parshall Flume accelerates flow through a contraction of both the parallel sidewalls and a drop in the floor at the flume throat. Under free-flow conditions the depth of water at specified location upstream of the flume throat can be converted to a rate of flow.

Percolation Rate: The change in water level in a basin over a period of time. Represents the water absorption rate of soil.

Seven Oaks Dam: A 550 foot high earthen dam across the Santa Ana River in the San Bernardino Mountains, about 4 miles northeast of Redlands in San Bernardino County, southern California. Constructed between 1993 and 2000 in order to protect the Orange, Riverside and San Bernardino Counties from flooding of the Santa Ana River. The dam was built by the U.S. Army Corps of Engineers (USACE) and is owned and operated by local flood control districts.

Soft Plug: A low berm (ideally two feet tall by ten feet wide) made of dirt, sand, and rock designed to divert water from the Mill Creek diversion structure away from its original course through the main canal. In the event of a sudden large flow resulting in a high water level, the soft plug is washed away. The destruction of the soft plug protects the location at which the water was being diverted from flood damage and debris.

Soil Liquefaction: Soil liquefaction is a phenomenon in which the strength and stiffness of soil is reduced, causing it to behave like a liquid. This phenomenon occurs during earthquake shaking or other rapid loading on the soil. Liquefaction and other related phenomena have been responsible for tremendous amounts of damage in earthquakes around the world.

Spreading Basins: Large depression in the earth’s surface where water (usually rain water diverted form a river) is allowed to collect. The water then flows through the sand, rock, and gravel at the bottom of the basin which recharges the groundwater. The SBVWCD currently maintains roughly 53 basins in the Mill Creek Spreading Facilities and 18 in the Santa Ana River Spreading Grounds.

Stilling Well: Used to dampen surface disruptions that may cause inaccurate water level readings. A tube is lowered into the center of the well, inside of which a level probe floats on the surface of the water.

The tube has a vent hole towards the top in order to equalize the pressure and allow for an accurate measurement of the water level inside of the well.

Swale: A shallow trough dug into the land usually with a trapezoidal cross-section. Its purpose is to allow water time to percolate into the soil while also allowing water to cross roadways with minimal changes to the landscape.

Tailrace Pipeline: A pipeline which carries water away from the Edison Power House #1 to the North Fork Box. In general, a channel or pipeline that carries used or excess water away from a dam, water mill, water wheel, etc.

Tailrace Valves: Three valves are used to allow water from the Tailrace Pipeline to join together with water entering the SBVWCD's Sandbox from the Cuttle Weir.

Weir: A barrier across the width of a river or waterway that alters height of the water level. Weirs are most commonly used to prevent flooding, divert a portion of the flow, and measure the flowrate or discharge of the water. Water is allowed to flow freely over the top of the weir crest and then cascades down the other side to a lower water level. Since the geometry of the top of the weir is known and all water flows over the weir, the depth of water behind the weir can be converted to a rate of flow.

# Section 1: Introduction, Background, and Plan Purpose

## The District and Its Operations

The San Bernardino Valley Water Conservation District (the "District") was formed by the San Bernardino County Board of Supervisors on January 4, 1932 to obtain water for conservation purposes.[1] The District was created to recharge the Bunker Hill groundwater basin with native water in order to conserve that water for future use. At that time, the water was primarily for agriculture; today this water is used for agricultural, municipal, and industrial purposes. The District's mission is to ensure recharge of the Bunker Hill Groundwater Basin in an environmentally and economically responsible way, using local native surface water to the maximum extent practicable.

The District has historically operated water recharge facilities in two areas: the Santa Ana River and Mill Creek and holds Water Rights for both the Santa Ana River and Mill Creek. A summary of the District's recharge facilities is provided in section two of this Manual. At present, the District recharges water primarily during the rainy season in winter and spring and when water is released from the Seven Oaks Dam. Imported water has occasionally been provided by other entities for recharge by the District, and its usage has increased in times when native water is less available.

The District has fee title ownership on approximately 2,340 acres within the cities of Highland, Redlands, and Mentone for spreading operations. Additionally, the District also has easements and limited use of the Bureau of Land Management lands in the Santa Ana River recharge facility. In total the District has access to approximately 3,650 acres for recharge operations. The District, as an agency, encompasses a total of approximately 50,000 acres within its boundary, including these 3,650 acres. In 2016 the District purchased 16 acres of land east of the Mill Creek Spreading Facility.

The District operates and monitors various facilities as part of the Cooperative Water Project and monitors and maintains surface water and groundwater records for the upper watershed and basin. These various facilities can be found in Appendix C. The District is also a court appointed member of the Big Bear Watermaster, whose most recent annual report summary can be found in Appendix B.

Figure 1-1 shows the regional context of the overall District Boundaries within the Bunker Hill Groundwater Basin as well as the District's sphere of influence as appointed by the Local Agency Formation Commission for San Bernardino County. Figure 1-2 shows the land owned by or under easement of the District in the Santa Ana and Mill Creek Recharge Basins areas. The District's historical groundwater recharge is shown in Table 2-1 of this report.

[1] A predecessor to the District, the Water Conservation Association (WCA), was formed on January 28, 1910. The WCA was dissolved in the early 1940s.

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# Figure 1-1: Regional Context
# Operational Management Manual

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD. CASIL, SBVMWD
GIS Contact: K. Scholte
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August 22, 2017

SBV WATER CONSERVATION DISTRICT
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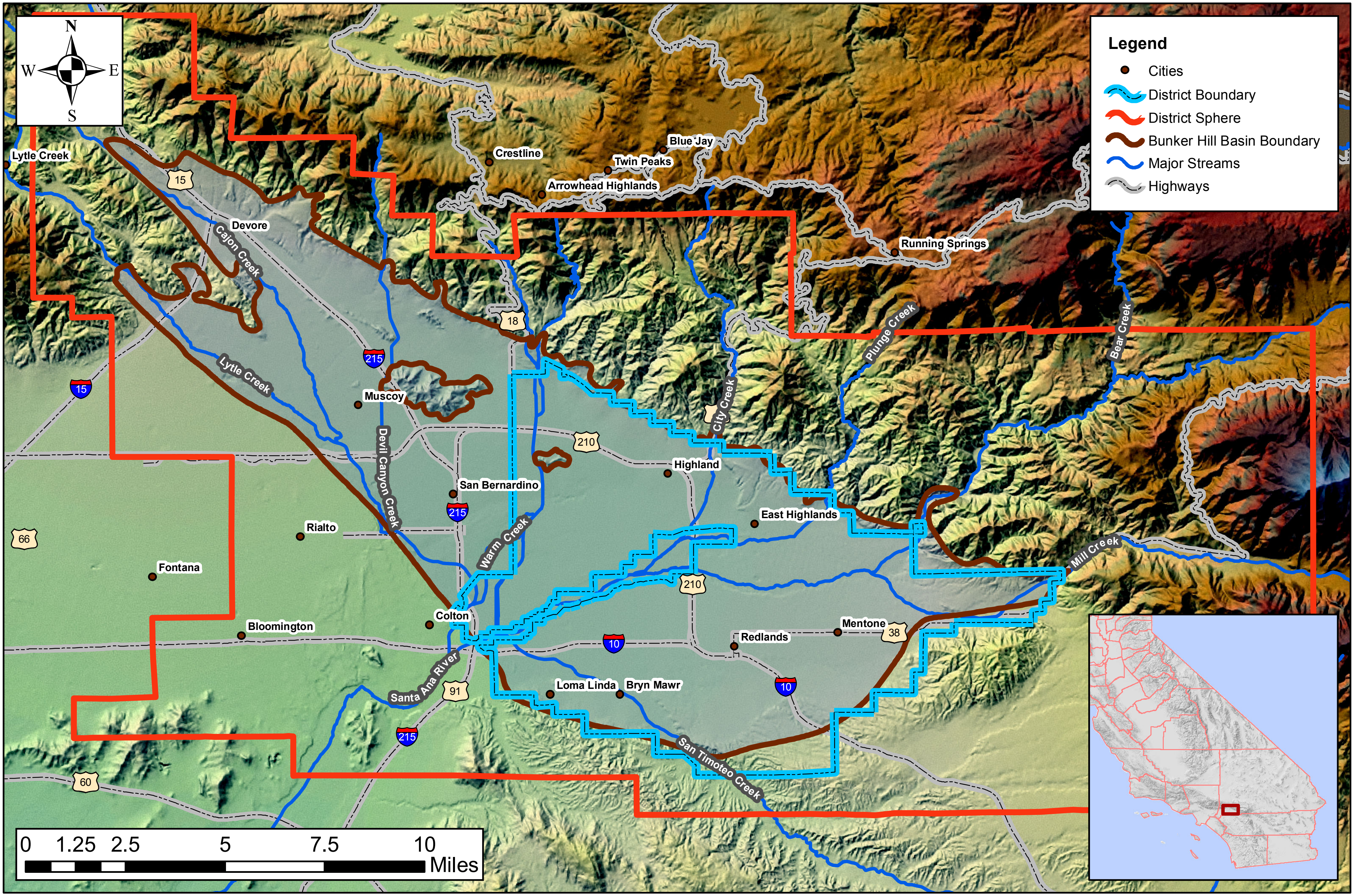

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# Figure 1-2: Facilities & Land Ownership
# Operational Management Manual

Coordinate System:
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Source: SBVWCD. CASIL, SBVMWD
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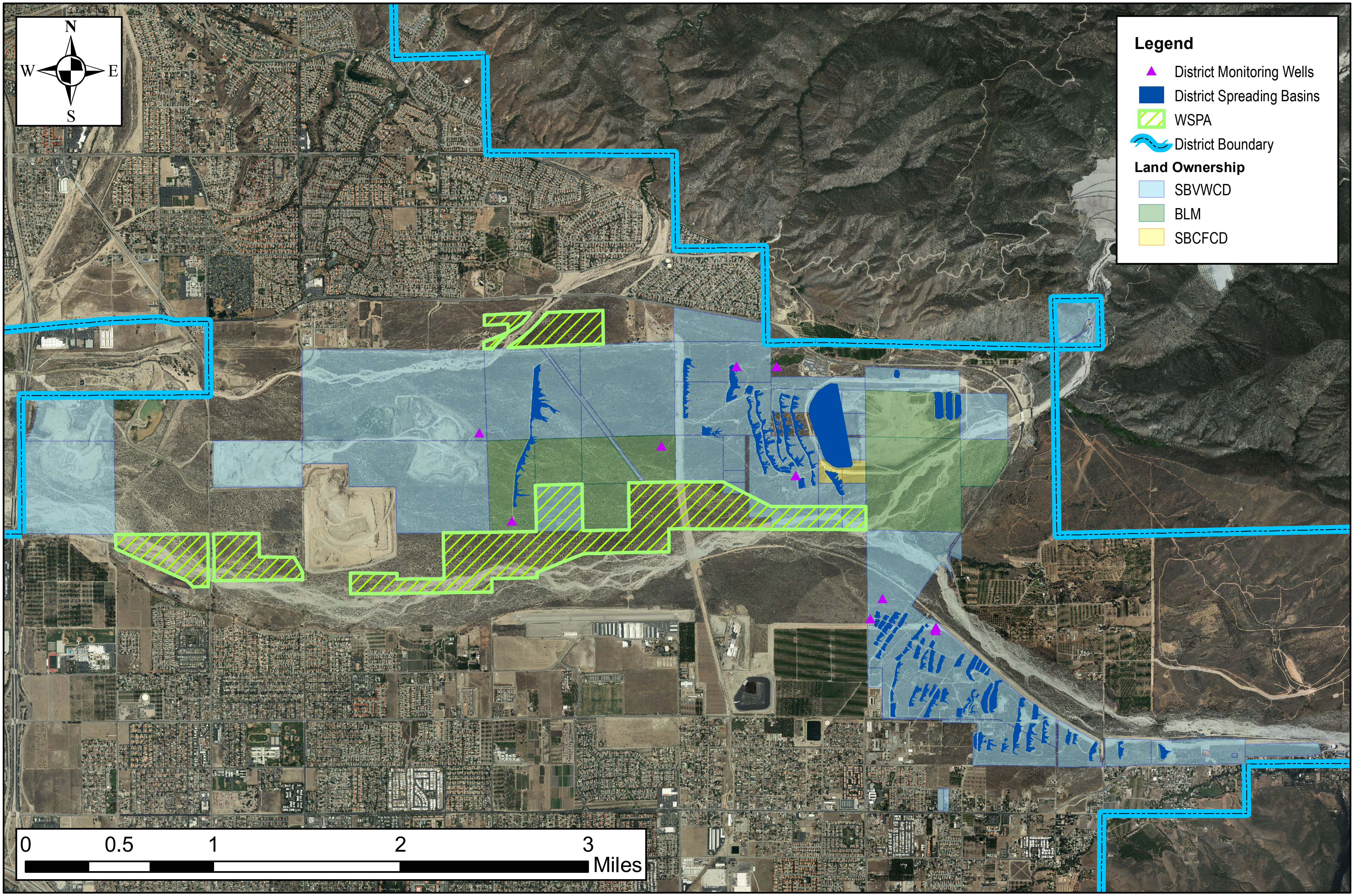

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Water Conservation Districts in California are granted broad authority to exercise a variety of powers necessary to further the District's primary goal of conserving and recharging groundwater (see Water Code Appendix A. These powers include:

- Making contracts
- Employing necessary personnel and consultants
- Acquiring property through eminent domain
- Bonds and assessments
- Constructing facilities to provide for the conservation of water
- Taking legal action where necessary to carry out its authority
- Groundwater charges
- Owning and operating related facilities in connection with the District's recharge facilities
- Operating and maintaining hydroelectric power plants
- Constructing and operating recreational facilities in connection with other District facilities
- Adopting ordinances to regulate activities within the District

In addition, the District has a variety of powers and duties specifically related to water resources, generally providing for the construction and use of facilities to recharge water, the distribution and sale of water, and the generation and sale of hydroelectric energy. To date, the District has not constructed or operated any recreational or hydroelectric facilities, although it retains the option to do so at a future time. Figure 1-3 is a copy of the District's organizational chart.

## Bunker Hill Groundwater Basin

The "Bunker Hill Basin" is the term commonly used to describe a distinct groundwater basin in the San Bernardino Valley. The Bunker Hill Basin is bounded on the north by the San Bernardino Mountains, on the southeast by the Crafton Hills and the Badlands, and on the west by the San Jacinto fault. This basins boundary is generally defined by earthquake faults which effectively act as subsurface "dams," trapping groundwater. The faults in the vicinity of the District's Mill Creek recharge facilities may restrict the movement of water into the larger Bunker Hill Basin. An illustration of the Bunker Hill Basin and the system of earthquake faults in and around the basin is shown in Figure 1-4. Note the District boundary does not include the entire Bunker Hill Basin.

As shown in Figure 1-5, three subareas within the Bunker Hill Basin have been identified. These are commonly referred to as Bunker Hill I, Bunker Hill II, and the Pressure Zone. The Lytle Creek Basin is also shown as it is included in the District's Engineering Investigation. Due to a combination of factors, which include the confinement of groundwater by the earthquake faults and bedrock and annual rainfall and snowpack levels, the Bunker Hill Basin is one of a small number of such basins in California which has recently or historically had high groundwater levels. According to the U.S. Geological Survey, the "Pressure Zone" area of the Bunker Hill Basin (near the San Jacinto fault) was throughout most of history a marshland. Water levels in the Pressure Zone were above ground surface, creating a shallow marsh. In the 1870s, many wells near present-day downtown San Bernardino were artesian.

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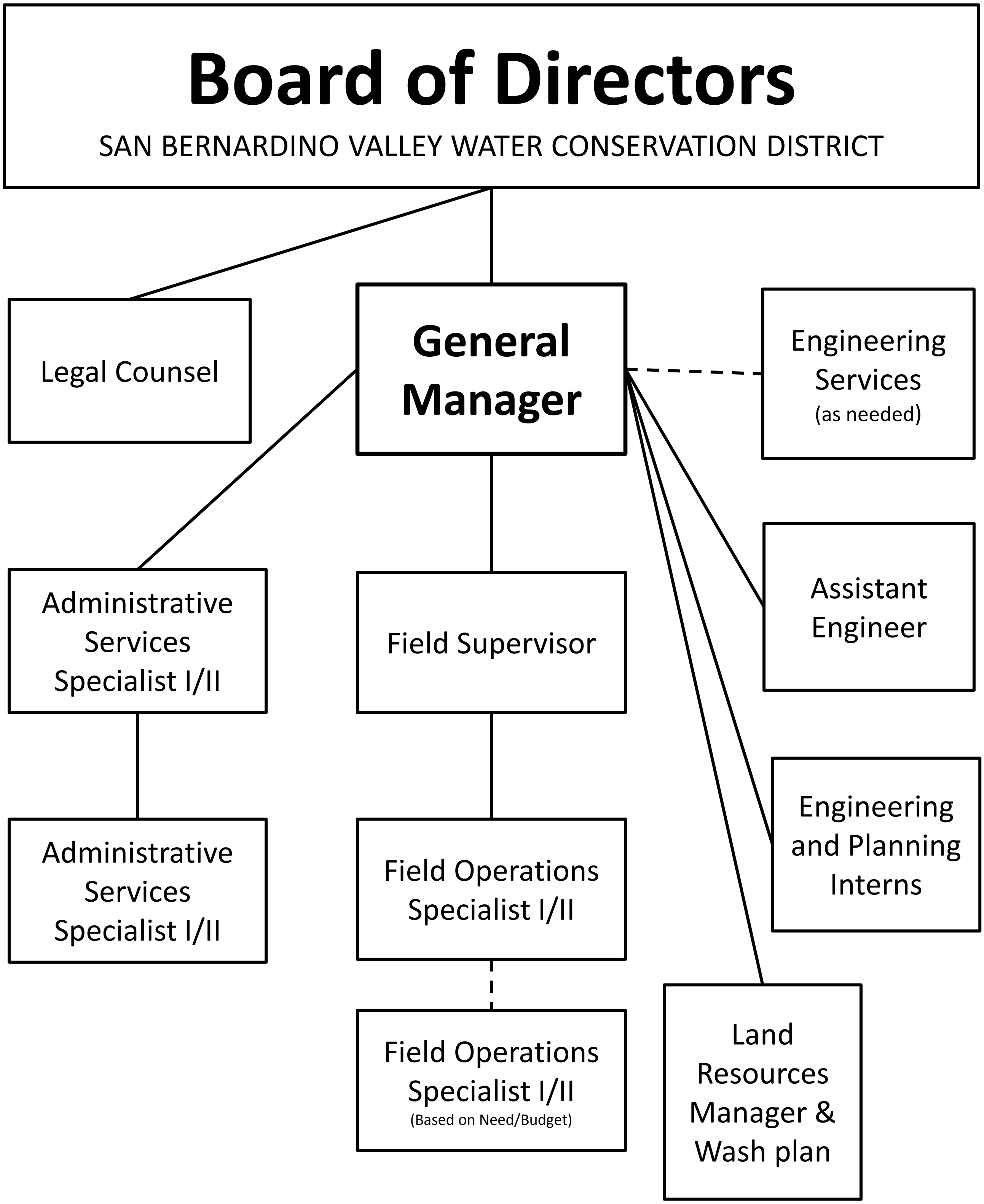
# Figure 1-3: District Organization Chart



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# Figure 1-4: Bunker Hill Fault System
## Operational Management Manual

Coordinate System:
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Projection: Lambert Conformal Conic
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Source: SBVWCD. CASIL, SBVMWD
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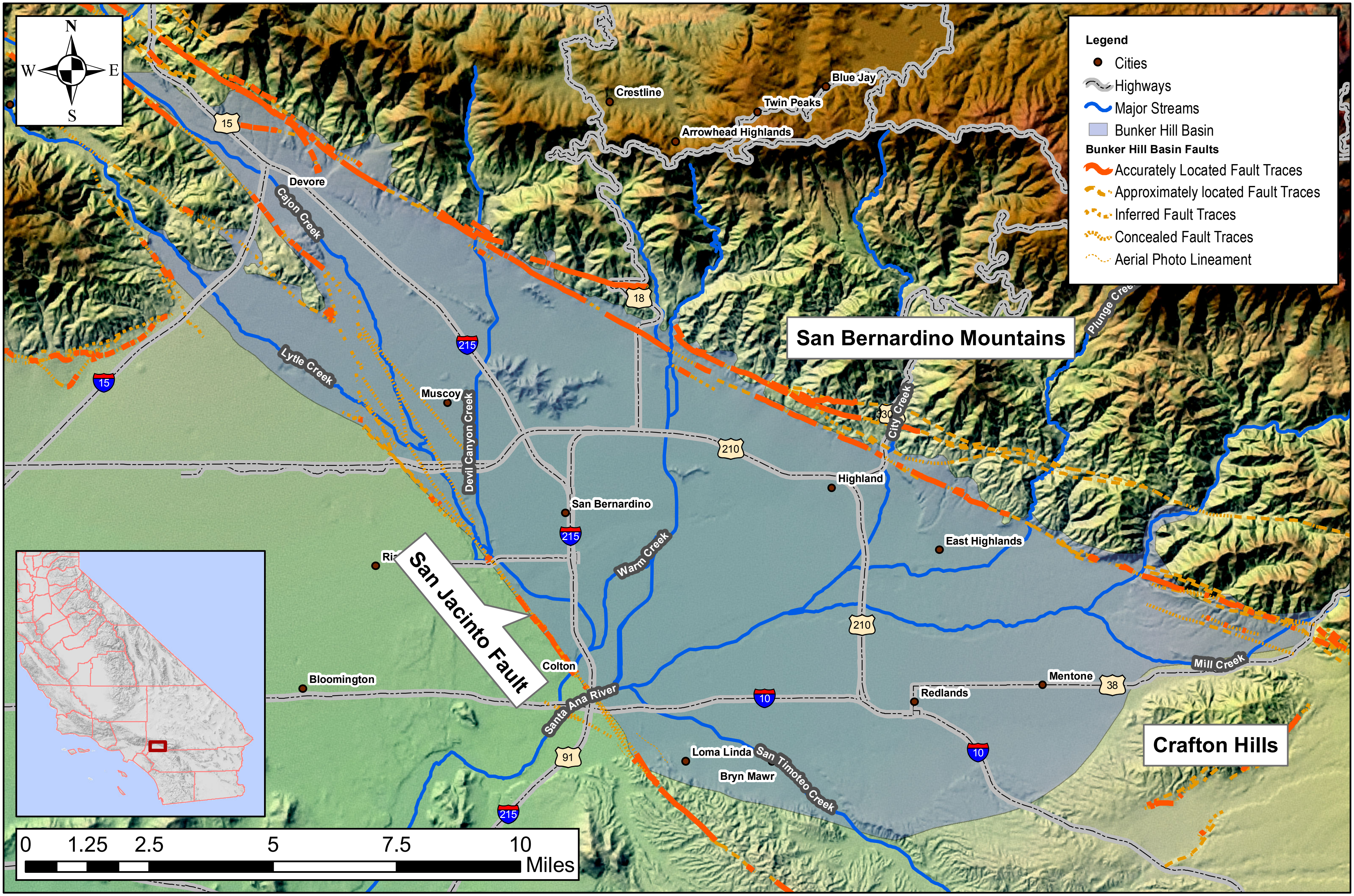

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# Figure 1-5: Bunker Hill Sub-Basins
# Operational Management Manual

Coordinate System:
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Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD. CASIL, SBVMWD
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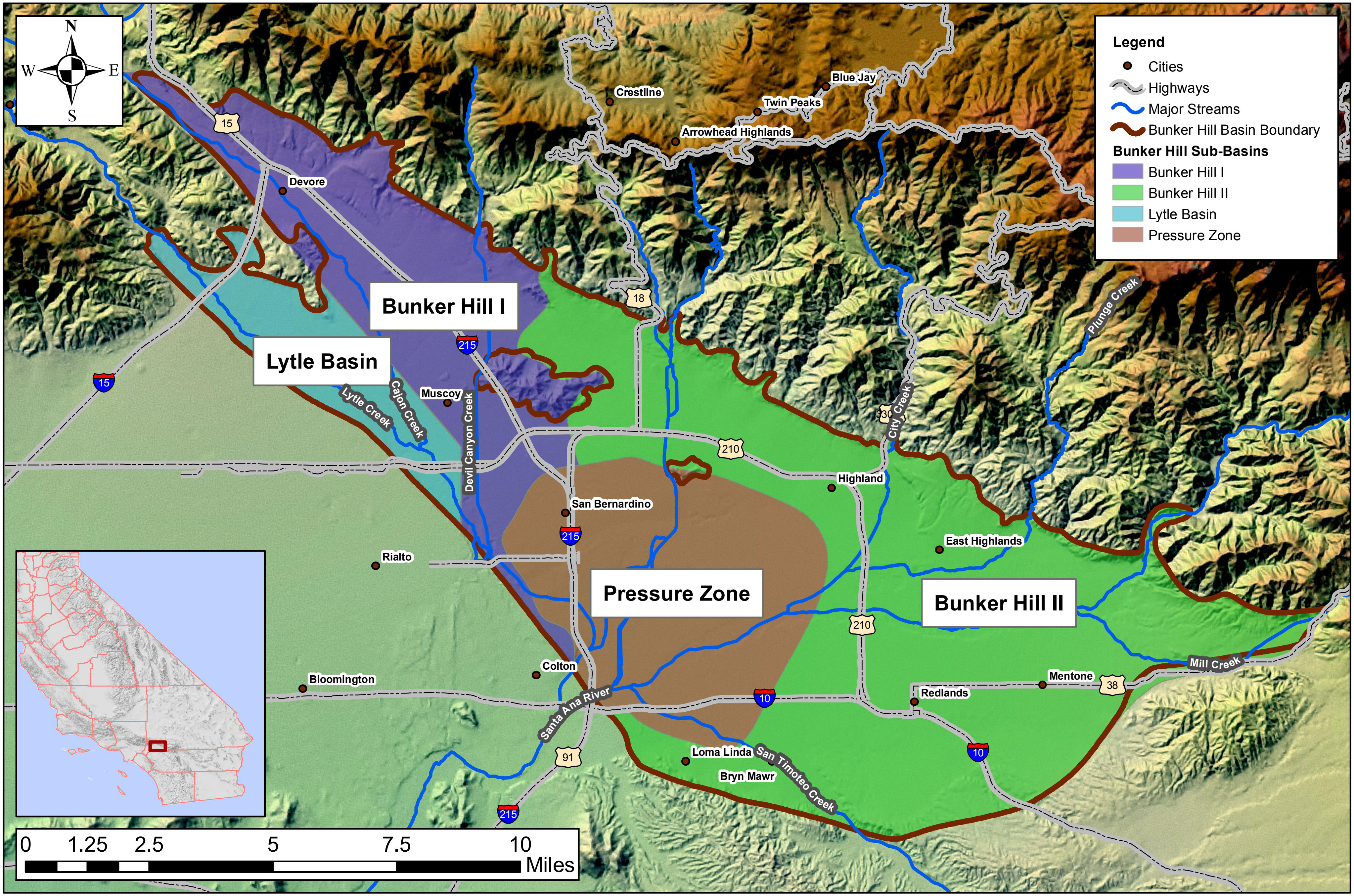

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The historic pattern of high groundwater levels was changed, however, in the 1930s when farming and groundwater pumping increased at the same time that the local area experienced lower-than-normal precipitation (historical rainfall records are shown in Figure 1-6). The net result was that groundwater levels declined and the marshland diminished.

Beginning in the 1960s, a change in the pattern of groundwater use and recharge occurred. In the place of the high groundwater of the second quarter of the century, a pattern of decreased pumping and decreased evaporative loss due to plants (which had once been the largest source of groundwater loss) began and continued through the decades of the 1960s and 1970s and into the 1980s. In the 1980s this declining use of groundwater supplies coincided with increased recharge from natural and imported sources.

By the early 1980s the water level in the historic marsh area had again risen to near or above the surface. These high water levels have led to a number of problems, as described in a report prepared by the U.S. Geological Survey.[2]

*"Streets have buckled, basements have been flooded, and concrete-lined flood control channels have been damaged."*

As the U.S. Geological Survey report points out, high groundwater levels, combined with the presence of two major earthquake faults, also raises the potential for liquefaction of soils in the downtown area of San Bernardino during an earthquake. When soils liquefy, they become somewhat like quicksand--more liquid than solid--with the result that buildings and other structures built on the soil can suffer extensive damage. This type of soil liquefaction caused much of the damage in San Francisco's Marina District during the 1989 Loma Prieta earthquake.[3]

Management of high groundwater levels in the Pressure Zone area of the basin is done collectively through guidance and the groundwater model prepared for the Integrated Regional Water Management Plan (IRWMP), and constant oversight by the Basin Technical Advisory Committee (BTAC) which includes District staff participation. This body and its Engineering Committee use tools and information provided by the members and stakeholders to forecast the water levels and maintain the basin in balance through a variety of management alternatives. Recharge targets across the basin are set by the BTAC each year in the fall or early winter based on the overall status of the basin, the modeled hydrologic conditions and expected weather conditions. The District contributes its information on recharge, well levels and other data to assist with this collaborative BTAC recommendation. In 2016, the process for the creation of a Groundwater Council began, with the ultimate goal of collaborative basin management and replenishment. This includes an agreement from all parties and a cost share to bring state water project water into the Bunker Hill basin, when available, for replenishment and direct use. The details of the agreement and cost share are still being developed by the agencies within the basin.

[2] Ground-Water-Flow Modeling and Optimization Techniques Applied to High-Ground-Water Problems in San Bernardino, California, 1989.
[3] Ibid.

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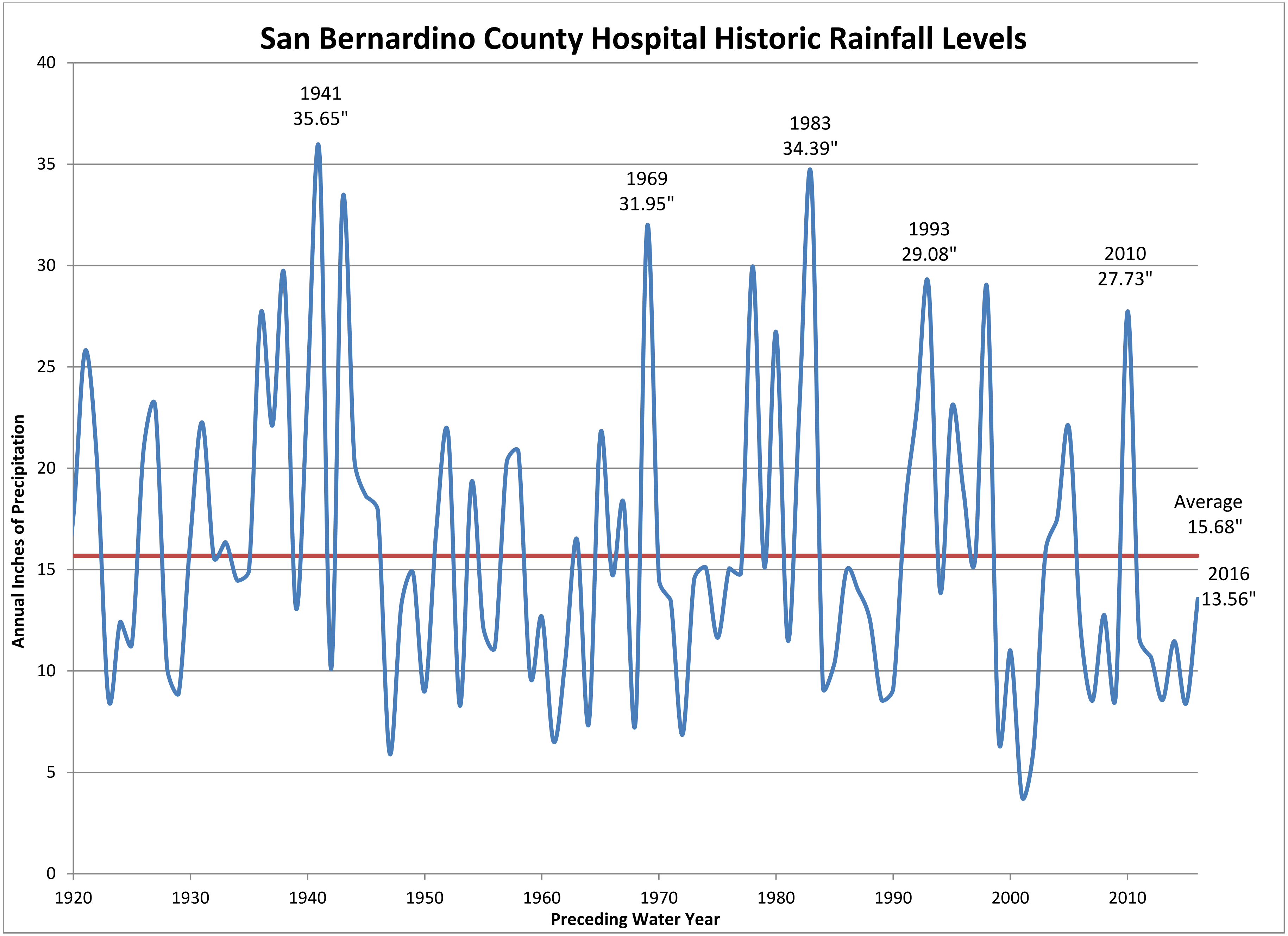
San Bernardino County Hospital Historic Rainfall Levels
Annual Inches of Precipitation
Preceding Water Year
0
5
10
15
20
25
30
35
40
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
1941
35.65"
1969
31.95"
1983
34.39"
1993
29.08"
2010
27.73"
Average
15.68"
2016
13.56"

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In 2009 the District prepared with San Bernardino Valley Municipal Water District (SBVMWD) the Santa Ana River Recharge Optimization Study. The purpose of the study was to evaluate the District's Santa Ana recharge facilities to assess their current capabilities for diversion, conveyance, and recharge. The study included extensive field work and forms the basis for the major design criteria for the Enhanced Recharge Facilities, which have been designed by the SBVMWD and Western Municipal Water District (WMWD). The phased enhanced recharge facilities construction project will expand the District's facilities to divert and convey up to 500cfs of flow from the Santa Ana River and recharge up to 80,000 AF per year. These facilities will be built by SBVMWD and WMWD and operated and maintained by the District.

In December 2011, a collaborative principles agreement was approved by the District and SBVMWD and WMWD to allow the District to make land available to SBVMWD and WMWD to build facilities and to compensate the District for the lease and for the operations and maintenance of the new facilities. The Agreement to Develop and Operate Enhanced Recharge Facilities was approved in fall of 2012. Phase one of the Enhanced Recharge Facilities is expected to be under construction during summer 2017 through winter 2018. More information of the Enhanced recharge project is available in Section 6:

## Development History

The "Water Conservation Association" (WCA) was first organized in Riverside, California on June 2, 1909. The WCA was formed with the purpose of organizing a permanent agency for the spreading of the floodwaters from the Santa Ana River. WCA members were chosen from three counties, San Bernardino, Riverside and Orange. The WCA first recorded the spreading of water in 1911 at the mouth of the Santa Ana River. On October 6, 1911, they published a notice to appropriate a flow of 300 Cubic Feet per second from winter flood waters of the Santa Ana River for the purpose of conserving said waters by spreading it over certain lands near the mouth of Santa Ana Canyon near Mentone.

In response to water level concerns from property owners in the San Bernardino Valley, a public water conservation district (the San Bernardino Valley Water Conservation District) was organized and held their first meeting on January 19, 1932, The District originally included 12,600 acres located in the valley east of the City of San Bernardino but quickly expanded in 1935 to encompass the 46,950 acres. Although the District's duties originally included observing, measuring, and recording water and well levels within its boundaries, it eventually took an active part in spreading water and conserving any runoff not necessary for irrigation in 1935. In 1937 the District worked closely with the WCA and their spreading operations at the Santa Ana River before taking over all responsibility and work of spreading water when the WCA withdrew from all activity.

With the District in charge of spreading and monitoring water from both the Santa Ana River and Mill Creek, the District had the ability to provide for the recharge of the Bunker Hill Basin. The District's new land ownership and operations were not welcomed by all downstream of the Santa Ana River, especially the Irvine representatives who now felt their water supply was threatened by the District. The Watermasters as well as the Orange County Water District assisted in developing studies of the watershed to determine appropriate regulations regarding spreading and allotments to downstream water agencies.

The District, with support of major water companies in the Redlands-Highlands area, decided to stand firm in protecting its rights to spread all normal flows of the Santa Ana River. This angered the representatives of Orange County, and in 1942 an agreement was called for, a stipulated judgment. The 1942 judgment placed limitations regarding the spreading of water from the Santa Ana River. The District applied to the State for water rights licenses for the diversion of water, and received two licenses (see Appendix A) for the diversion of a total of 10,400 AF per year of Santa Ana River water in 1945.

In 1935 the District began participation in spreading activities in Mill Creek that had begun in 1910 by various entities. Similar to the Santa Ana River Spreading Facility, the Mill Creek Facility has been used for the purpose of groundwater recharge; however from 1956-1975 while the land was under ownership of the City of Redlands, a portion was leased to the Grand Central Rocket Company and later Lockheed Propulsion Company for the manufacture and storage of explosives. The detrimental impacts to the groundwater quality (TCE, PCE and perchlorate) by Lockheed Propulsion were a result of improper disposal of rocket propellants. As a result of the company's actions, ongoing water quality sampling from wells continues in order to determine the levels of harmful chemicals in the groundwater and the expanse of the groundwater contaminant plume, which has migrated offsite into the Bunker Hill Basin. In 1979 the Redlands City Council unanimously voted to give the land to the District to continue spreading operations.

See Section 2:  for a detailed description of both the District's Santa Ana and Mill Creek spreading facilities.

## Current Use

Both the Santa Ana River and Mill Creek spreading facilities are currently solely used for the purpose of groundwater recharge. The District's facilities are managed throughout the year to ensure that the Bunker Hill Ground Water Basin is efficiently recharged when water is available to the District for spreading. However, the District's land resources are also used for aggregate mining, habitat conservation, and limited recreational activities.

## Purpose and Function of this Operational Management Manual

The purpose of this Operational Management Manual is to document and provide guidelines regarding operation and maintenance procedures for District facilities. This Manual seeks to provide information useful not only to the District, but to the public and other entities. It is organized into 7 sections with 9 Appendices. This Manual is intended to be a "living document" with a formal review and updating every year.

# Section 2: Existing Facilities Description

The District currently operates two recharge areas. The primary recharge area is adjacent to and on the north side of the Santa Ana River, the Santa Ana Spreading Facility (Figure 2-1). The other facility is the Mill Creek Spreading Facility (Figure 2-4), located adjacent and south of Mill Creek upstream of the merge of Mill Creek and the Santa Ana River. The District has recharged more than 1.5 million Acre-Feet of water in both facilities since 1912. Table 2-1 is a record of historic annual spreading in both facilities.

**Table 2-1: Historic Recharge**

| Water Year | Santa Ana River Recharge (AF/yr) | Mill Creek Recharge (AF/yr) | Imported Water Recharge (AF/yr) | Water Year | Santa Ana River Recharge (AF/yr) | Mill Creek Recharge (AF/yr) | Imported Water Recharge (AF/yr) | Water Year | Santa Ana River Recharge (AF/yr) | Mill Creek Recharge (AF/yr) | Imported Water Recharge (AF/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1912 | 9,103 | - | - | 1947 | 5,160 | 2,986 | - | 1982 | 16,118 | 5,096 | 3,171 |
| 1913 | 2,211 | - | - | 1948 | 1,134 | 627 | - | 1983 | 15,222 | 13,205 | 0 |
| 1914 | 23,934 | - | - | 1949 | 5,087 | 0 | - | 1984 | 12,995 | 2,504 | 0 |
| 1915 | 28,596 | - | - | 1950 | 2,595 | 208 | - | 1985 | 186 | 4,144 | 0 |
| 1916 | 11,776 | - | - | 1951 | 394 | 50 | - | 1986 | 8,198 | 3,993 | 0 |
| 1917 | 7,463 | - | - | 1952 | 8,786 | 4,197 | - | 1987 | 0 | 1,888 | 0 |
| 1918 | 4,441 | - | - | 1953 | 2,653 | 2,691 | - | 1988 | 2,057 | 1,718 | 0 |
| 1919 | 4,969 | - | - | 1954 | 6,672 | 2,271 | - | 1989 | 2,950 | 248 | 545 |
| 1920 | 6,145 | - | - | 1955 | 3,760 | 1,060 | - | 1990 | 1,436 | 339 | 0 |
| 1921 | 8,717 | - | - | 1956 | 1,234 | 1,140 | - | 1991 | 6,971 | 3,330 | 82 |
| 1922 | 80,065 | 24,480 | - | 1957 | 2,922 | 1,562 | - | 1992 | 12,206 | 6,559 | 0 |
| 1923 | 18,518 | 8,051 | - | 1958 | 11,308 | 5,173 | - | 1993 | 38,993 | 19,800 | 0 |
| 1924 | 3,304 | 1,244 | - | 1959 | 1,149 | 1,121 | - | 1994 | 11,308 | 9,921 | 1,223 |
| 1925 | 0 | 394 | - | 1960 | 1,937 | 1,686 | - | 1995 | 19,822 | 16,054 | 0 |
| 1926 | 8,678 | 2,044 | - | 1961 | 64 | 32 | - | 1996 | 13,041 | 3,741 | 0 |
| 1927 | 14,417 | 6,056 | - | 1962 | 4,756 | 1,883 | - | 1997 | 10,000 | 5,359 | 0 |
| 1928 | 1,217 | 4,159 | - | 1963 | 590 | 171 | - | 1998 | 39,306 | 16,270 | 163 |
| 1929 | 1,268 | 757 | - | 1964 | 1,099 | 332 | - | 1999 | 6,043 | 2,159 | 0 |
| 1930 | 2,089 | 2,766 | - | 1965 | 3,464 | 863 | - | 2000 | 5,871 | 4,001 | 99 |
| 1931 | 0 | 896 | - | 1966 | 5,766 | 4,026 | - | 2001 | 3,468 | 3,343 | 7,153 |
| 1932 | 10,227 | 6,179 | - | 1967 | 9,406 | 6,677 | - | 2002 | 1,364 | 386 | 5,737 |
| 1933 | 0 | 2,143 | - | 1968 | 6,456 | 3,524 | - | 2003 | 10,729 | 4,894 | 1,791 |
| 1934 | 222 | 273 | - | 1969 | 31,354 | 12,906 | - | 2004 | 2,934 | 3,093 | 2 |
| 1935 | 2,021 | 7,732 | - | 1970 | 10,330 | 3,222 | - | 2005 | 27,841 | 29,138 | 2,096 |
| 1936 | 541 | 4,375 | - | 1971 | 5,587 | 531 | - | 2006 | 14,476 | 9,510 | 3,782 |
| 1937 | 10,551 | 20,047 | - | 1972 | 2,881 | 102 | - | 2007 | 4,002 | 1,631 | 1,994 |
| 1938 | 6,942 | 4,190 | -- | 1973 | 18,245 | 2,932 | - | 2008 | 17,550 | 3,810 | 0 |
| 1939 | 8,730 | 6,413 | - | 1974 | 9,458 | 1,167 | - | 2009 | 8,456 | 4,450 | 2,704 |
| 1940 | 5,707 | 6,547 | - | 1975 | 9,699 | 708 | - | 2010 | 21,674 | 8,891 | 11 |
| 1941 | 8,558 | 10,912 | - | 1976 | 5,905 | 808 | 260 | 2011 | 37,801 | 16,185 | 1,513 |
| 1942 | 4,635 | 5,217 | - | 1977 | 3,038 | 314 | 10,438 | 2012 | 9,036 | 4,666 | 603 |
| 1943 | 8,473 | 8,927 | - | 1978 | 52,172 | 13,692 | 5,103 | 2013 | 5,519 | 1,734 | 0 |
| 1944 | 6,394 | 7,478 | - | 1979 | 49,484 | 13,753 | 126 | 2014 | 1,537 | 888 | 19 |
| 1945 | 7,332 | 9,042 | - | 1980 | 39,054 | 13,662 | 0 | 2015 | 2,982 | 1,080 | 61 |
| 1946 | 3,794 | 2,572 | - | 1981 | 16,750 | 4,604 | 8,494 | 2016 | 2,634 | 1,044 | 5,899 |
| | | | | | | | | 2017 | 20,924 | 5,395 | 16,694 |
| | | | | | | | | **Total** | **1,077,037** | **484,042** | **40,856** |

## Santa Ana Spreading Facility

The District's Santa Ana River Spreading Facility is located 1.5 miles southwest of the canyon mouth, where the Santa Ana River flows out into the Valley. From the initial development of the spreading facilities to its current extent today, the District's Santa Ana Facility has always encompassed this chaparral environment for the purpose of sinking water and recharging the groundwater basin.

The early construction of the Santa Ana River Spreading Facilities first included a crude boulder dam in the Santa Ana River, which was then followed by the Pratt Dam made of iron and wire. In 1930, the WCA replaced the previous dams with a more permanent structure; a diversion weir made of low rubble-concrete across the entire river channel. The weir was located at the canyon mouth near Southern California Edison's Santa Ana Power House No. 3 and diverted water into a concrete channel and opened unlined canal; these canals delivered water to the parallel contour ditches of the spreading grounds that were located southwest of the power house. A visual of the estimated locations of the contour ditches is shown in Figure 2-1. Some of the remnant channels are still visible within the facility and can be used for additional recharge. The largest recorded spreading of water by the WCA took place in the winter of 1921-1922 in which 80,000 acre feet of water was diverted.

The construction of the Seven Oaks Dam resulted in the creation of the 100 acre Borrow Pit, approximately 12 to 45 feet deep, and altered the original channel and basins dynamics within the spreading facility. Earthen material was excavated and transported to the construction site at the Dam, ultimately removing approximately 9 contour basins from the Santa Ana River Facility resulting in one large pit. Three basins were reconstructed within the Pit on the eastern end, and water can also be spread at the west end of the Pit, but with reduced percolation capacity due to removal of the alluvium. The Santa Ana Spreading Facility currently consists of 14 percolation basins, including the Borrow Pit.

The percolation basins vary in size and are connected through manually adjustable weirs where the District can control the volume of water distributed to each basins with overflow gates. After the Santa Ana River passes through the Seven Oaks Dam water is diverted from the river channel through the District's Cuttle Weir intake structure to the spreading basins. Water can also be diverted from Edison's Santa Ana Powerhouse #3 after-bay through the Tailrace pipeline into the District's canal. River water that is not captured and diverted percolates into the River channel downstream of the District's facilities. In addition State Project Water can be delivered by San Bernardino Valley Municipal Water District for recharge from the Santa Ana Low into these facilities. Figure 2-2 is an overview of the District's current Santa Ana spreading facilities and Figure 2-3 contains a process flow diagram for the facility.

The canals and channels that divert water to the District's Santa Ana Recharge facilities vary in size and characteristics. The Main Channel is primarily an unlined canal with exceptions at the Cuttle Weir intake structure, the District Sandbox, and the Parshall Flume. The Parshall Flume is the District's flow measurement device for the Santa Ana Facility. It is approximately 18 feet wide and has an attached stilling well with tape and float that is connected to SBVMWD's online data recording site.

District field staff maintains the Parshall Flume and the stilling well, and SBVMWD maintains the online system. Appendix D contains the measurement table converting the measurement in inches at the Parshall Flume to the flow rate in cubic feet per second.

The area of each basin and its estimated volume is shown in Table 2-2. The Santa Ana basins total wet area is 105 acres. Basin 9 was disconnected from the rest of the basins by the creation of the borrow pit and is unable to receive any flows and is therefore not included in the recharge totals.

**Table 2-2: Santa Ana Recharge Facilities**

| Percolation Basin | Footprint Area (acres) | Average Depth (ft) | Volume (AF) |
|---|---|---|---|
| 1 | 2.46 | 7 | 17.20 |
| 2 | 2.29 | 8 | 18.29 |
| 3 | 2.53 | 9 | 22.76 |
| Pit | 43.38 | 10 | 433.77 |
| 9 | - | - | - |
| 10 | 6.28 | 5 | 31.42 |
| 11 | 6.84 | 5 | 34.19 |
| 12 | 2.90 | 4.25 | 12.33 |
| 13 | 6.11 | 7 | 42.75 |
| 14 | 4.26 | 5.5 | 23.45 |
| 15 | 4.68 | 14 | 65.49 |
| 16 | 1.51 | 8 | 12.06 |
| 17 | 4.77 | 5 | 23.84 |
| (18)D | 16.87 | 6.8 | 114.74 |
| **Total** | **104.87 acres** | | **852.28 AF** |

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# Figure 2-1: Historic SAR Spreading Facilities Operational Management Manual

Coordinate System:
NAD 1983 StatePlane California V FIPS 0405 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD. CASIL, SBVMWD
GIS Contact: K. Scholte & J. Zhou
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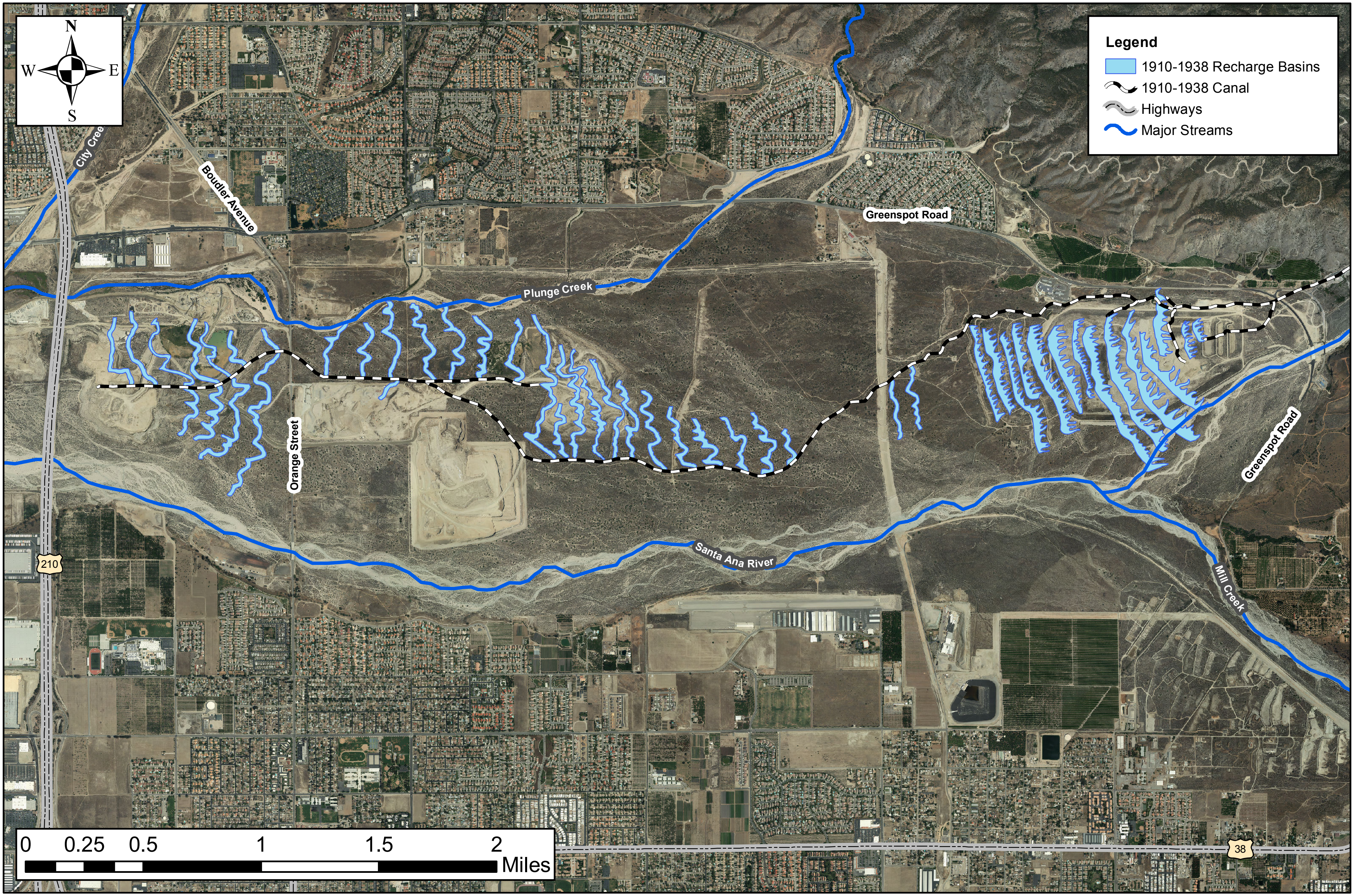

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# Figure 2-2: Santa Ana Spreading Facilities Operational Management Manual

Coordinate System:
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Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD. CASIL, SBVMWD
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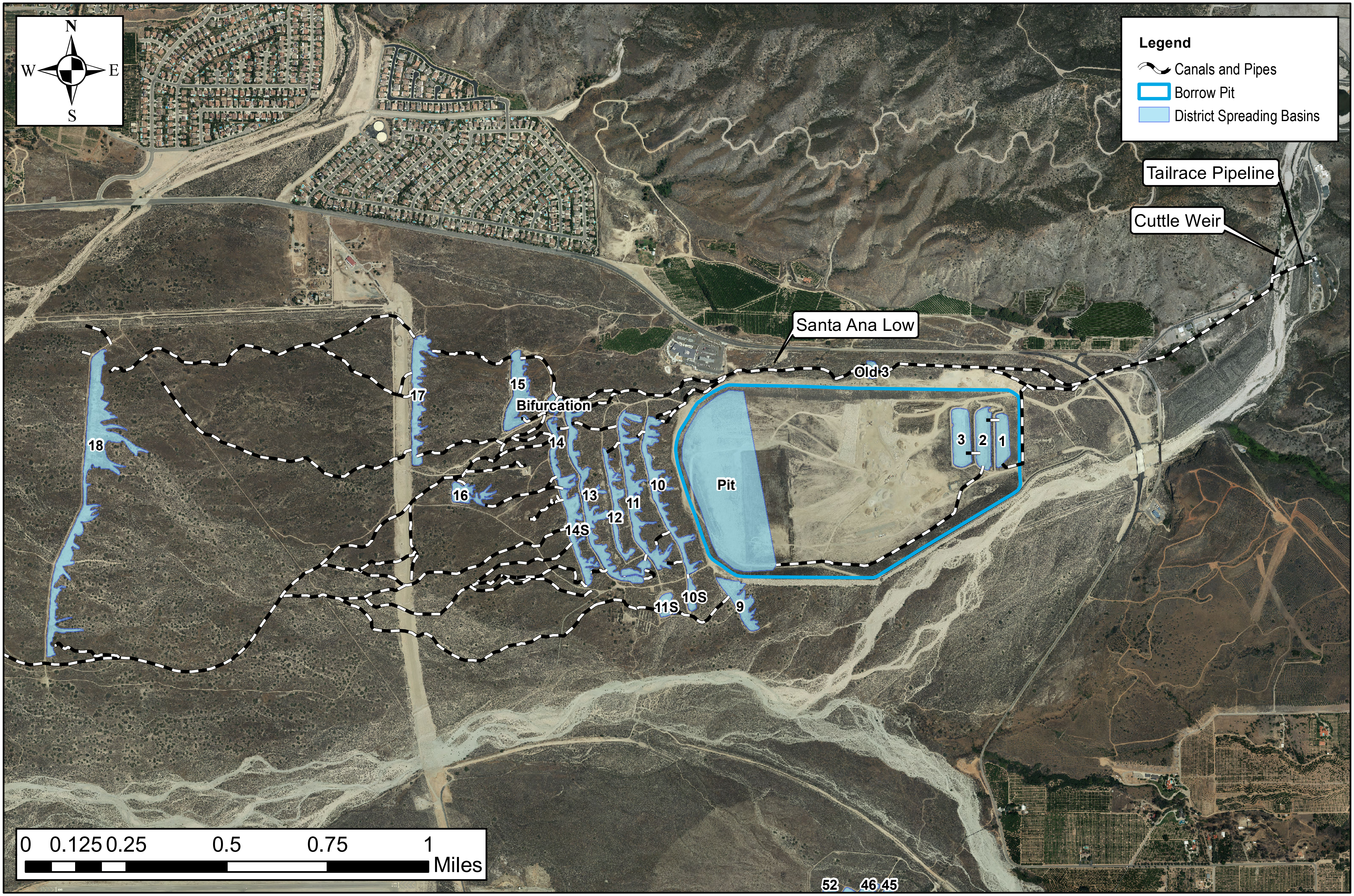

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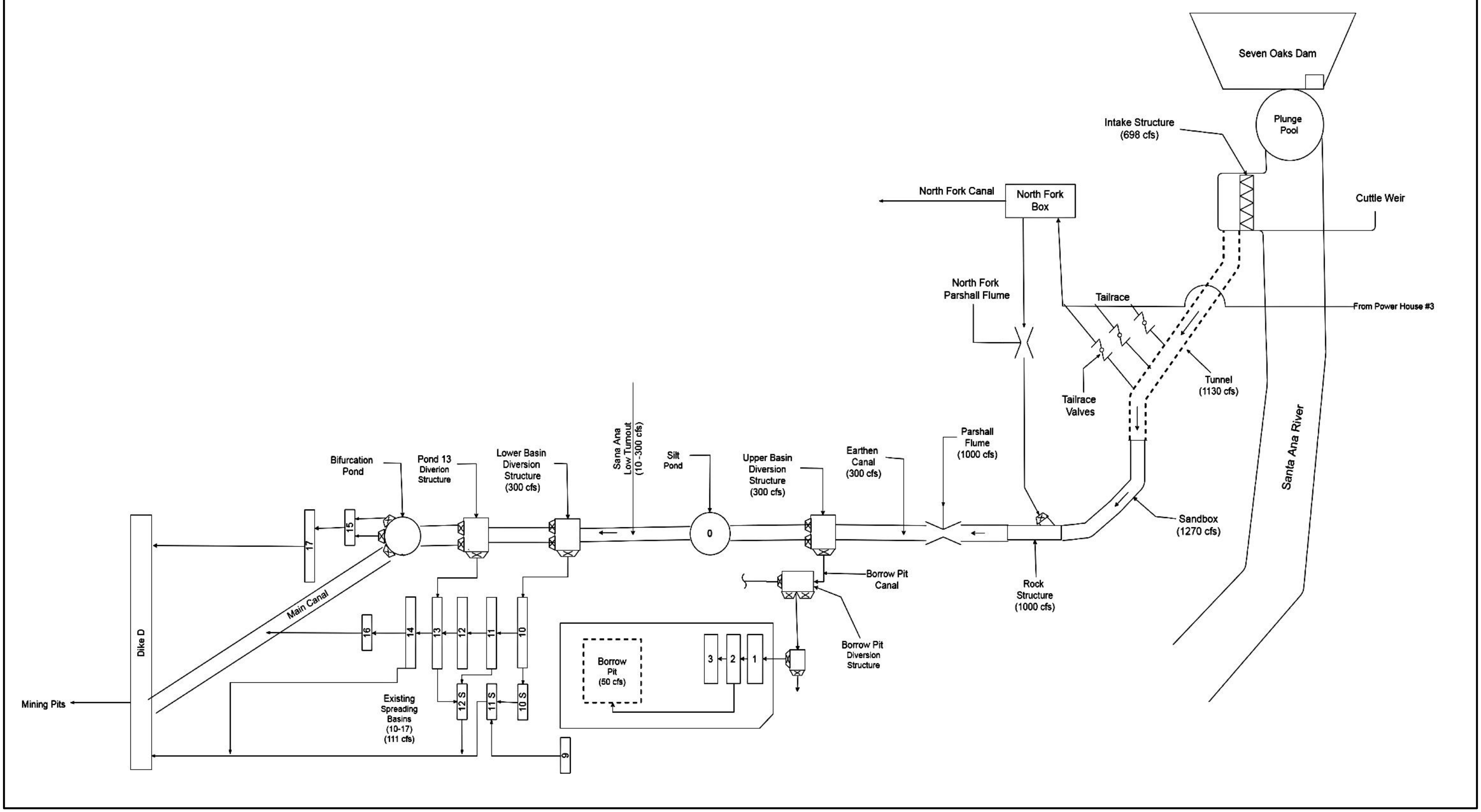


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Figure 2-3: Santa Ana River Spreading Facilities


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July 21, 2017

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## Mill Creek Spreading Facility

The spreading of Mill Creek water onto the Mill Creek debris cone (currently the Mill Creek Spreading Facility) began in 1910 by the Mentone Irrigation Company, which developed tunnels and wells in Mill Creek. It was taken over in 1922 by the East Lugonia Water Company and the City of Redlands. The District began participation in Mill Creek spreading activities in 1935, and assumed full responsibility for spreading in 1942, however all of the land had previously been leased from the East Lugonia Water Company to the City of Redlands.

For the period of 1925-1950, spreading was achieved by a series of hand dug small ditches and furrows maintained by men with shovels, which led to the creation of percolation basins in 1952 by the District. In 1956 the Grand Central Rocket Company leased 400 acres in the spreading area from the City of Redlands for the manufacture and storage of explosives. Their lease with the city stipulated that operations were not to unnecessarily interfere with the District's spreading operations. In 1962 Lockheed Propulsion Company took over Grand Central's operations and lease and worked in conjunction with the District till 1975 when they ceased operations. The Lockheed Propulsion Company used the facility for the testing, production and disposal of solid rocket motors and propellant that were used in commercial, military, and NASA applications. On October 16, 1979, the Redlands City Council unanimously voted to give the land ownership rights to the Conservation District, and on December 10th of the same year, Resolution No. 270 authorized the purchase for $1.00 to accept the deed.

The Mill Creek Spreading Facility is on the south side of Mill Creek and is primarily used to recharge waters from Mill Creek, although at certain times arrangements can be made with other agencies to sink their water for them. Small amounts of Santa Ana River water can also be recharged in the Mill Creek Facility from the Redlands Aqueduct. State Water Project water can be delivered by SBVMWD in three locations within the spreading facility: the Zanja Tate Meter Station, the Crafton Unger Turnout, and the Redlands Aqueduct.

The District's Mill Creek diversion structure is located in the main Mill Creek stream channel east of Garnet Street and north of the San Bernardino County Flood Control District's Mill Creek Levee Wall. Water is directed towards the structure by use of three soft plugs, consisting one main berm and two blow offs or easements. Soft plugs are approximately 2 foot tall by 10 foot wide earthen berms placed to direct reasonably sized flows (400cfs or less) towards the diversion structure. The berms are designed to wash away in debris filled high flows in order to protect the diversion structure from damage. The diversion structure can direct flows either south immediately under the flood control levee wall to basin 1 or down the north side of the flood control levee past Garnet Street and ultimately under the flood control wall to basin 12.

The Mill Creek Spreading Facility is made up of three settling ponds (1, 2, & 12) and 56 percolation basins with a total of 67 acres of wetted basin area. The settling ponds purpose is to remove sediments before the water is distributed through overflow gates into the percolation basins. The area of each basin and its estimated volume is shown in Table 2-3, a map of the Mill Creek Facility is show in Figure 2-4 and a process flow diagram in Figure 2-5.

**Table 2-3: Mill Creek Recharge Facilities**

| Percolation Basin | Footprint Area (acres) | Average Depth (ft) | Volume (AF) | Percolation Basin | Footprint Area (acres) | Average Depth (ft) | Volume (AF) |
|---|---|---|---|---|---|---|---|
| 1 | 1.53 | 4.5 | 6.90 | 26 | 0.91 | 6 | 5.48 |
| 2 | 1.18 | 6 | 7.06 | 27 | 0.81 | 5 | 4.03 |
| 3 | 1.50 | 4.75 | 7.12 | 28 | 2.30 | 6 | 13.78 |
| 4 | 0.65 | 6.5 | 4.20 | 29 | 1.22 | 4 | 4.86 |
| 5 | 1.03 | 6 | 6.20 | 30 | 1.44 | 5.5 | 7.94 |
| 6-N | 0.14 | 6 | 0.84 | 31 | 1.90 | 6.33 | 12.02 |
| 6-S | 1.79 | 8.33 | 14.88 | 32 | 0.57 | 5 | 2.86 |
| 7 | 2.90 | 7.67 | 22.26 | 33 | 1.23 | 4.5 | 5.53 |
| 8 | 2.91 | 6.5 | 18.92 | 34 | 1.19 | 5.5 | 6.53 |
| 9 | 0.90 | 8.25 | 7.44 | 35 | 0.48 | 4 | 1.91 |
| 10 | 0.95 | 7.25 | 6.92 | 36 | 1.22 | 6 | 7.31 |
| 10-W | 0.12 | 5 | 0.58 | 36-N | 0.19 | 6 | 1.15 |
| 11 | 1.38 | 6 | 8.30 | 37 | 0.48 | 6.5 | 3.10 |
| 11-W | 0.86 | 4.5 | 3.86 | 38 | 0.50 | 5.5 | 2.75 |
| 12 | 1.59 | 7 | 11.14 | 39 | 0.11 | 3.5 | 0.39 |
| 13 | 1.63 | 6.5 | 10.59 | 40 | 0.46 | 3.5 | 1.60 |
| 14 | 3.54 | 6 | 21.26 | 41 | 0.66 | 5 | 3.28 |
| 15 | 2.98 | 5.75 | 17.11 | 42 | 0.53 | 5 | 2.65 |
| 15-W | 1.30 | 4 | 5.19 | 43 | 0.76 | 4.5 | 3.43 |
| 16-N | 0.72 | 4 | 2.88 | 44 | 0.45 | 2.5 | 1.14 |
| 16-S | 0.90 | 4.5 | 4.05 | 45 | 1.15 | 4 | 4.60 |
| 17 | 1.41 | 7 | 9.89 | 46 | 1.35 | 4.5 | 6.06 |
| 18 | 2.62 | 5.5 | 14.41 | 47 | 1.16 | 4.5 | 5.24 |
| 19 | 0.73 | 6.75 | 4.90 | 48 | 0.73 | 5.5 | 4.02 |
| 20 | 1.37 | 7 | 9.60 | 49 | 0.29 | 6 | 1.93 |
| 21 | 1.68 | 8.17 | 13.70 | 50 | 0.66 | 4.5 | 3.53 |
| 22 | 1.49 | 7 | 10.40 | 51 | 0.42 | 4.5 | 2.04 |
| 23 | 0.57 | 5.5 | 3.11 | 52 | 0.59 | 4.5 | 2.73 |
| 24 | 1.32 | 8 | 10.59 | 53 | 0.59 | 4.5 | 2.59 |
| 25 | 0.45 | 4 | 1.79 | | **66.66 acres** | | **390.56 AF** |

The location of both the Santa Ana and Mill Creek facilities is shown on Figure 2-6, including regional water conveyance pipelines operated by SBVMWD, Bear Valley Mutual Water Company, SCE, and others, and major locations where water is delivered. There is a great degree of flexibility of water that can be diverted to both spreading facilities.

# Figure 2-4: Mill Creek Spreading Facilities Operational Management Manual

Coordinate System:
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Projection: Lambert Conformal Conic
Datum: North American 1983
Source: SBVWCD. CASIL, SBVMWD
GIS Contact: K. Scholte
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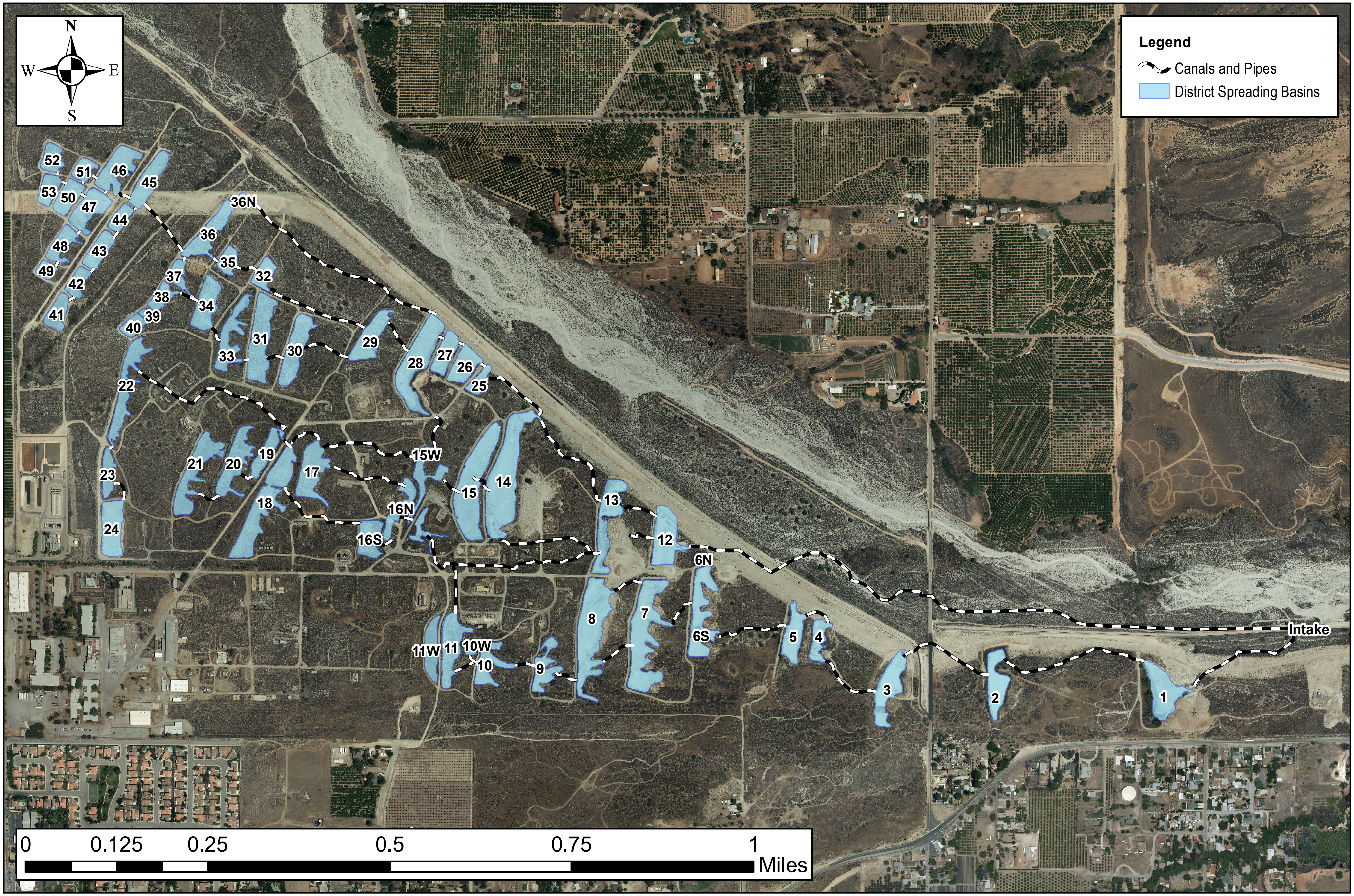

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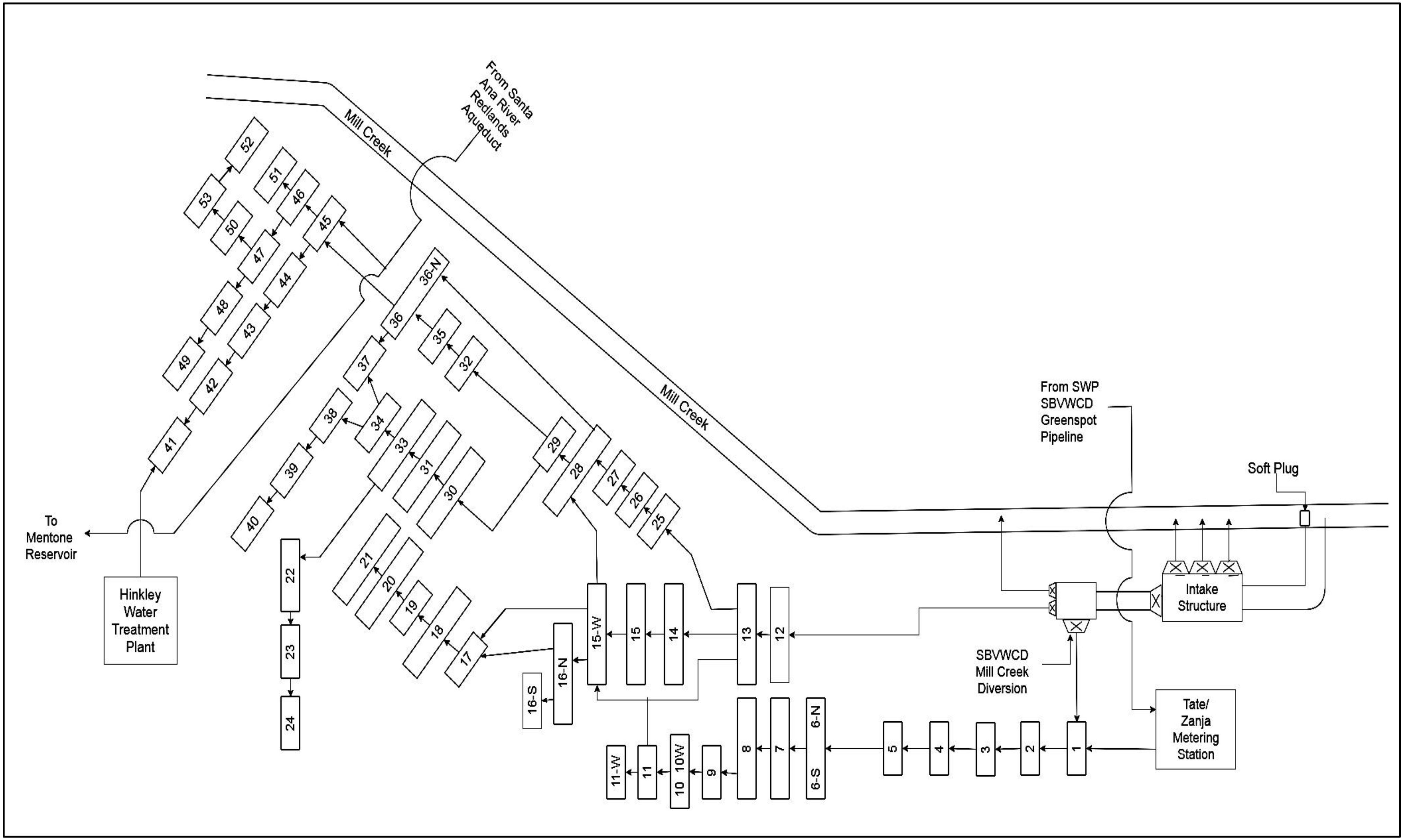


Operational Management Manual

Figure 2-5: Mill Creek Basins Process Flow


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July 19, 2017

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# Figure 2-6: Map of Regional Facilities Operational Management Manual

Coordinate System:
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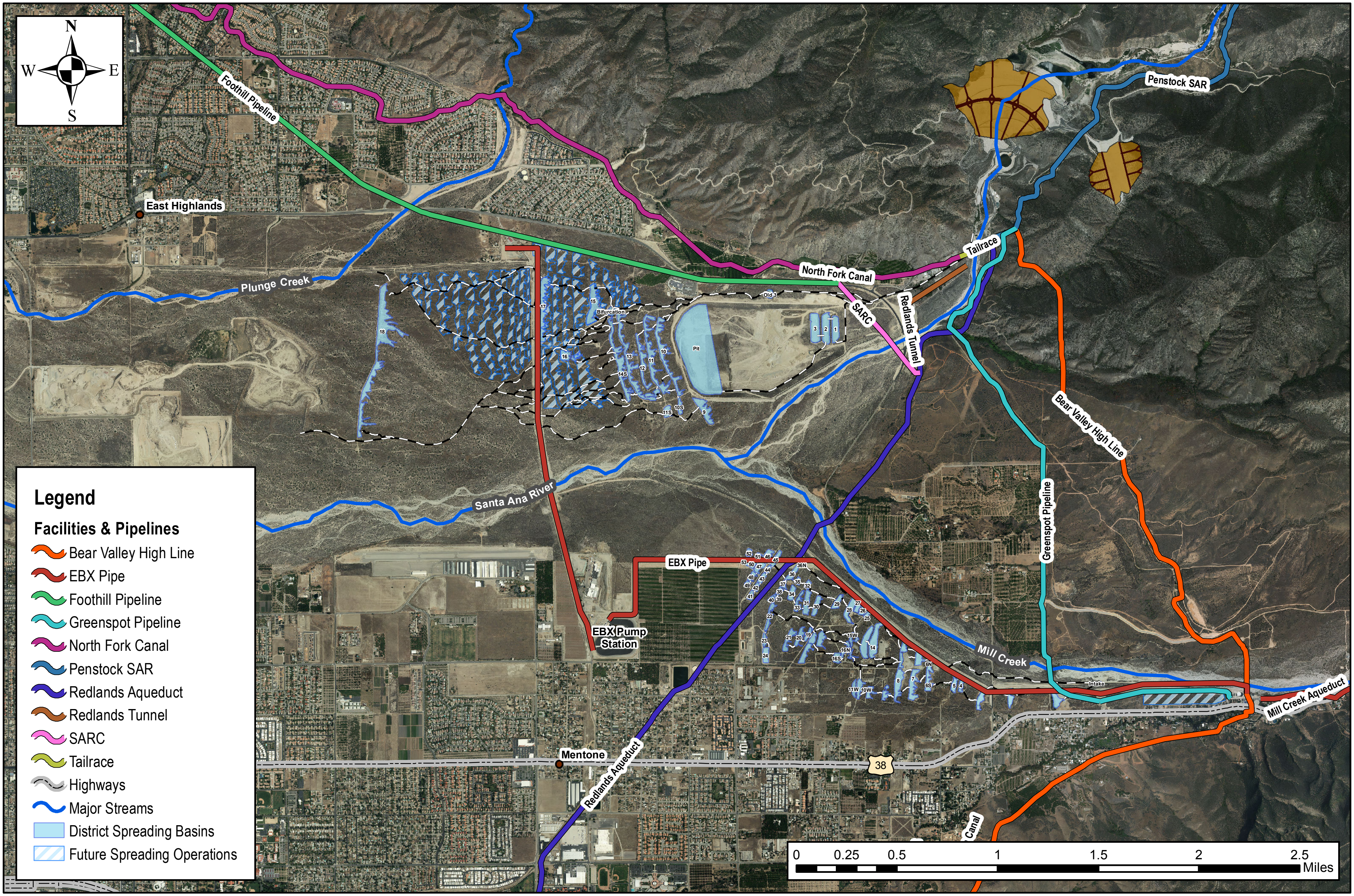

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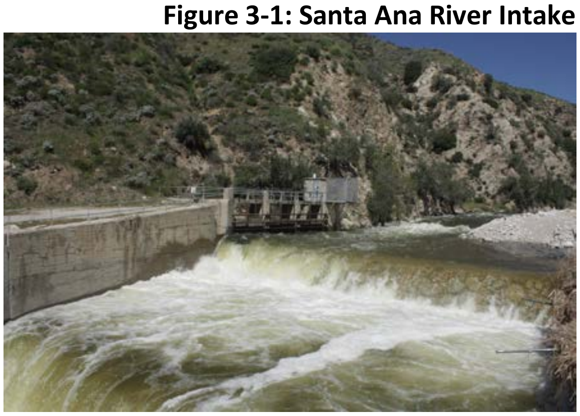
# Section 3: Spreading Operations

## Facility Operations

### Santa Ana River Spreading Facility

Water is distributed to the District's Santa Ana recharge facilities through a system of pipelines, canals, gates and weirs. The facility primarily receives its water from the Santa Ana River after it makes its way through the Seven Oaks Dam. The Seven Oaks Dam impedes the natural flow of the river. Water is periodically released by the Flood Control District based on conditions downstream. The river exits the dam through the outlet tunnel and into the plunge pool before it makes its way out of the canyon. Water can be diverted to the District's Cuttle Weir Intake Structure (Figure 3-1) and/or to the Bear Valley River Pick-Up. Water at the District's Cuttle Weir enters the District's Sandbox where it can join additional water from the SCE Powerhouse via the Tailrace Pipeline by use of the Tailrace Valves. Water exits the District Sandbox to the District's Main (Figure 3-1). Additional water from the North Fork Ditch can join the District's Main Canal via the North Fork Parshall Flume. The Main Canal travels through the District's Parshall Flume where a flow measurement is obtained. The Main Canal then continues under Greenspot Road to the Santa Ana Spreading Facility.

**Figure 3-1: Santa Ana River Intake at the Cuttle Weir and Main Canal**



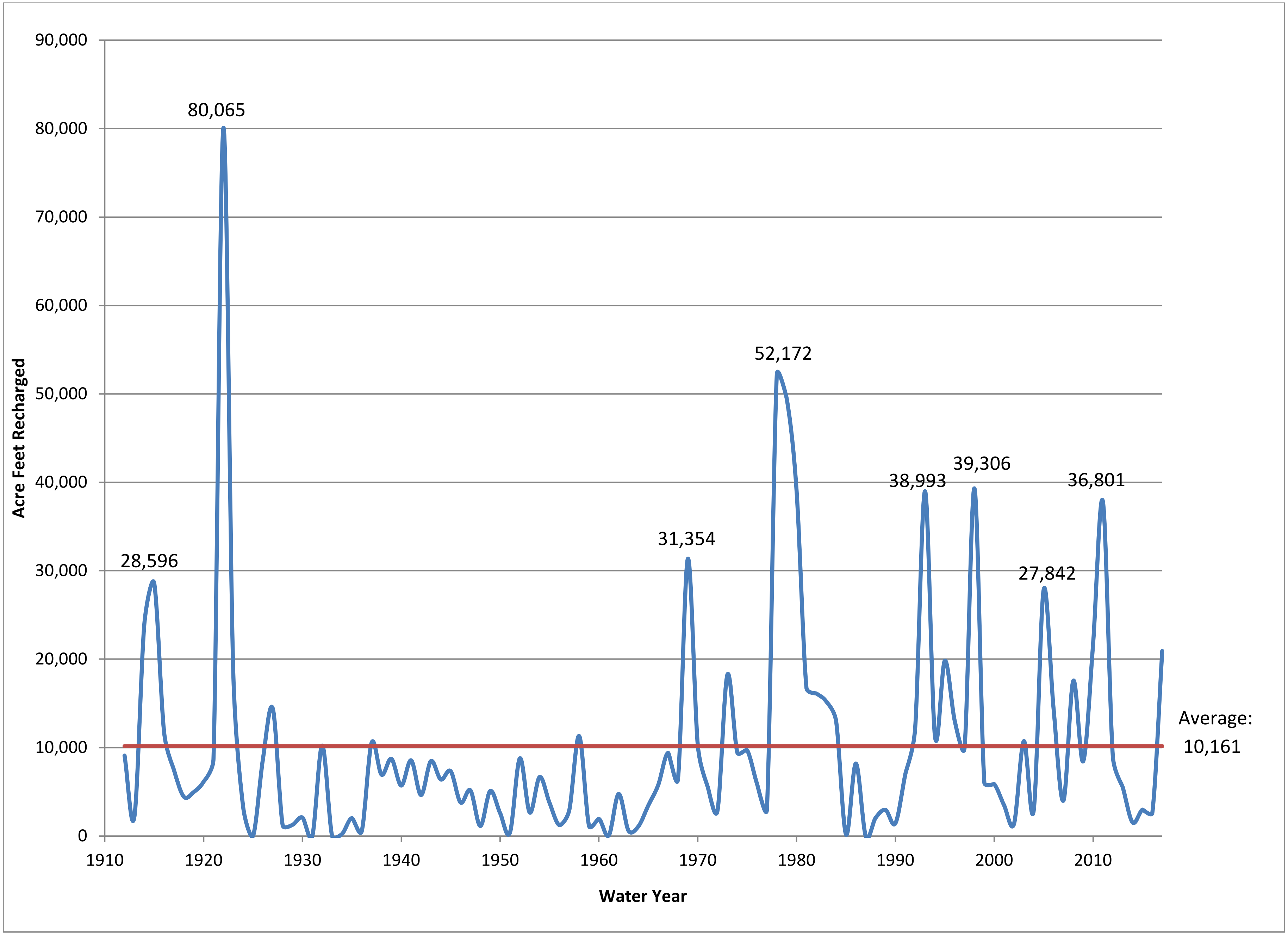
The District's Parshall flume is the only measurement device for the entire Santa Ana facility. It is designed for flows up to 1,000 cfs, and has been in use since at least the 1940s. Flow rate has been historically taken visually using staff gage within the flume, a float in the attached stilling well, and a rating table. This reading is visually taken every morning as part of the Daily Flow Report and any time District staff makes adjustments that would affect the flow rate. The District Parshall Flume Flow table is available in Appendix D. In 2012, San Bernardino Valley Municipal Water District (SBVMWD) and Western Municipal Water District (WMWD) obtained additional water rights for spreading due to the completion of Seven Oaks Dam. At that time they installed an automatic measurement system that utilized the Parshall Flume and it's stilling well. A measurement is taken approximately every four minutes and uploaded to data.sbvmwd.com via SCADA.

From the Main Canal, water can first be diverted to the Borrow Pit. The Borrow Pit includes the first three basins as well as an area at the west end for recharge. Basin 1 is located at the eastern side of the Borrow Pit and automatically feeds basin 2. When at capacity, basin 2 has the ability to automatically fill basin 3 or divert water to fill the Borrow Pit. The Borrow Pit is the largest percolation basin in the Santa Ana facility; the water level must be kept 10ft below road level, or it will be considered an impoundment and the District may receive fines from the Department of Water Resources. When receiving and spreading large amounts of water, the District must be conscience of the water level at the Borrow Pit as it can affect the percolation rate in other nearby basins.

The District can also choose to spread water from the main channel to basins located in the western part of the facility. Water enters basins 10 and 13 through sets of manual weirs. Basin 10 automatically fills basins 10S, 11 and 12. Water can also exit basin 10S and fill basin 11S and the Cone Camp Area, ultimately following canals to the final percolation basin, Dike D. Basin 13 fills basins 14 and 16 when at capacity. Basins 15 and 17 also have manual gates off the main canal. The main canal then enters percolation basin Dike D. Beyond dike D, water can only empty into either the CEMEX or Robertson's mining pits. The mining pits offer large water holding capacity, but due to the compacted bottoms and removal of sediment, have less efficient percolation rates than the spreading basins. There also may be a loss of royalties to the District from the mining operations when water is spread in the mining pits. See Figure 2-2: Current Santa Ana Spreading Facilities, for all possible spreading basin interconnections.

The historic recharge of Santa Ana River water in the Santa Ana facility is shown in Figure 3-2.

Figure 3-2: Santa Ana River Historic Recharge



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## Mill Creek Spreading Facility

To supply water to the Mill Creek spreading facility, the District first diverts water from Mill Creek's natural channel through the use of soft plugs. The District utilizes three low (ideally 2ft) sand and gravel earthen berms, known as soft plugs, to divert water from the natural Mill Creek Channel to the District's Diversion Structure. The soft plugs are designed to leak and then break apart as flows increase above safe levels; this allows a portion an up to all of the flows to remain in the natural channel of Mill Creek. When the soft plugs break apart they have to be rebuilt by hand or with a bulldozer utilizing the native material within Mill Creek.

The water then reaches the District's Mill Creek Diversion Structure which is located immediately adjacent to the Mill Creek Levee Wall. This levee and wall were constructed by the Army Corps of Engineers and is managed by the San Bernardino County Flood Control District. The diversion structure currently consists of four manually operated gates, three to return water and debris back to the normal flow of Mill Creek, and one that directs water to the District's intake channel. Historically the District allows the "first flush," or the water from the start of a storm event to return to the natural channel of Mill Creek. These first flows are typically laden with debris and sediment, which interfere with the percolation within the basins. Once the water is determined to be of higher quality, it is "picked up" or diverted to the District's Intake Canal to the Intake Structure. Images of the District's Diversion Structure are in Figure 3-3.

**Figure 3-3: Mill Creek Diversion Structure**

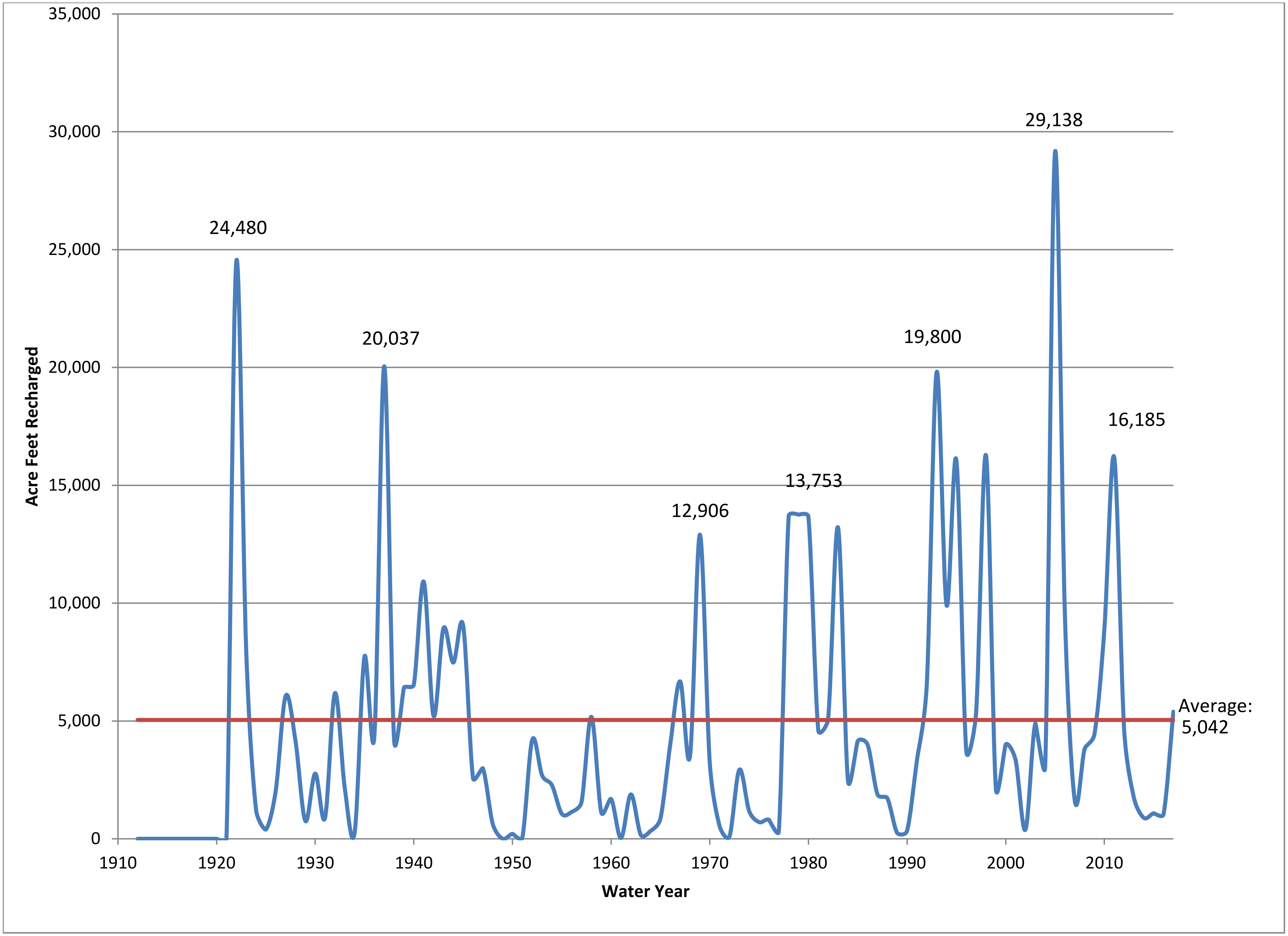
The District's Intake Structure (Figure 3-4) serves as both a point of operational flexibility and the point of flow measurement. Water is measured by use of a weir with an ultrasonic sensor that measures the water level every fifteen minutes. Water that flows over the measuring weir then travels under the flood control wall and into the South Canal. The South Canal directs flows to sand ponds 1 and 2 and then onto the other spreading basins located downstream to the west. Water can also be diverted along the base of the flood control wall in the North Canal. The North Canal enters the Mill Creek Facility East of Garnet Street and then flows under the flood control wall, finally entering sand pond 12. Flows to the North Canal are not directly measured. In order to obtain a reading, the gate to the North Canal must be closed and a total reading over the weir is obtained. The gate is then reopened and the reading is retaken. The difference between the two readings is the amount of water in the North Canal. The measurement table for the Mill Creek weir is available in Appendix D.

**Figure 3-4: Mill Creek Intake Structure**

There are 59 percolation basins in the Mill Creek Facility that have a total volume of over 300 Acre-Feet. The facility automatically fills itself through a series of overflows and conduits that link the percolations basins together. Unlike the Santa Ana River Facility, there is less operational flexibility in the Mill Creek system, which can decrease the amount of water that can be spread if an earlier pond is not percolating at a desired rate. The historic Mill Creek water recharge within the Mill Creek Facility is shown in Figure 3-5.

Santa Ana River water can also be spread within the Mill Creek Spreading Facility starting with pond 45. Water can be diverted from the Redlands Aqueduct at times when there is more water within the aqueduct than the Redlands and Bear Valley facilities can handle.

Figure 3-5: Mill Creek Historic Recharge



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## State Water Project Water Spreading

Both the Santa Ana and Mill Creek Spreading Facilities have the ability to spread water via the California State Water Project. This water is imported by Valley District from Northern California. The District's typically does not purchase this water, but spreads it on behalf of other agencies in the area. Agencies within the Bunker Hill basin are in the process of creating a Groundwater Council which would purchase water more frequently in order to sustainably operate the Groundwater Basin. With completion of the Groundwater Council the District anticipates that the spreading of imported water will occur on a regular basis.

The Santa Ana River facility has the ability to spread State Water Project water by means of the Santa Ana Low, the SARC West, and East Valley Headquarters Turnout which are operated by Valley District. The Santa Ana Low diverts water from the Foothill Pipeline directly to the District's Main Canal prior to basin 10 at a maximum of 200cfs. The Santa Ana Low is currently the largest turnout for imported water in the Bunker Hill Basin. The SARC West diversion is also fed by the Foothill Pipeline but deposits water into the main channel above the Parshall Flume at a maximum of 40cfs. The East Valley Headquarters Turnout is a low flow turnout within East Valley Water District's Headquarters sending water into EVWD's conservation garden an ultimately south onto District Lands.

State Water Project water can be delivered three ways in the Mill Creek facility. A maximum of 30 cfs can be delivered just before pond 1 from the Zanja-Tate Station. Water can also be released from the Crafton Pump Station at a maximum of 20cfs and delivered to the Mill Creek Channel upstream of the Districts Mill Creek Diversion. Imported water can also be spread in the west end of the Mill Creek Facility from the Redlands Aqueduct. This spreading of imported water is often done unintentionally, as Santa Ana River water and imported water are mixed upstream of this diversion. Water is diverted at this location when the District choose to send Santa Ana River water to the Mill Creek facility or when Bear Valley Mutual asks the District to take water to ease pressure on their downstream facilities.

## Seven Oaks Dam

The Seven Oaks Dam is located on the Santa Ana River at the narrowing of the upper Santa Ana Canyon, approximately one mile upstream of the canyon mouth. Seven Oaks was completed in November of 1999 for flood control purposes and is currently the 10th largest earthen dam in the world. For the history and complete specifications of the Seven Oaks Dam refer to Appendix E.

The construction of the Seven Oaks Dam has greatly affected the District's Santa Ana River spreading facility. Prior to the construction of Seven Oaks, the District was at the mercy of the Santa Ana River and its natural fluctuations. Water would be regularly spread throughout the percolation basins during the winter and spring months due to precipitation and snow melt runoff. Recharging the Bunker Hill Basin in accordance with the natural flow of the Santa Ana River allowed for the District to spread water over a period of several months. This facilitated the District's recharging ability by allowing them to carefully fill the basins based on observed percolation rates. Although the dam provides essential flood control, the District's ability to recharge the groundwater table is now at the mercy of the Seven Oaks Dam Operations. Since the completion of the dam in 1999, the District now spreads water at the

Santa Ana River facility when the Flood Control District chooses to release water from the dam's reservoir. The District now takes large amounts of water during releases which can threaten the ability to carefully and efficiently fill the percolation basins. In contrast to receiving water during the winter and spring months, the time period in which the District currently receives water is now minuscule although the volume of incoming water remains relatively the same. The dam operations require the District to recharge whenever water is released from the dam despite an increase in difficultly. The amount of sediments in the receiving waters has also significantly increased since the construction of Seven Oaks. Sediments build up in the dam's reservoir and are released through the outlet tunnel along with the water. Waters with heavy sediment loads can decrease a basin's recharge efficiency by creating a layer of sediment along the bottom of the basin, thus reducing the rate of percolation. Although the Seven Oaks Dam has influenced how and when water is received from the Santa Ana River, the District has successfully adapted to the change and continues to recharge the Bunker Hill Basin.

## Water Quality

Generally the water quality from Mill Creek and Santa Ana River is among the highest in the Santa Ana Watershed because the water is low in total dissolved solids and there is minimal development in the watershed above the District's diversions.

The US Army Corps of Engineers (USACOE) undertook a study of water quality shortly after Seven Oaks Dam was constructed due to the poorer water quality impounded behind the dam in its early operations. This water was not suitable for direct users of the water, Bear Valley Mutual, EVWD and City of Redlands, and caused increased maintenance when percolated in the District's basins. In later years the water volume was lower and of somewhat better quality. In 2010 water was impounded behind SOD to test the gates. This water was not suitable for direct use but was adequate for spreading and groundwater recharge in the District's Basins. Water quality was significantly impacted after the high volume and high intensity storms in December of 2011 and January 2012. The USACOE accumulated water for a high flow test of Seven Oaks Dam. This caused the water quality to improve in the weeks leading up to the testing. By the time the release was planned the water had cleared to approximately 20 NTU. This was deemed to be acceptable for recharge and only created minor decreases in the recharge rates.

During high flows, especially as flows are increasing, water quality is greatly degraded as turbidity levels increase, and should generally not be diverted. Once flows are stabilized, the water tends to clear quickly over the following few hours and can be diverted for recharge up to about 300 cfs. A high flow plan is included in Appendix D.

Lockheed Propulsion Company, a division of Lockheed Martin Corporation operated in the same location as the current Mill Creek Facility. Lockheed operated, produced, tested, and disposed of solid rocket propellants in the 1970s. As a result trichloroethylene (TCE) and ammonium perchlorate were detected in the groundwater basin. These contamination plumes have negatively affected the ground water quality in parts of the Bunker Hill basin. The contamination plumes are being monitored and have slowly been making their way towards the bottom of the basin.

## Aggressive Recharge

After several years of drought, the District has modified its prior operations. Previously the District would wait until the available water in either Santa Ana or Mill Creek was of high enough quality and low enough damage risk before allowing it to enter the facilities. This decreased the amount of sediment that needed to be removed from the basins and decreased the risk of damages to the facilities. In turn, it also decreased the amount of water that could have been recharged. As less native water is available for spreading on an annual basis due to recent drought water has been taken earlier and earlier into storms. This has required increase attentiveness by field staff to prevent damages to the facilities while still sinking the most groundwater possible.

In the 2016-2017 water year, there was not a single month where the District was not spreading water in the Santa Ana Facility. This is primarily due to the approximately 23,000AF of State Water Project water that was spread in that water year. This non-stop spreading activity required the water to be continually moved from different basins to allow for adequate drying time as well as restructuring of certain basins. Field staff also utilized open space lands to recharge water and reestablished old canals to recharge as much water as possible. Figure 3-6 shows some of the locations where water was spread outside of recharge basins in order to increase recharge capacity and operational flexibility. Recharging on open space lands can also be beneficial to species and habitat in those areas. The District must coordinate with the San Bernardino County Flood Control District to spread flows on the woolly start preservation area.

In the Mill Creek Facility, water was taken into the facilities as early as one hour after the water arrived at the diversion. This required meticulous monitoring of the facility as the flows were laden with sediment and rock.

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# Figure 3-6: Aggressive Recharge Operational Management Manual

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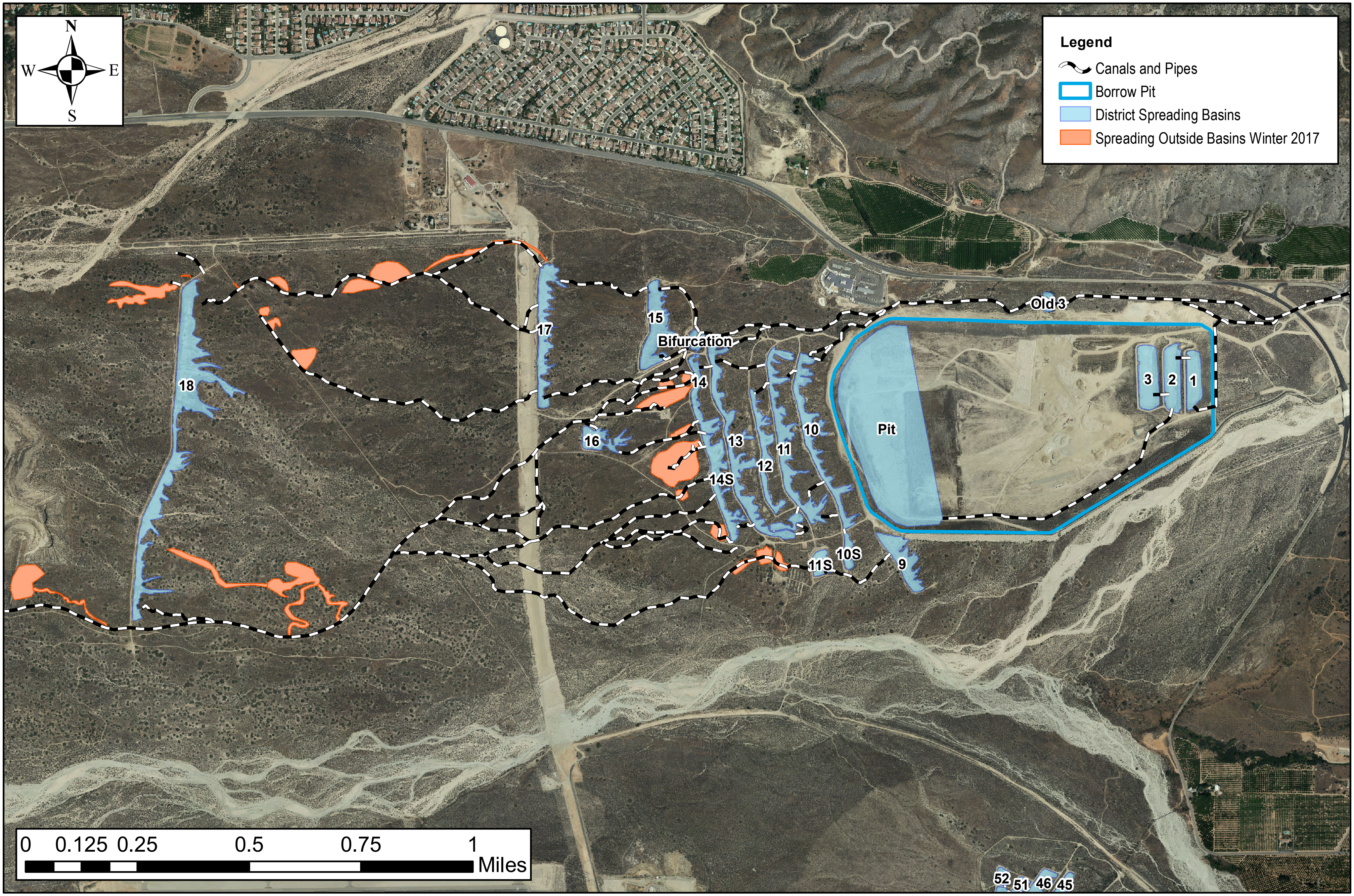

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## Monthly Distribution and Spreading

The District has two water right licenses, numbers 2831 and 2832. These water rights regulate the amount of water the District is legally allowed to divert and sink each year. The Basin Technical Advisory Committee (BTAC) annually calculates the amount of water that can be safely recharged in different areas of the Bunker Hill Basin without causing liquefaction potential. Currently the BTAC allows 166,000 Acre-Feet from the Santa Ana River, and 99,700 Acre-Feet from Mill Creek to be recharged. A Monthly Recharge Report is used to assure the District doesn't replenish more water than allowed, and to ensure the maximum replenishment occurs. This report is compiled every month and shows the amount of water that has been diverted to date compared to the maximum diversion amount. Based on the data from the report, adjustments to the diversion rates and to the locations of diversion can be made. The flow measurements are collected as part of the Daily Flow Report. An example of the Monthly Distribution Report is located in Appendix C.

The state of California now requires all water right holders that divert more than 1,000 acre feet of water per year to monitor the diversions on an hourly basis. This data is obtained through use of automated measuring devices. The Mill Creek Intake still requires further instrumentation to meet the State's requirements as the North Canal is still not measured on an hourly basis.

## Wells

The District owns ten monitoring wells, six in the Santa Ana Facility and four in the Mill Creek facility. Staff takes well readings twice a month, approximately on the 1$^{st}$ and 15$^{th}$. These wells allow the District to monitor how recharge activities are affecting the groundwater within the facilities. When water levels approach the surface, recharge activities should be decreased until the groundwater levels drop. A description on how to take a well reading as well as the locations for each of the District's wells is included in Appendix D.

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# Section 4: Non-Spreading Operations

## Coordination with Other Agencies

Although large portions of the Santa Ana Spreading Facility and the Mill Creek facility are owned by the District, other agencies have facilities and lands within the Districts operation areas. District field staff coordinates with these agencies on access, trespassing, and facility coordination. Table 4-1 lists the agencies that have facilities or interest in either the Santa Ana or Mill Creek Facility.

**Table 4-1: Agencies with Access to District Facilities**

| Agency | Acronym | Interest | Facility | Contact |
|---|---|---|---|---|
| Bear Valley Mutual Water Company | BVMWC | Pipeline facilities | Both | Jim Evans<br>(909) 583-1469 |
| Bureau of Land Management | BLM | Land Ownership | Santa Ana | - |
| California Department of Fish and Wildlife | CDFW | Habitat and Species | Both | - |
| CalFire | CalFire | Facility maintenance | Both | Jacob Ching<br>(809) 215-8272 |
| City of Redlands | Redlands | Well | Mill Creek | Redlands On Call:<br>(909) 478-4642 |
| Department of Water Resources | DWR | EBX II Maintenance | Both | - |
| East Valley Water District | EVWD | Well | Santa Ana | EVWD On Call:<br>(909) 963-6877 |
| Larry Jacinto Construction | Jacinto | Emergency repairs | Both | Eric Nixon<br>(909) 208-2023 |
| Metropolitan Water District | MWD | Inland Feeder Pipeline | Santa Ana | Mo Duncan<br>(909) 240-8785 |
| San Bernardino County Flood Control District | SBCFCD | Flood Control Structures | Both | Melissa Walker<br>(909) 387- 7995 |
| San Bernardino Valley Municipal Water District | SBVMWD | Wells and Spreading Operations | Both | Muni On Call:<br>(951) 315-2246 |
| Southern California Edison | SCE | Power Lines | Both | Sean Payne (909) 503-7775<br>Bishop Control:<br>(760) 873-6333 |
| San Manuel Band of Mission Indians | San Manuel | Gathering and Collecting | Santa Ana | Lee Clauss<br>lclauss@sanmanuel-nsn.gov |
| United States Fish And Wildlife Service | USFWS | Habitat and Species | Both | - |
| United States Geological Society | USGS | Wells | Santa Ana | Redlands Field Office<br>(909) 798-3272 |
| San Bernardino County Vector Control District | Vector | Mosquitos | Both | - |

## Daily Flow Report

In order to ensure accurate and up-to-date water measurements within the Upper Santa Ana River Watershed, the District strategically records data at specific locations in coordination with other local water districts. In order to monitor the flows, recharge, and diversions of the Santa Ana River, Mill Creek, and the State Water Project the District produces a daily flow report (DFR). The DFR records the flow and volume of water at locations within the District's boundaries. A sample DFR is available in Appendix C.

Measurements are recorded by 7am on business days, by the District's field staff. Some locations have gauges that record the flows, while others are measured using a formula that takes in to account the height of the water flowing through weirs. The DFR accounts for all water coming in and out of all important locations in and around the District. Appendix C includes a description of each facility included in the DFR.

The DFR has several purposes for the District and other water agencies in the area. The amount of water recharged in certain basins, or parts of the river can be determined by calculating the difference of entering and exiting flows in the area. Theses flows are monitored directly by the DFR. By knowing how much water is recharged in certain locations the District can monitor what percent of their water rights are being used. The DFR is used to report values for Watermaster reports in the area, as well as specific reports used by the District.

## Marks Club

A model airplane club, the Marks Club, has an access permit to utilize a portion of the Borrow Pit for its operations. Members have access to the facility and have installed a run way in the base of the Borrow pit. District staff maintains access roads for the club so access is available for most vehicles, as well as allowing the club to place a lock on the District's access gate along Greenspot road.

The Marks club also serves as an additional set of eyes within the Santa Ana Facility. They coordinate regularly with District staff to report issues such as damages, illegal access, and illegal dumping. Their presence discourages users who would mistreat the facility.

## Bee Boxes

The District has had access permits with local bee keepers to place bee boxes on District Property, primarily the Santa Ana Facility. Currently Ron Soffel has an active access permit to store bees and bee boxes on specified locations as determined by District Field staff. Staff is responsible for ensuring that bee keepers are in line with the terms of their access permit and placing the bees in agreed upon locations. District staff coordinates with the bee keepers to ensure they have access to the facilities and for relocation of the bees in case of complaints. Bees are beneficial to the habitat within the facilities as well as the surrounding citrus groves.

## Cone Camp

Within the Santa Ana Facility, we can find the remains of a camp erected to house the Bracero Program workers. The Bracero Program was a series of laws and diplomatic agreements for the importation of temporary contract laborers from Mexico to the United States. The program ran for 22 years, from 1942 to 1964, and was terminated due to reports of poor living conditions and improper wages. The camp consisted of nine barracks with additional tents erected as needed. The camp was erected in the debris cone formed by the Santa Ana River where the river exits the San Bernardino Mountains, and thus became known as Cone Camp, or the Highland-Redlands Labor Association. At the height of the program, over 1,000 workers were served. At the end of 1974 the citrus industry had significantly declined which reduced the need for large numbers of field workers. The camp was eventually decimated by time, fire, and termites. In February of 1977, the camp became the site of S.W.A.T. and "Burn to Learn" exercises. Now all that remains of Cone Camp in the Wash Area are the foundations of the barracks. District staff limits ground disturbing activities on the historic site, however water spreading activities do occur adjacent to the area.

## Species Awareness and Conservation Efforts

The District is aware of endangered species inhabited within its boundaries and makes a conscience effort to conduct operations with their presence in mind. The District works closely with local biological conservation organizations and environmental planning agencies such as the U.S. Fish and Wildlife Service and California Department of Fish & Game. The District also makes an effort to compile its own information regarding threatened and endangered species that can be potentially affected by field operations. When taking daily measurements in the field, and conducting maintenance, field crews stay on designated roads and trails in an attempt to limit their environmental impact. Whether it is in the field or through research, the District understands the importance of preserving natural ecosystems and ensuring the longevity of threatened and endangered species.

## Biological Studies

Both the Sana Ana and Mill Creek facilities have prime habitat for several important native plants and animals. More details on the specific species are available in Appendix F. Biologist studying these species frequently utilizes the facilities for research. Access permits must be obtained from the District, with the exception of the Federal and State resource agencies (USFWS and CDFW). District staff ensures that the biologists have access to the facilities, and often check in throughout the day to ensure that there are no problems. Biologists make staff aware of their entry and exit from the facilities.

## Special Events

The District occasionally allows public access to its property for special events in the community. Most recently the District allowed a user group, the Clampers, access to a portion of the Borrow pit for an event. They had access to the area for a weekend in fall of 2016. The District has also opened up the facilities as part of the City of Highland's Trails Day. Users were able to enter the Santa Ana facility and utilize the existing access roads as trails. During special events District staff is available both by phone and/or in person for the events to ensure guests have access to the facilities, is available to answer any questions, and discourages misuse of the facilities.

The San Manuel Band of Mission Indians has an MOU with the District allowing access to the Santa Ana Spreading Facility for the gathering and collection of plants. Gathering events are preplanned and coordinated with the District. Field staff ensures the tribal members have access to the areas where they plan to gather and roadways are cleared.

## Trespassing and Illegal Dumping

As District facilities are large open space areas, they attract trespassers and squatters. Main violators include off-roaders and homeless camping on or near District Lands. These users often damage gates to create swimming areas, drive off designated roads harming habitat, or leave debris. These trespassers are first asked to leave by District staff, and authorities from either the City of Redlands or Highland are contacted if necessary. In an effort to protect facilities from damage and decrease illegal access, additional gates and rock piles have been placed across the facilities. Figure 4-1 represents the gate locations to date for the Santa Ana Facility, and Figure 4-2 for the Mill Creek Facility.

Illegal dumping is also a constant issue for Field staff. Items such as paint cans, tires, furniture, and even boats have been abandoned on District property and must be properly removed by staff. Dumped goods need to be removed as quickly as possible in order to discourage more illegal dumping.

The District's staffs regularly patrol the facilities for damage to fences, gates and locks as well as disposes of illegally dumped trash. Specifically, the cutting of fences and gates are serious problems in the Mill Creek facility where repairs are frequently and must be made immediately. Warning/ trespassing signs and stencils are constructed and strategically placed throughout all of the District's facilities to prevent trespassing and vandalism.

# Figure 4-1: Santa Ana Facility Access Points
## Operational Management Manual

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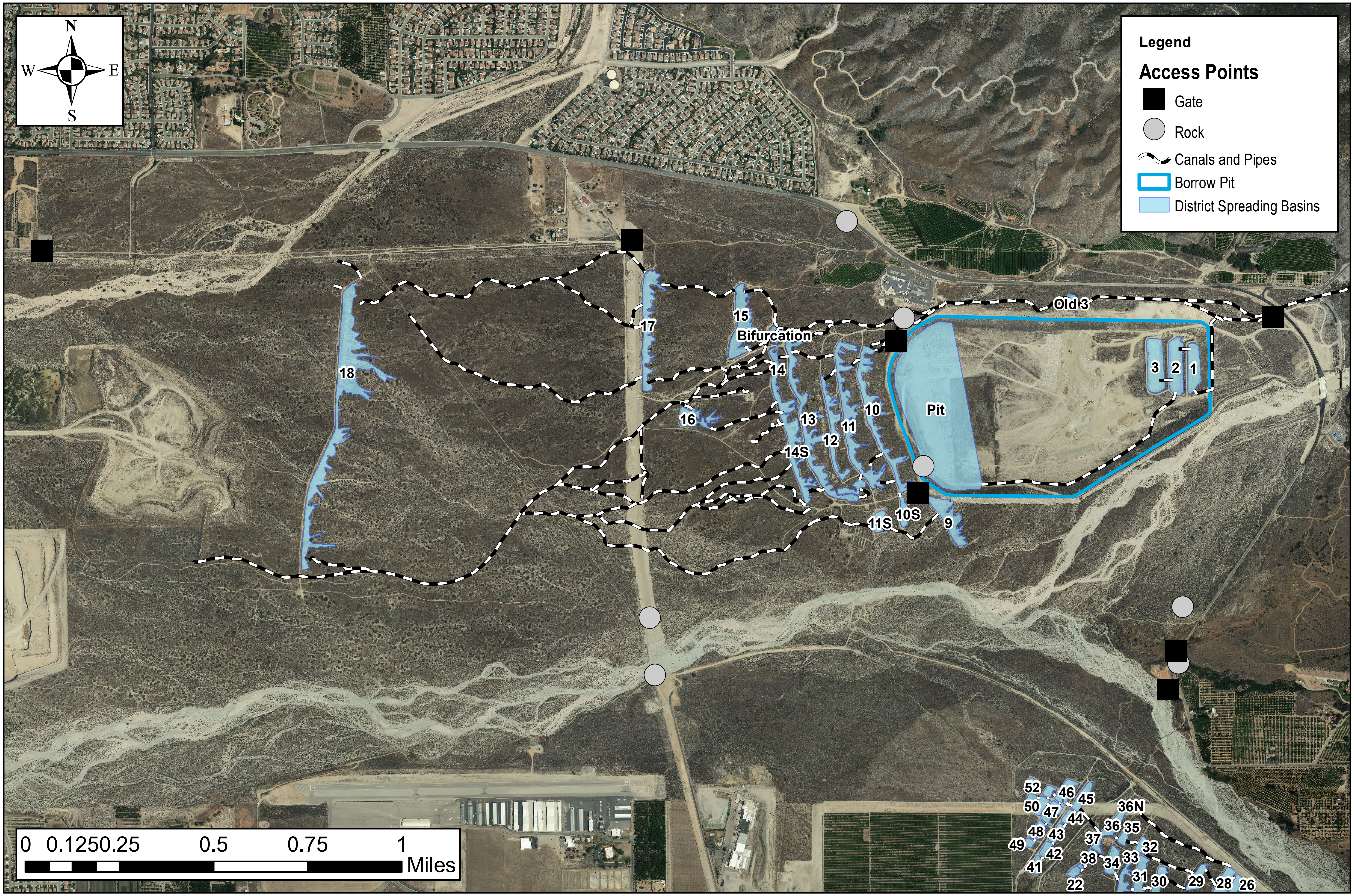

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# Figure 4-2: Mill Creek Facility Access Points Operational Management Manual

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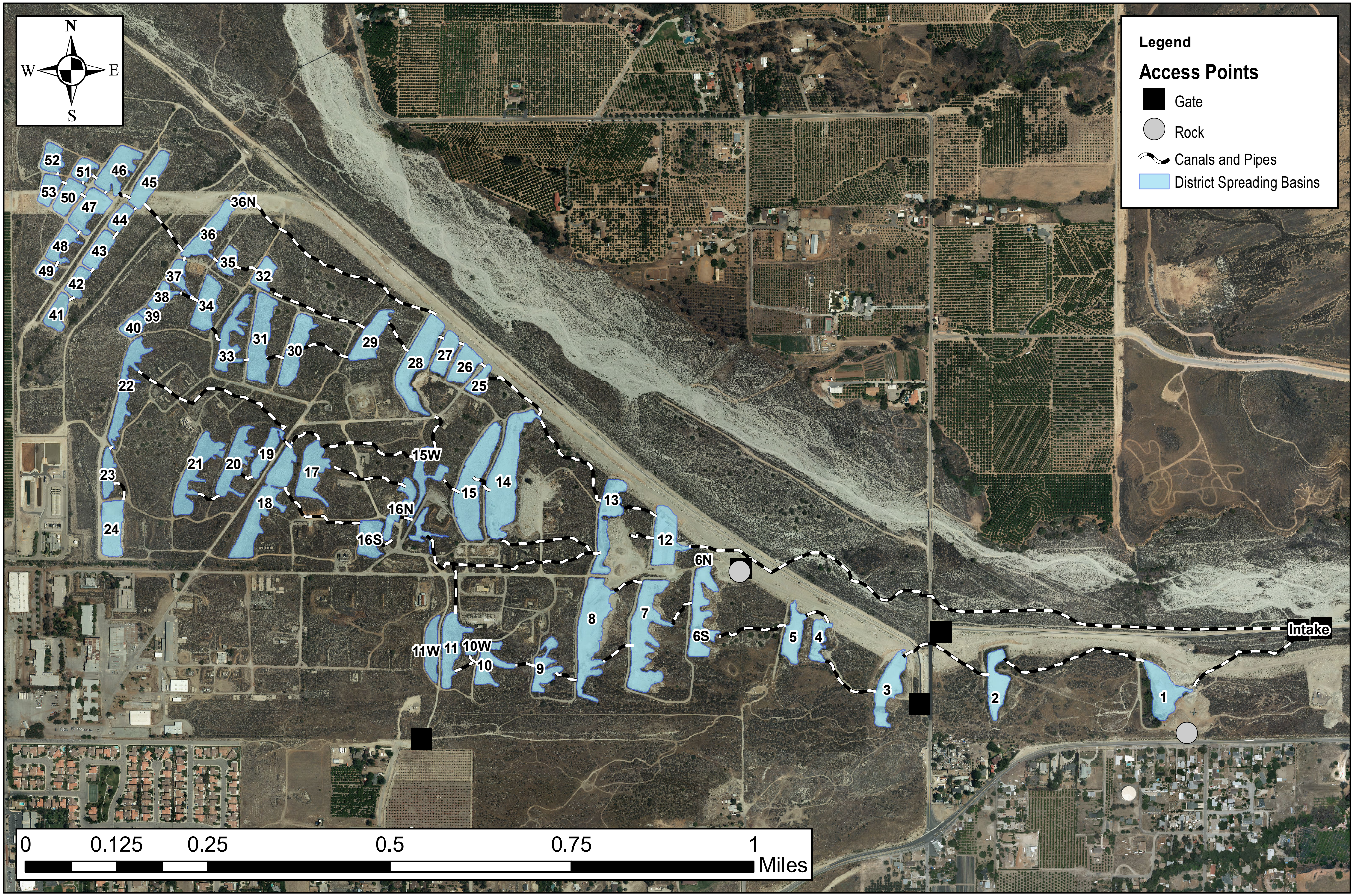

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## District Shops

The District owns two maintenance buildings the shop and the old shop. The shop is located at 2181 Mentone Blvd. Mentone, California. This location serves as the main office for the field staff, and houses all of the smaller equipment and vehicles. This location also includes an open lot and a rental home that has been previously utilized by District staff. The old shop is located just below Seven Oaks Dam along Santa Ana Canyon Road. It is primarily used for the storage of large equipment. Field staff maintains the shop facilities in order to protect the equipment that resides within. A list of all available equipment, its condition, and the facility in which it resides is available in Appendix G.

## Aggregate Operations

The District owns lands west of its Santa Ana Spreading Facility that are used for aggregate mining. These mining operations are completed by Cemex and Robertson's Ready Mix. The District receives royalties for aggregate removed from its lands by these aggregate companies. The mining operations are fairly independent and require little to no attention by District Field Staff. The District has the ability to utilize the mining quarries for the spreading of water. This has been done in times of high flows; however the percolation rate of the quarries is significantly lower than the District's basins due to the removal of alluvium. The District also forfeits its royalties from the sale of aggregate at times when water is spread within the quarries.

## Aggregate Management

The District also maintains a license with an aggregate company for material processing within the spreading facilities. This license includes access to the facilities, as well as the ability to sort, clean and sell the material from within the District's facilities, primarily the Borrow Pit. The license does not permit mining. The current license is with Upland Rock, and is for the management of material in both the Santa Ana and Mill Creek Facilities. Field staff utilizes the aggregate licensee for assistance with cleanout within basins and canals in order to maintain high percolation rates. The areas within the facilities utilized by Upland Rock for processing and storing, as well as the quarry ownership for aggregate mining is shown in Figure 4-3.

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# Figure 4-3: Aggregate Operations Operational Management Manual

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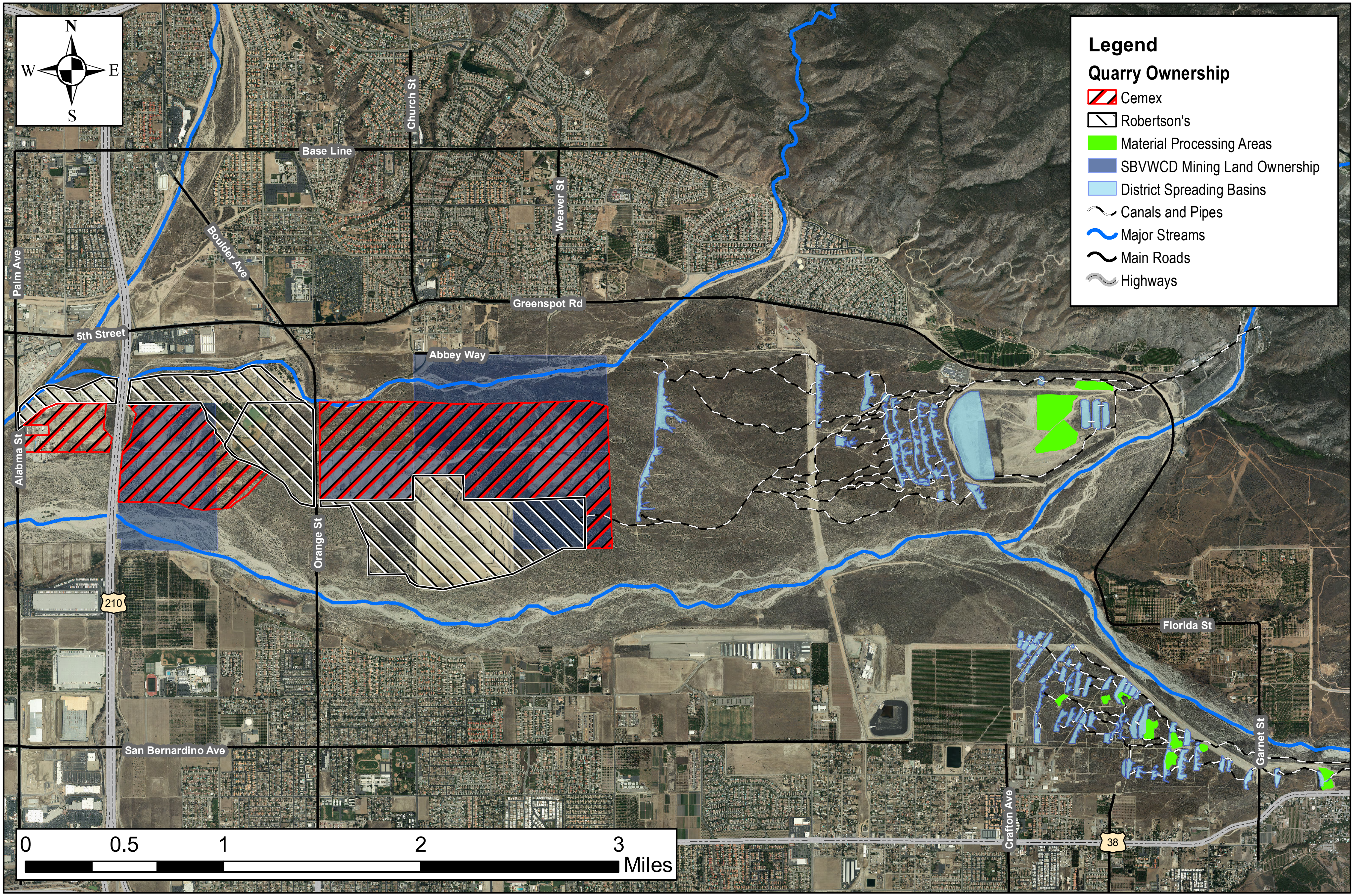

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# Section 5: Facility Maintenance

## Normal Maintenance Activities

The District's facilities undergo routine maintenance; activities are conducted both outside and within the percolation basins when necessary. These activities include maintenance of the spreading basins, canals, access roads, intake structures and weirs/gates. In general the District performs maintenance, wherever possible, from access roads or within basins and canals so as not to disturb native habitat. During facility and habitat maintenance activities, any remnant water facilities, such as rock walls and gate structures will be protected in place.

### Spreading Basins

Within the percolation basins, maintenance is conducted on a less frequent basis but repairs and general upkeep are of the upmost importance and essential to ensuring efficient groundwater recharge. Basins are occasionally restructured and reshaped to define basin boundaries or change basin dynamics in order to optimize percolation rates. Ideally, each basin must be cleaned out every three years to maximize the rate of percolation. Debris, sediments, algae and 3-5 inches of silt can build up during a three year period and decrease the efficiency of the spreading grounds. The District occasionally receives water from the California State Water Project which has a higher content of algae. A pond chosen to spread State Water may become plugged with silt and algae faster, and may require more frequent cleaning, potentially even annually. Larger basin restructuring is often completed by an outside contractor or the aggregate contract holder in order to reduce wear and tear on District equipment.

### Canals

Maintenance within the canals is typically minimal and is completed on an as needed basis. The primary goal is to ensure that the canals are clear to allow flow to pass from basin to basin without being hindered. Vegetation, primarily invasives, are frequently removed by hand and treated with an aquatic pesticide. Larger debris occasionally need to be removed with the assistance of heavy equipment such as an excavator. Sediment build up is typically not an issue as the flows within the canal move sediment into the basins. A notable exception is the Mill Creek North Canal, which receives a larger quantity of sediment, some of which collects within the canal west of Garnet St. District staff restructures this section of the canal using the loader on an as needed basis when flows are not present.

### Access Roads

Access roads must be kept clear of vegetation and debris in order to allow passage. The District utilizes either the loader or drags to clear the access roads of vegetation encroachment, typically annually during the summer. Minor pot hole appear in times of heavy spreading activities, and can typically be repaired by hand. Major road washouts require the assistance of a contractor with heavy equipment.

### Intake Structures

Both the Santa Ana and Mill Creek diversion structures must be monitored for debris build up in front of gates in times of heavy flows. Debris can limit the amount of flow for spreading and can potentially cause damage to intake structures.

### Weirs, Gates, and Overflows

The District has 11 access gates, 33 culverts, 2 flumes, 38 water gates, 101 overflows, 3 soft plugs, 3 valves and 3 weirs that must be maintained in order to recharge groundwater. Access gates must be inspected for damage, repainted, signage replaced, and fully replaced as necessary. Culverts must be monitored for clogging of debris, vegetation growth and damage. The district owns and operates two Parshall Flumes, one for the measurement of the Santa Ana Spreading as described in Section 3 and one to measure flows at the Bear Valley River Pick Up. Flumes must be kept clear of debris and vegetation growth and their stilling wells must be cleaned for algae and sediments in order to achieve an accurate reading. Gates that move water from sources and between basins must be regularly inspected for damage and have their wheels and stems greased to facilitate their opening and closing. When necessary, debris such as tree branches, broken boards, and algae must be removed from the weir gates that may restrict the flow of water. Overflows are maintained in a similar manner to gates, with the addition of board replacement upon damage. Soft plug maintenance is included as part of emergency maintenance. The district operates 3 valves along the Tailrace pipeline to divert Santa Ana River water from Power House 3. These valves were replaced in 2009. Little to no maintenance can be performed by District staff on these valves. The district owns and operates three measurement weirs; the Cuttle weir at the Santa Ana River Diversion Structure, the Mill Creek Weir at the Mill Creek Intake structure, and a weir that measures Santa Ana water being spread in the Mill Creek Facility from the Redlands Aqueduct. These weirs must have ideal entrance conditions in order to obtain an accurate reading which includes the upstream area being free of vegetation, sediment, rocks, and debris. The crest of the weir must also be adjusted so that it is level with the base of the measurement device. Figure 5-1 shows the locations of the District's entire water conveyance infrastructure in the Santa Ana Facility and Figure 5-2 shows the same for the Mill Creek Facility.

# Figure 5-1: Santa Ana Flow Infrastructure Operational Management Manual

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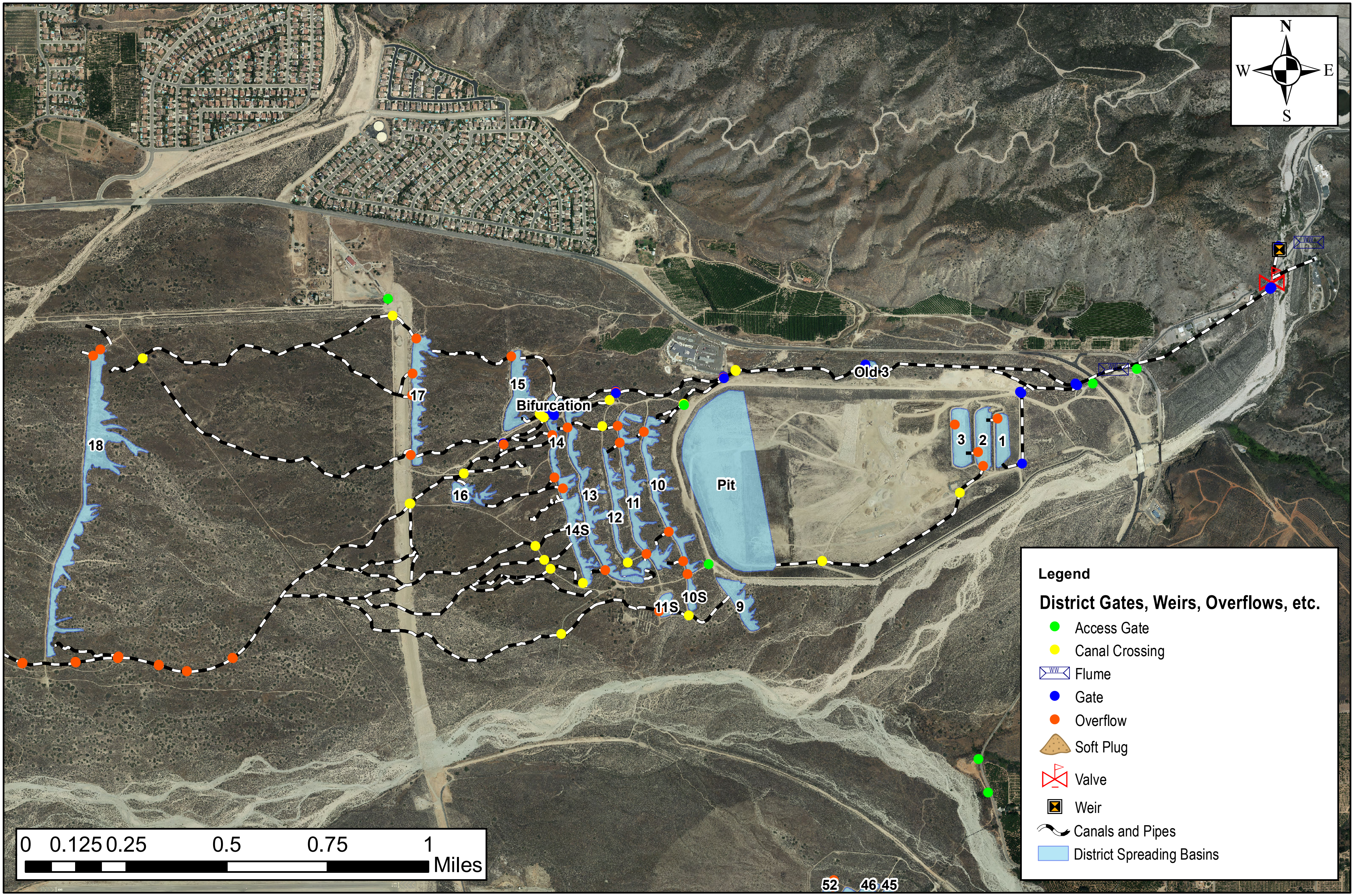

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# Figure 5-2: Mill Creek Flow Infrastructure Operational Management Manual

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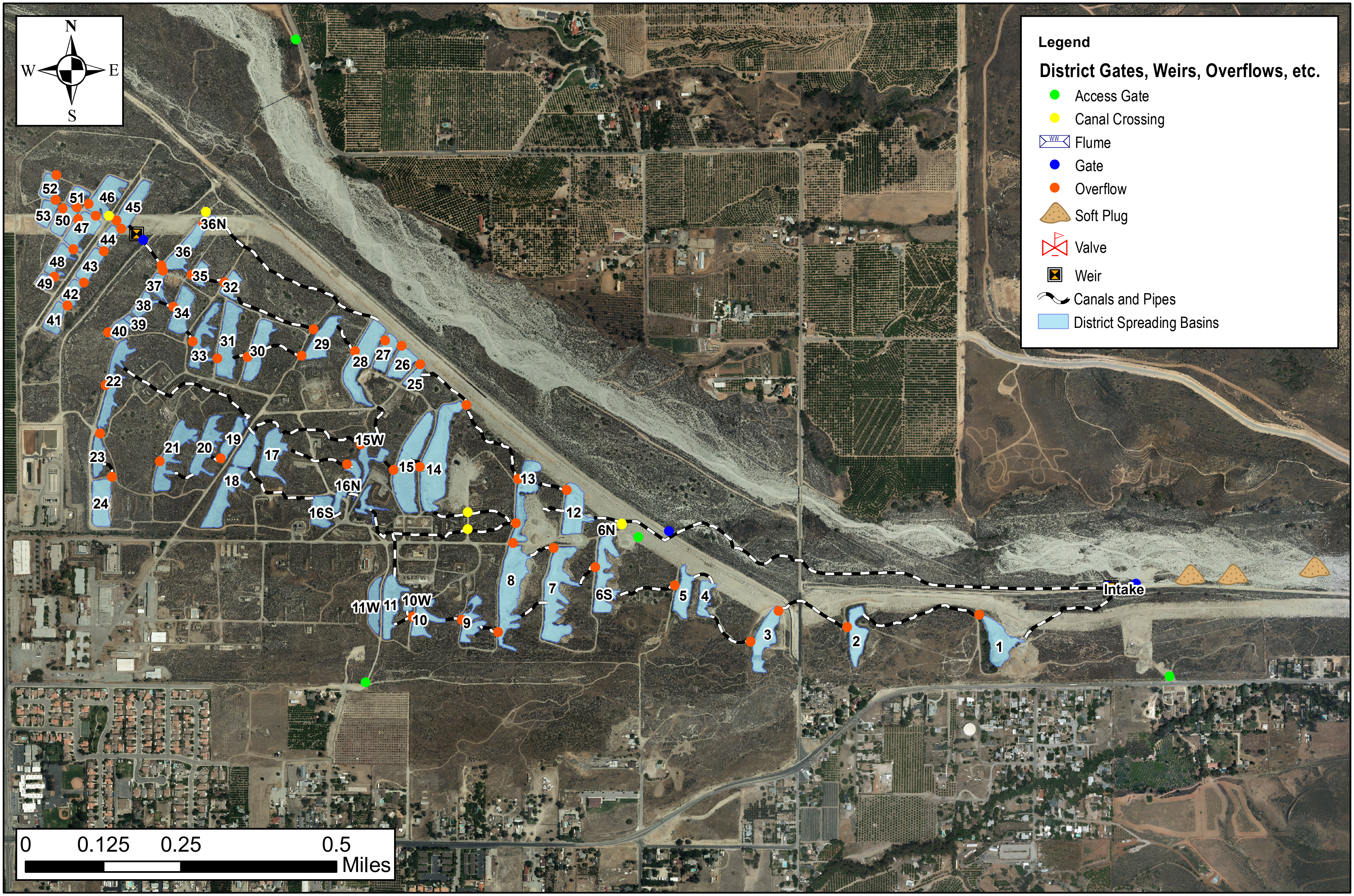

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## Aggregate Management

Aggregate (sand, silt, gravel, rocks and boulders) move into the Districts facilities with the water that is recharged. This natural process would render the recharge basins useless over time. Annual maintenance must be completed in many basins to keep them percolating water at a desirable rate.

While the activities required to maintain the basins (moving, loading, processing and hauling) may appear similar to aggregate mining they fundamentally different. These activities attempt only to maintain, repair or rehabilitate the basins. Aggregate materials brought in by water are removed with minimal removal of the underlying materials. Mining seeks to remove native materials and is not a renewable resource. The District utilizes two primary methods to manage the cleaning of the basins:

1. Equipment Contracts with operators to scrape and move material from the bottoms of the basins with large heavy equipment. This is generally used where the basins accumulate less aggregate and are less amenable to other options. These costs are significant and should be budgeted and executed carefully. Additionally this contract type is used for emergency repairs.
2. Access permits/processing licenses to allow maintenance contractors to remove the materials from the basins and process the material for removal from District property. These are used in areas where the quantity and value of the aggregate is adequate to offset the cost of removing the material or under appropriate conditions pay a royalty to the District for the materials.

In addition, District staff will perform some maintenance on smaller or limited scale. This is done cautiously as it can place considerable strain on District equipment and staff.

## Emergencies and Urgent Work

Emergency maintenance is conducted occasionally but due to the costs of such repairs and their effects on the basins, the District takes precautionary measures to reduce the possibility of severe damage. The District’s facilities may require emergency maintenance during the winter and early spring when there are large amounts of precipitation and snow melt that enters both the Santa Ana River and Mill Creek. When heavy rains are forecasted, the District can close the spreading grounds by choosing not to take any water from either the Santa Ana River or Mill Creek. This water can cause additional problems because increased amounts of suspended solids plug up the bottom of the spreading basins faster causing the need for more frequent costly cleaning. Not taking water can prevent uncontrollable amounts of water from entering the percolation basins, thus preventing damage to the facilities.

If the District does choose to take water during periods of heavy rainfall, basins are cleaned and equipment is relocated to ensure that the water can safely enter the spreading grounds and percolate at maximum efficiency. If these precautionary measures are not taken, or the amount of water entering the spreading facilities exceeds capacity, emergency work is often required. During such events, the District faces the possibility of eroded or destroyed dikes and damage to soft plugs. Both of which require the District to contract out because of the lack in heavy machinery. Most major emergency work occurs at the Mill Creek Diversion structure as it sits unprotected with in the active Mill Creek Channel.

### Soft Plugs

Soft plugs are designed with the sole purpose of falling apart when there is too much water or debris in the natural Mill Creek Channel. This does mean that they also have to be replaced with heavy machinery once the flows in Mill Creek have disappeared. The District has a contractor, typically Jacinto Construction utilize a bulldozer to reconstruct the soft plugs. This is a very important, time sensitive operation as the District cannot receive any water from Mill Creek until the soft plugs are reconstructed, however the soft plugs cannot be reconstructed while there is water in Mill Creek as the bulldozer has to travel in the active channel.

### Mill Creek Diversion

The Mill Creek diversion can still be inundated with debris even when the soft plug remains in place. Larger debris pile up in front of the three return gates blocking sediment and water from returning to Mill Creek. This blockade can cause the sediment berm between the diversion canal and the Mill Creek channel to become inundated with water and wash away. This levee berm must be replaced in a similar manner as the soft plugs with heavy equipment in the active Mill Creek channel.

Occasionally debris will build up in front of the Mill Creek return gates but not cause damage to the levee berm. If the District is in need of removing this debris quickly a Sennenbogen 825M can be rented from Bejac Scrap and Recycling Corporation in Placentia, CA, with a cost per day of $1,450 and cost per week of $5,800. The Sennenbogen 825M is an industrial material handling machine used for moving heavy loads of equipment, material, and debris. It has a working radius of forty seven feet and a maximum load of 825 pounds. The machine can be transported to Mill Creek within a day with a transportation estimate of about $350 to $375 round trip. This machine has the capability of reaching over the Mill Creek Flood Levee Wall and removing debris in front of the return gates.

**Figure 5-3: Sennenbogen 825M**

## Maintenance Frequency

Maintenance and repairs of the District's facilities are completed when necessary. The District is capable of conducting minor repairs and general maintenance but for work that requires heavy machinery, the District must contract outside companies. Contracting outside companies for major repairs can be costly and sometimes restricted financially. Examples of repairs that require the assistance of outside companies include dike and soft plug repair as well as the cleaning of each basin. For maximum percolation the first three basins in series should be cleaned every year, the second two basins should be cleanout out every other year, and the rest should be cleaned every three years.

## Invasive Removal

In the fall of 2013, the District began management of invasive plant species within its spreading facilities. These species may cause operational or maintenance issues within the facilities as well as being capable of taking over native species.  The District's is currently managing five invasive plant species in both of its spreading facilities; Tree Tobacco, Castor Bean, Fountain Grass, Tamarisk and Arundo.  These species have been found within the facilities within the past 5 years, and are managed differently based on the plant type. District Staff utilizes additional assistance for planned removal efforts of specific species. Cal Fire and IERCD have been contracted with for additional assistance.

### Arundo (Giant Reed)

Arundo, also known as Giant Reed, is on the noxious weed list for 46 different states and is on the list for California invasive plant control. Giant reed is invasive in warm freshwater riparian habitats from Maryland to California. It is believed to be native to eastern Asia, but has been cultivated throughout Asia, southern Europe, northern Africa, and the Middle East for thousands of years. Giant reed is a hydrophyte (grows only in or on water) found in riparian or wetland areas as found in or around the spreading basins. It grows in dense strands topped with large plume-like flower clusters as seen in Figure 5-2. Giant reed has been known to be a source of reeds for musical instruments and industrial cellulose. They can tolerate excessive salinity and long periods of excess moisture. All known reproduction is vegetative with introduction from vegetative material washing down from upstream. They can grow to 20 feet tall and can be approximately 2 inches in diameter.

**Figure 5-4: Arundo**

The District has not had excessive amounts of arundo within its facilities, and has currently been able to hand pull any stray plants that are found or spray treat larger patches with herbicide. The staff works relentlessly to ensure arundo does not become an issue as it quickly spreads and would be very difficult to remove. An area where a dense patch was located was within the Mill Creek North Canal. Staff sprayed the area and monitors it for regrowth.

### Tamarisk

Tamarisk are native to dry areas of Eurasia and Africa, but were introduced in the southwest around the turn of the century.  These old world shrubs or trees have scale like leaves and very thin terminal twigs.  They can reach 8 to16 feet in height and have small pink and white flowers as seen in Figure 5-3. Tamarisks are capable of completely replacing native vegetation especially in riparian areas such as the banks of the spreading basins. They are aggressive users of waters and are capable of taking up salt into their foliage. When this foliage falls into areas where there is not sufficient flooding, the salinity of the soil surface can increase. This salinity increase can prevent the growth of native species that are unable to handle an increase salt content.  A single tamarisk can absorb 200 gallons of water in one day, which can greatly reduce the capability of a basin.

**Figure 5-5: Tamarisk**

Tamarisk has previously been treated with assistance of contract help either with IERCD or Cal Fire. The larger tamarisk within the basins and canals has to be hand cut, removed, and ultimately chipped. The stumps are treated with an aquatic herbicide, monitored for regrowth, and retreated as necessary. Smaller plants can be sprayed either by hand or by the use of an ATV. Tamarisk is a recurring issue in the Borrow Pit, the Santa Ana Facility Main Canal, and ponds 12 and 13 in Mill Creek.

### Castor bean

Castor bean is native to the tropics of Africa, but has become very popular in gardens in the United States. It can reach 15 feet in height when grown in a warm open area. The fruit of the castor bean is an oblong spiny pod which typically contains 3 seeds, as seen in Figure 9. The seeds resemble pinto beans and require a long frost-free season to mature. Each leaf typically contains 8 leaflets. Castor bean has become naturalized near stream beds, dumping grounds, barnyards, and along roadsides in areas that have mild winters. The plant and seeds are highly toxic as they contain ricin.

**Figure 5-6: Castor Bean**

Castor bean is typically just pulled out as an entire plant either by hand or by use of the loader or vehicle. Castor is present primarily in the Santa Ana facility, but has not been the main focus of the invasive removal. It is typically removed when found by field staff or as part of another removal effort.

### Tree Tobacco

Tree tobacco is an evergreen shrub that grows to approximately 9ft by 9ft. It is frost tender and is in flower from August to October. It will grow in light, medium, and heavy clay soils and ultimately prefers well drained soils. It does not tolerate shade. They require 14 hours of sunlight per day in order for flowering to occur. It is a species of wild tobacco that is native to South America. Ingestion of the leaves can be fatal to humans .The plant is currently being investigated as a potential biofuel.

**Figure 5-7: Tree Tobacco**

Tree tobacco is removed in the same manner as the tamarisk, and has become increasingly present along the EBX pipeline scar in both facilities.

### Fountain Grass

Originating from Africa and the Middle East, Fountain Grass (Pennisetum setaceum) has been introduced to California as a popular ornamental plant.  It is easily dispersed by vehicles, humans, livestock, and, over short distances, by wind by water, and possibly by birds. Fountain grass is a coarse perennial bunchgrass with stems usually one and a half to five feet tall. The flower heads are feathery cylinders usually four to twelve inches long and can be white, pink, or purple. It's a vigorous growing plant with the ability to adapt too many different types of conditions. In California, Fountain Grass has no natural enemies and often displaces other native plants that provide habitat for wildlife. Fountain grass is usually more flammable than native vegetation and greatly increases to the fuel load of an area. Consequently, fountain grass contributes to a larger number of wildfires also resulting in loss of habitat.

**Figure 5-8: Fountain Grass**

Fountain grass has become the invasive of primary concern for District Field staff as it spreads at an alarming rate. The plants themselves can grow to several feet in diameter at the and often have to be removed with the use of heavy equipment. Staff has utilized Cal Fire crews to assist in the removal of fountain grass within the main canal in Santa Ana. Seeds are cut and placed in a sealed bag to prevent spreading and remove the plants.

### Stinknet

Stinknet is a nonnative annual herb who gets its name for its unpleasant smell. The flowers are round and can be a gold or yellow color. It flowers between March and July and can grow to two feet in length or greater. It is a fast growing noxious weed that was first introduced in Arizona and has spread to parts of California. It is currently listed as an invasive or noxious weed.

**Figure 5-9: Stinknet**

Stinknet was found in the District Mill Creek facilities in September of 2017. A removal and management plan is currently being developed, but no major removal efforts have been completed at this time. If found the most effective removal method currently appears to be hand removal.

## Wash Plan Required Maintenance

Implementation of the Wash Plan introduces additional maintenance requirements, some of which the District has already implemented. With the creation of the Wash Plan HCP Preserve comes the responsibility of managing lands for covered species through the control of non-native annual grasses and other invasive non-native plants and the restoration and enhancement of spineflower and woolly-star populations. The species covered by the Wash Plan as well as other important species present within the spreading facilities are listed and described in Appendix F. Below is a list of general measures and best management practices associated with implementation of the HCP:

- Barriers such as boulders, fences, and gates will be placed and maintained on the perimeter of the Plan Area to help prevent unauthorized activities including dumping and off-road vehicle use.
- Regular patrols of the HCP Preserve to prevent unauthorized use and access will be made.
- Illegal dumping, including hazardous waste, which occurs on HCP Preserve will be cleaned up within 7 days of its discovery. Illegal structures or settlements (e.g., homeless camps) will be removed following appropriate municipal and county protocols.
- Personnel will strictly limit their activities, vehicles, equipment, and construction materials to the designated work area.
- Ingress and egress of construction equipment and personnel will be confined to designated access points. Cross-country travel by vehicles and equipment will be prohibited.
- Equipment (e.g., passenger vehicles, trucks, and heavy equipment) will be cleaned prior to entering worksites and between worksites to prevent the importation and spread of exotic plant species.

- Litter control measures will be implemented. Trash and food items will be contained in closed containers and removed daily to reduce the attractiveness of the area to opportunistic predators.
- The area of Covered Activity disturbances will be confined to the smallest practical area, considering topography, placement of facilities, location of Covered Species habitat, public health and safety, and other limiting factors, and will be located in previously disturbed areas to the extent possible.
- Adequate fire suppression capability will be maintained in active construction areas including having a water tender on site during periods of high fire danger.
- Except on paved roads with posted speed limits and in aggregate mining operations areas with established speed limits per their mining plan, vehicle speeds will not exceed 15 miles per hour during travel associated with the Covered Activities. If work must take place at night, the speed limit will be 10 miles per hour.

The Wash Plan also includes coverage for trails that, when established will allow public access to specific portions of the Wash Plan area. Additional signage, trash facilities, rest facilities, etc. will be installed and require routine maintenance. Patrols of the facility would also be required to ensure the trails are being used appropriately and damage is not being done to facilities and habitat. Additional field staff may be hired after implementation of the Wash Plan.

Additional data will be collected in association with the Wash Plan Covered Activities. Operations and maintenance of District facilities will need to be quantified and tracked for annual reporting. Invasive and vegetation management will also be closely monitored through the use of geospatial applications. Applications for tracking covered activities and habitat are currently being developed and will be implemented as part of tracking for the Wash Plan.

# Section 6: Future Projects and Facilities

The District is currently (2017) working on or involved with four major projects that lead to new facilities and responsibilities. In addition, a few small capital projects are identified and budgeted yearly as planned.

## Enhanced Recharge Facilities

This project is the result of San Bernardino Valley Municipal Water District and Western Municipal Water District obtaining new water rights to the Santa Ana River due to the construction of the Seven Oaks Dam. Based on the Santa Ana River Groundwater Recharge Optimization Study, a number of improvements to District facilities and the addition of new spreading basins are required to capture additional Santa Ana River water released from the dam. The spreading facilities need to handle a peak flow rate of 500cfs and be able to recharge 80,000 AF per year of Santa Ana River water. The District's existing Santa Ana spreading facilities and channel capacities are currently able to handle 300cfs and are presented in Section 2. The proposed improvements include: Cuttle Weir intake structure improvements including a mechanical debris cleaning device; a sedimentation pond after diversion; increased channel capacity; and additional spreading basins. The project has been divided up into two phases; phase 1 comprises everything outside of the Santa Ana River Wash including the construction of the sedimentation basin, the Plunge Pool pipeline, and the improvements to the Cuttle Weir Intake and phase 2 is the construction of additional spreading basins and the enhancement of the existing canal.

Phase 1 of the Enhanced Recharge project has been further divided into Phase 1A and Phase 1B due to environmental permitting. Phase 1A has been fully designed and construction began in summer of 2017. Phase 1A included the construction of a sedimentation basin directly following the District's existing sandbox diversion structure. The sedimentation basin will divert water back to the districts earthen canal or to the Plunge Pool Pipeline, a portion of which is being constructed as part of phase 1A. The Plunge Pool Pipeline will have a connection to the existing Foothill Pipeline and will ultimately extend into the Santa Ana River wash for increased spreading capacity. Phase 1B includes the improvements to the existing Cuttle Weir Diversion structure with the mechanical debris cleaning device. Phase 1B currently does not have design drawings. A copy of the design drawings for phase 1A is available in Appendix H.

Phase 2 of the Enhanced Recharge Project includes the enhancement of the existing District Canal, the creation of additional spreading basins, and the continuation of the Plunge Pool Pipeline. Phase 2 is included as a project within the Wash Plan and therefore cannot begin construction until the Wash Plan is completed. A map showing the location of the planned spreading basins is also available as part of Appendix H.

## Plunge Creek Conservation Project

The Plunge Creek Project is an integrated habitat and water conservation project proposed in the Wash Plan HCP as a "Habitat Enhancement" with the goal of restoring the Plunge Creek system back to a braided stream using natural processes and hydrology. The project will increase the areas of suitable habitat for SBKR and other sensitive species, as well as allow water to spread out and infiltrate into the ground. The project was proposed for funding from the Integrated Regional Water Management coordinated by the Santa Ana Watershed Project Authority and received a grant. ICF International submitted the final project design in 2016 and the District is currently undergoing the permitting process with a goal of starting construction in the summer of 2018.

The design is meant to utilize natural materials to divert a portion of the flow of Plunge Creek away from the normal channel to pilot channels that ultimately reestablish flows in existing channels that no longer receive regular flows. Diversion will be created by the use of splitter mounds made of 1-3 ton rocks and 10-30 ft rot resistant logs. All rock is available within the Santa Ana River Wash, as well as some if not all woody material. Engineering plans were developed to 90% completion, and the design engineer will be present during construction recognizing that the subsurface in the plan area is unknown and making adjustments to the plans onsite would be more cost effective than dealing with the unforeseen obstacles. A copy of the 90% design plans as well as the design report is included in Appendix H. Construction is anticipated for summer 2018. The project currently ends east of Orange st., but has the potential to be expanded west in the future.

## Mill Creek Diversion and Debris Management Improvement

The Mill Creek Diversion and Debris Management Improvement project is an internal project designed to increase the District's ability to manage debris and sediment. Currently, in high flows larger debris will build up in front of the intake structure, often blocking the District's ability to take water until the debris can be removed with heavy equipment. Heavy equipment cannot access the sight until weather permits; ultimately creating a loss of water that could have been recharged. The improvement has also been designed to decrease the amount of sediment that currently deposits either in the canals or basins and has to be removed to maintain an optimal percolation rate.

Designs for the Improvement project were created by CWE in Anaheim, California and include the following:

- hardening on the levee berm with grouted rip-rap
- widening of the angle of the return gate
- replacement of the existing 3 return gates with a singular 17 foot wide gate
- creation of a sediment bypass channel with sluice gate
- creation of four 10x2x7 foot diverter walls to direct debris towards the wider gate
- instillation of a trash rack in front of the intake gate

The project is currently in the permitting process and construction is anticipated to start sometime between April and October of 2018. Appendix H contains a copy of the design plans.

## Wash Plan Habitat Conservation Plan

The Upper Santa Ana River Wash Land Management and Habitat Conservation Plan (Wash Plan) is a multi-agency land-use planning effort for approximately 4,500 acres in the Santa Ana River wash area, as shown in the figures in Appendix H. The plan has multiple goals and benefits that include: consolidating mining activities in one large area on land currently disturbed by mining or land adjacent to disturbed areas; habitat conservation located in large connected areas with intact natural habitat; continuation of water conservation and flood control in areas historically utilized for these activities; and establishment of a designated, connection trails and access roads. To accomplish these goals in exchange of land between the District and BLM is required.

The Wash Area extends from the District's Santa Ana spreading facilities on the east, to just west of the State Route 210 highway on the west, and north and south in the Santa Ana wash/flood plain area between the Cities of Highland and Redlands. Participating entities in the plan in additional to the District, which is the Incidental Take Permit holder, include: San Bernardino Valley Municipal Water District, County of San Bernardino, City of Highland, City of Redlands, East Valley Water District, CEMEX Inc., and Robertson's Ready Mix. In addition, a number of regulatory agencies are involved in permitting the plan including US Fish and Wildlife Service, US Bureau of Land Management, the US Army Corps of Engineers, and California Department of Fish and Wildlife.

The Plan was started a number of years ago and has been impacted by a number of regulatory hurdles and requirements, primarily due to endangered species issues and set-asides. Progress has been slow but steady as multiple meetings have been held to come to a consensus on the Habitat Conservation Plan (HCP), Environmental Impact Report and Statement (EIR/EIS), and an Implementing Agreement (IA) that includes a Memorandum of Understanding (MOU) between the Task Force and participating stakeholders. Two bills – H.R. 4024 and S. 3080 - have been introduced into the House of Representatives and the Senate that will allow for the land transfer needed for the successful implementation of the HCP. Both bills have been successfully passed. The District has finalized the HCP and is working with the resource agencies to finalize the EIR. Issuance of the ITP is anticipated by the spring of 2018.

As part of the Wash Plan, additional maintenance requirements will be implemented upon issuance of the ITP. In addition to the existing vandalism and trespass prevention and water conservation maintenance, the field staff will also have to handle some habitat management in order to meet the biological objectives as listed in the HCP. These additional maintenance activities are described in Section 5.

## Yearly Capital Projects

District Field staff identify annual improvement projects and bring these projects to the Operations Committee for review and inclusion in the annual budget operations. Recently these projects have involved the purchase of new or replacement equipment, projects that the Field staff can construct themselves, and smaller specialty construction contracts. Yearly capital projects have recently included the purchase of a new loader, automated metering of the Mill Creek Diversion Structure, enhancement and protection of the Mill Creek North Canal diversion pipe, and an ongoing invasive species removal program.

A list of potential projects will be prepared by Field staff and reviewed by the Resources Committee before the next budget cycle.

# Section 7: Fiscal Management and District Agreements

## Groundwater Resource Enterprise

With the 2017 District Budget the Board approved an enterprise approach for all District budgeting and accounting. This provides for clearer transactions in the District and transparency in funds provided and used for groundwater recharge.

The Groundwater Recharge Enterprise encompasses all activities directly allocable to groundwater recharge or water management operations. This enterprise includes the facilities at Mill Creek and Santa Ana River spreading grounds. This enterprise is funded by the Groundwater Charge and any service reimbursements or leases of facilities for groundwater purposes. Additionally, funding from the sale of aggregate from the cleaning of the District's facilities and interest from enterprise reserves are allocated to this enterprise. Expenses of this fund include the directly allocable portions of the following:

- Field staff, salary, burden, and overhead
- Field equipment, fuel, maintenance and related costs
- Non-Capital Repairs and Maintenance, basin cleaning and reconstruction
- Field Shop (Mentone) utilities, maintenance, grounds and IT Communications costs, cell phones and etc.
- Capital Improvements and major repairs that are capitalized
- Share of insurance based on facilities and carrier advice.
- Share of Board costs recovered on labor overhead.
- Directly allocable legal costs.

The groundwater enterprise tracks revenue from the groundwater charge and reimbursements and covers the costs of recharge operations and maintenance of the facilities. In many past years inadequate revenue was raised through the groundwater charge to fund the groundwater recharge costs resulting in either the Districts use of mining revenue or reserves for operations costs. With establish of the groundwater enterprise the full funding of this enterprise is expected using the groundwater charge in the future.

Other enterprises include:

- District's General Fund containing the operating revenue and cost related to District and Board activities
- Land and Wash Plan Enterprise containing mining costs and revenue as well at the Wash Plan project costs and revenue and costs related to habitat or other land leases.
- Property/Redlands Plaza Enterprise containing the costs and revenue of leased real property facilities (not including mining royalties).
- The District also approved an initial Reserve Policy that develops and dedicates reserve funds for the various enterprises and allows the enterprises to lend or borrow funds among the reserves.

## Facility Budgeting

The Groundwater Enterprise budget was developed based on historic costs and an outline of significant maintenance needed on a one, two or three year basis. These maintenance costs plus any capital costs (when revenue allows) along with labor are the main expenses of the enterprise. In general the more water recharged the higher the basins cleaning costs. Managing maintenance and repairs will keep costs in check. Also contributions to the GW Enterprise reserve should be budgeted to allow larger costs to be accommodated for repairs without significantly increasing the Groundwater Charge in a given year.

## Groundwater Charge

The groundwater charge is administered by the District and based on the recovery of costs associated with the recharge of groundwater and related costs of the Enterprise. This charge is set each year by the Board after a careful deliberative process to determine the appropriate level. The majority of the groundwater charge is contributed by the local municipal retail water entities: City of Riverside/Gage Canal, East Valley Water District, City of Redlands and the City of San Bernardino.

In the winter of each year an Engineering Investigation is performed to determine the status of the Groundwater basin and to support the groundwater charge. The District accounts for the amount of water pumped for the Bunker Hill Basin, the amount of rain in the year, the level of the Bunker Hill Basin, and the amount of time and money spent replenishing the Bunker Hill Basin. Keeping all of these factors in mind, the District comes up with a reasonable groundwater charge based on the acre feet of water pumped for each agency or private entity within the District. Semi-annual invoices are prepared based on the reported amount of water pumped by each agency or entity.

## Cost Recovery, Reimbursement and Use of Facility by Others

The District has several cooperative agreements to allow the use of District facilities for the recharge of water beyond the Districts Licensed Diversion and rights. A regional agreement with agencies in the area, referred to as the Exchange Plan provides options to move water through District facilities and allows the District to seek reimbursement for tracking, monitoring and reporting the water in Santa Ana and Mill Creek. The Exchange plan costs are billed to SBVMWD.

The Big Bear Watermaster agreement names the District as a member of the Watermaster Committee, and while the District does not recharge water for them, they track and provide information to the Watermaster.

The District also currently has two agreements the 1975 Spreading Agreement and the 2007 Easement Agreement that provide recharge of State Project Water and Santa Ana River Water, respectively, for SBVMWD. These agreements pay a proportional share of the District's Maintenance costs for the facilities. The Spreading Agreement provides for year to year proportional share and the Easement agreement provides for a 5 year rolling average share of costs.