Program for Expansion of Recharge Capacity (PERC) Comprehensive Feasibility Study

Volume 1

Feasibility Study Summary Report for Ten PERC Project Alternatives in the Upper Santa Ana River Watershed

November 2025

SAN BERNARDINO VALLEY
WATER CONSERVATION DISTRICT
EST. 1932

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Introduction

Feasibility Study Summary Report for Ten PERC Project Alternatives in the Upper Santa Ana River Watershed

Volume 1 of the *Program for Expansion of Recharge Capacity (PERC) Comprehensive Feasibility Study* consists of a Summary Report of the Feasibility Studies conducted for ten PERC Project Alternatives in the Upper Santa Ana River Watershed.

Volumes 2, 3, and 4 of the Feasibility Study provide a Detailed Feasibility Analysis for each PERC Alternative, grouped geographically. **Table 1** lists all PERC Alternatives considered and the corresponding sites, geographic locations, and Study Volumes.

Table 1. PERC Comprehensive Feasibility Study Alternatives

Volume/ Location	Site	PERC Alternative
Volume 2 East Twin Creek Watershed	Waterman Recharge Basins	Waterman Grading Alternative
	Twin Creek Recharge Basins (TCRB)	TCRB Small Grading Alternative
		TCRB Large Grading Alternative
	Lynwood Recharge Basins	Lynwood Operational Alternative
Volume 3 Plunge Creek Watershed	Oak Creek Recharge Basins (OCRB)	OCRB Construction Alternative
	Plunge Creek Recharge Basins (PCRB)	PCRB Interim Construction Alternative
		PCRB Ultimate Construction Alternative
Volume 4 Mill Creek Watershed	Mill Creek Recharge Basins (MCRB)	MCRB Grading Alternative 1
		MCRB Grading Alternative 2
		MCRB Grading Alternative 3

The Detailed Feasibility Analyses in Volumes 2, 3, and 4 provide design considerations and preliminary conceptual designs for each Alternative as well as technical analyses, permitting considerations, and characteristics that were considered for project scoring.

Evaluation of PERC Sites and Alternatives focused on identifying the highest priority projects to implement rather than which, if any, projects should be removed from consideration[1].

Each of the project alternatives considered under PERC can enhance groundwater recharge. Therefore, the primary goal is that project implementation be **prioritized** rather than projects being eliminated. The evaluation of PERC Project Alternatives was discussed among the interested parties at two workshops[2] and agreed upon as a 50-year time horizon from a uniform start date for project analysis. The methodology and parameters for the analysis of project priority discussed and provided in written drafts were used in this Feasibility Study to rank and prioritize the projects.

Using the prioritization characteristics as a framework, each PERC Project Alternative has been assessed within the same framework. **The fundamental characterization of a PERC Project Alternative is its ability to utilize native runoff in the upper Santa Ana River watershed.** There are a variety of underlying technical studies conducted by SBVWCD contained in Volumes 2, 3, and 4 to this feasibility study that describe the probable increased volume of native water that each alternative could recharge. Each alternative has value in increasing water supplies and water supply resiliency. Thus, the challenge and the goal is to **prioritize the projects that merit the first efforts** to initiate them to increase water supply resiliency.

[1] Potential PERC project sites with fatal flaws such as City Creek, Cook Creek or Bledsoe Creek had already been eliminated and thus all PERC Project Alternatives considered are viable.
[2] Hosted at San Bernardino Valley Water Conservation District, Oct. 31, 2024, and Jan. 15, 2025.

Program Origins

On January 8, 2019, the San Bernardino Valley Water Conservation District (SBVWCD) Board of Directors approved the Partnership Agreement for Joint Active Recharge Project Development under the Upper Santa Ana River Habitat Conservation Plan (HCP) with the San Bernardino Valley Municipal Water District (SBVMWD). This five-year Agreement created an essential partnership between these agencies, providing conservation easements on SBVWCD-owned lands to satisfy anticipated habitat mitigation requirements for the HCP in exchange for approximately $36 million in funds dedicated to this program and increasing groundwater recharge in accordance with SBVWCD's mission. The Agreement specified certain planned active recharge projects to be transferred from SBVMWD to SBVWCD for analysis, design, and construction, recognizing the ability of SBVWCD to utilize the conservation easement funds for related land acquisitions, water quality or supply facilities development, and other related projects with similar benefits within the jurisdictional boundaries of at least one of the two parties. These Agreement Transfer Projects were initially termed the Active Recharge Transfer Projects (ARTP) and are now referred to as the Program for the Expansion of Recharge Capacity (PERC). The five-year Agreement term expired on January 8, 2024. On December 13, 2023, the Board approved a First Amendment to extend that Agreement through January 8, 2029, with a Second Amendment approved on July 10, 2024, adding a representative from the Basin Technical Advisory Committee to the PERC Policy Council.

A PERC partnership with San Bernardino County Flood Control District (SBCFCD) was formally initiated on February 9, 2021, with a Planning Memorandum of Understanding (MOU). SBCFCD has an extensive system of facilities, including dams, conservation basins, channels, and storm drains that intercept and convey flood flows through and away from the major developed areas of San Bernardino County. The MOU established the intent of the districts to cooperatively evaluate the feasibility of the combined use of SBCFCD’s facilities (into which stormwater flows) to divert water for recharge purposes, provided such use will not impair the primary function of the facilities—to provide flood protection.

Following adoption of the MOU, a San Bernardino County Board of Supervisors Resolution, dated April 26, 2022, supported SBVWCD joint use of SBCFCD facilities for water conservation and groundwater recharge when it is consistent with flood control operations and safety objectives.

The PERC Joint Implementation Committee, consisting of Directors from partner Boards and additional agencies served as a forum for all partners to discuss the PERC Sites and Alternatives.

1 Identifying Sites and Alternatives

Initially, SBCWCD identified a total of eight possible sites for new groundwater recharge, consisting of the following types of PERC Alternatives:

1) Potential areas for <u>new basins</u>
2) Retrofit of <u>existing SBCFCD stormwater basins</u> owned by to also provide groundwater recharge benefits
3) Optimization of <u>existing SBVWCD basins</u> to improve their functions

The final projects evaluated for this Feasibility Study included 10 Alternatives at the 6 sites listed below and shown in **Figure 1**:

- Waterman Recharge Basin Area
    - 1 Alternative grading *existing* SBCFCD basins
- Twin Creek Recharge Basin Area
    - 2 Alternatives grading *existing* SBCFCD basins
- Lynwood Recharge Basin Area
    - 1 Alternative re-operating *existing* SBCFCD basins
- Oak Creek Recharge Basin Area
    - 1 Alternative building <u>new</u> basins
- Plunge Creek Recharge Basin Area
    - 2 Alternatives building <u>new</u> basins
- Mill Creek Recharge Basin Area
    - 3 Alternatives grading *existing* SBVWCD basins

Two of the initial sites—Cook Creek and Bledsoe Creek—were eliminated due to the complexity of the project locations, significant environmental concerns, and the minimal hydrological benefits.

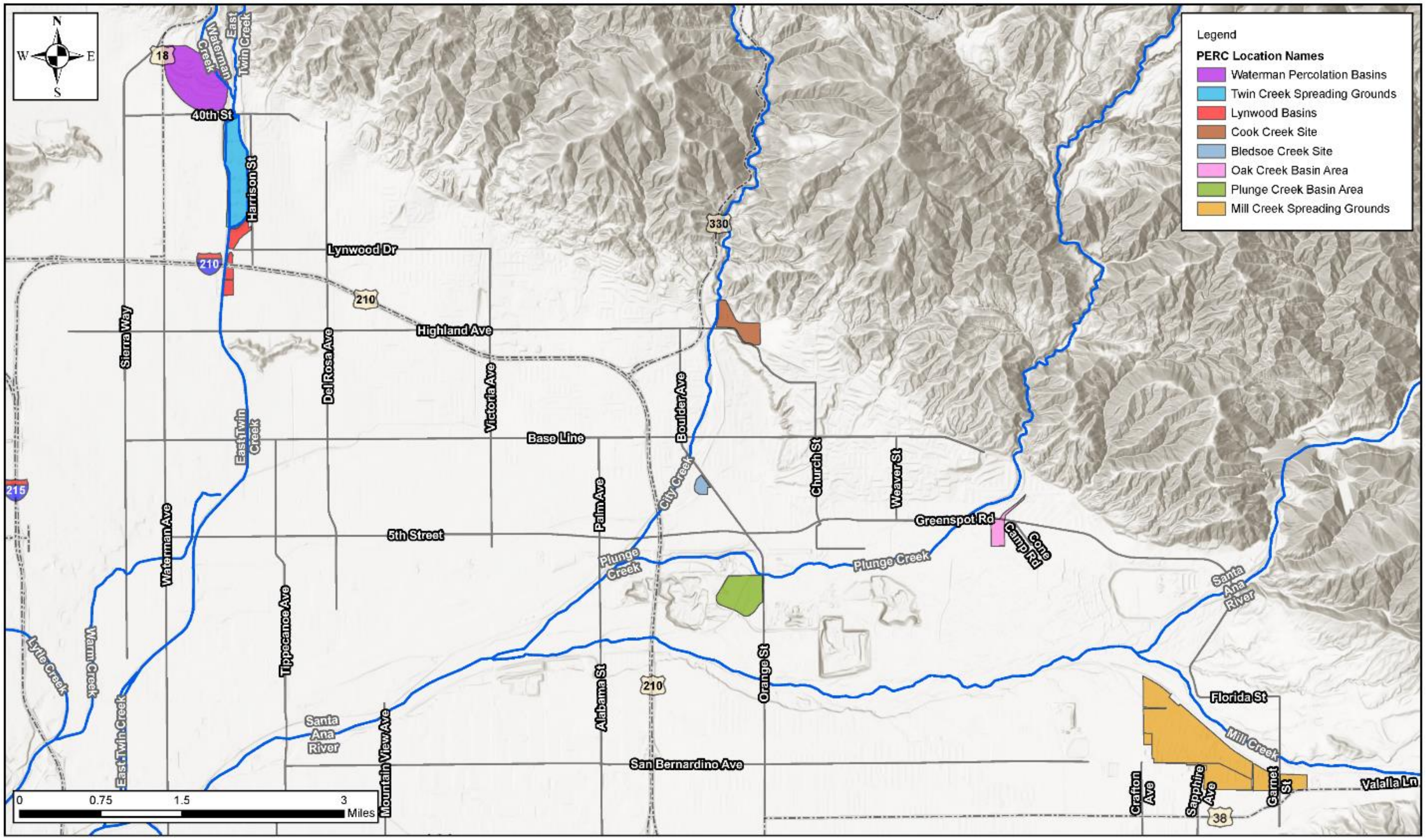

Figure 1. Final PERC Alternative Locations

2 Feasibility Study Process

The goal of the PERC Comprehensive Feasibility Study was to identify which of the ten Alternatives were the **highest priority to implement**. This process began with consensus-building discussions among the interested parties to define the most crucial factors for consideration. To promote an objective evaluation of the Alternatives, the Joint Implementation Committee hosted workshops with partner agencies in October 2024 and January 2025 to formalize its prioritization methodology. The details of the methodology are discussed in the Project Prioritization section of this Feasibility Study. The PERC Feasibility Study process is illustrated in **Figure 2**.

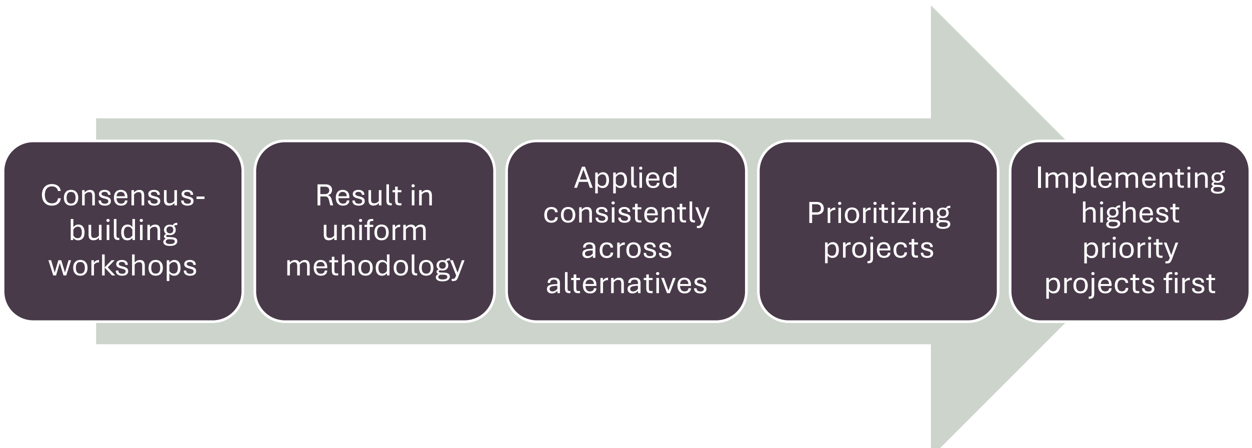

Figure 2. PERC Feasibility Study Process

Understanding the factors most important for prioritization also confirmed which technical studies and data would be necessary for Alternative assessment. There are a variety of underlying technical studies that were conducted to understand the benefits of each Alternative. The results of those analyses are reported in Volumes 2, 3, and 4 of this Feasibility Study. This document—Volume 1—reports the determinations reached by those studies and the resulting prioritization of the PERC Alternatives.

Technical Studies

Technical studies set the stage to compare merits of the Alternatives. The following data were gathered and analyzed for each PERC Alternative:

- **Geotechnical**: Geotechnical subsurface investigations were performed to identify percolation rates and to provide geotechnical design recommendations.
- **Watershed Hydrology**: Hydrology studies were conducted at a watershed scale to understand frequencies of storms and resulting flow volumes.
- **Water Source Hydrology**: Typical operational flows and potential maximum flows were quantified so that model simulations could calculate the potential recharge yield for each Alternative.

Two general hydrologies were used to evaluate the native waters available for the PERC Alternatives; these included:

- Unregulated local runoff in a tributary to the Upper Santa Ana River, which is referred to in this document as "**Local Site Hydrology**"
- Regulated runoff of the Upper Santa Ana River from flood control pool behind the Seven Oaks Dam that may become available through the Forecast Informed Reservoir Operations program to *some* of the PERC Alternatives, which is referred to as "**FIRO Hydrology**"

These hydrologies and their characteristics are described below. Alternative-specific hydrologies and hydrologic methods of analysis are discussed as a part of the Detailed Feasibility Analyses in Volumes 2, 3, and 4.

1 Local Site Hydrology

One of the biggest technical challenges in better utilizing native water in the Upper Santa Ana River watershed is that the flow rates in the various creeks are not regulated by a dam. A dam (such as the Seven Oaks Dam) provides flow rate regulation via detention storage and release. The upper tributaries to the Santa Ana River produce very steep runoff curves (storm hydrographs) from a rainstorm. This means that the bulk of a rainstorm's runoff volume passes a point on the creek in a matter of a few hours. It also means that it is unrealistic to attempt to divert most of the water from a large rainfall runoff event. The volume of water that can be retained for recharge is very small compared to the total volume of water in the storm. Therefore, annual average runoff volume is not an appropriate metric to predict recharge in an unregulated flow system, as the flowrates and volumes cannot be significantly diverted and held.

The PERC Feasibility Studies instead identify typical hydrology within each PERC project site's local watershed. In many regards, this is like identifying a median storm hydrograph where 50% are larger and 50% are smaller. This strategy enables conceptual projects to capture all the smaller storms and the manageable portion of the larger runoff events to more reasonably predict potential recharge in future real-world scenarios.

The Upper Santa Ana River and its tributary inflows have been measured for many years; some as far back as 1896. With the notable exception of Mill Creek, where the measurement gage went out of service in 1986, all other tributaries and the main stem of the Santa Ana River are currently measured by USGS flow gages. These gages capture the surface water elevation and flow rate every 15 minutes. The hydrologic analysis for the PERC Alternatives analyzed the 15-minute interval data for the shape and duration of stormflows as hydrographs (rather than to generate a modeled hydrograph). The targets in these analyses have been a "typical" storm size in terms of flow rates, total volumes, and time intervals between storms. The associated hydrographs are termed "**project typical hydrographs,**" or PTH.

- The PTH represents a storm size that occurs more than twice per year and, in most cases, 4 to 5 times per year.
- The PTH for Mill Creek, which has a good historic record of daily average flows (but no real-time data), was determined with a regional flow frequency analysis based on eight regional gages. The Mill Creek PTH is one that statistically occurs 5.5 times per year (daily average flow of 162 cfs).

2 FIRO Hydrology

In contrast to its unregulated tributary creeks, the runoff within the mainstem of the Santa Ana River watershed in its upper reaches is regulated by Seven Oaks Dam (**Figure 3**). Current operational rules do not allow for storage of water at Seven Oaks Dam. However, under Forecast Informed Reservoir Operations (FIRO), it may be possible to increase water conservation via storage with improved forecasting techniques for the extreme flood conditions for which the dam storage pool exists.

FIRO is an innovative approach promoted by USACE that uses modern weather forecasting technology and enhanced monitoring to selectively retain or release water from reservoirs in anticipation of future conditions. To date, it has been utilized by five dams in California, including in Sonoma County for Lake Mendocino and in Orange County for Prado Dam. During the development and analysis of the PERC Alternatives, development of a FIRO program for Seven Oaks Dam was initiated.

Figure 3. Seven Oaks Dam[3]

FIRO hydrology is, by comparison to local storm hydrographs, a smooth and steady hydrology enabling use of water conveyance infrastructure to lift water out of the Santa Ana River Wash below the Seven Oaks Dam and out to most of the PERC Alternatives, either directly or indirectly (i.e., by downstream flow).

There are three PERC Sites that can receive direct delivery of FIRO water. They are:

1. Waterman Recharge Basins Area via Foothill Pipeline
2. Oak Creek Recharge Basins Area via Foothill Pipeline
3. Mill Creek Recharge Basins Area via Greenspot Pipeline and/or Redlands Aqueduct

There are two additional PERC sites that can indirectly receive FIRO water. They are:

1. Twin Creek Recharge Basins Area via the overflow from Waterman Recharge Basins (existing conditions)

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[3] (Credit: Steve Schumaker via Wikimedia Commons, released under CC By-SA 1.0)

2. Lynwood Recharge Basins Area via the overflow from Waterman Recharge Basins (existing conditions) and out the Twin Creek Recharge Basins via an existing drain gate

Conservation water stored behind Seven Oaks Dam may enter the Foothill Pipeline to be redistributed to other recharge facilities; however, this may happen with or without FIRO and would occur after a storm event.

A FIRO Work Plan was completed and published for Seven Oaks Dam in June 2024. A Preliminary Viability Assessment (PVA), which assesses the rates and timing of potential water deliveries for water conservation through conjunctive management of the flood control pool at the dam, is scheduled for publication in October 2026. The Final Viability Assessment (FVA) is scheduled for publication in October 2028. There is no specific implementation date, but depending upon findings in the PVA trial, it is possible that implementation may begin between the Preliminary and Final assessments. Therefore, FIRO hydrographs and associated infiltration rates and recharge yields were calculated for the above listed PERC sites and associated Alternatives.

3 Studies Referenced

The multitude of studies that contributed to evaluation of PERC Alternatives are referenced throughout all four Volumes of this Feasibility Study report. Each Volume includes a list of citations with referenced studies and identifying information.

Project Prioritization

Each of the PERC Alternatives can enhance groundwater recharge. The goal of the Comprehensive Feasibility Study is for project implementation to be prioritized rather than projects being eliminated[4].

The method to evaluate PERC Alternatives was discussed with the Joint Implementation Committee and interested parties at two workshops[5]. At the workshops, a 50-year time horizon from a uniform start date was established. The methodology and parameters were discussed and provided in written drafts to define how the study would rank and prioritize the Alternatives. Each PERC Project Alternative was assessed within this same agreed-upon framework, which is described below.

The fundamental characterization of a PERC Alternative is its ability to utilize native runoff in the upper Santa Ana River watershed for the purpose of groundwater recharge. Additional benefits that could be generated from of PERC project implementation were evaluated for comparison and scoring of the Alternatives. An example of an additional benefit is habitat improvements for threatened and endangered species. Considerations for prioritization also included elements such as the opportunity to implement a project quickly, thereby increasing recharge capacity sooner. Quickly developing recharge capacity may reduce the opportunity cost of lost water. These benefits and more that would arise from project implementation are considered in the prioritization methodology, which is described in detail below.

1 Multiple-Accounts Analysis for Decision-Making

There is a large body of literature on multiple-objective decision-making in land and water use management (El-Swaify and Yakowitz eds., 1996). The accepted standard practice is to develop a decision-support tool that considers the most relevant factors in a defined and

[4] Potential PERC project sites with fatal flaws such as City Creek, Cook Creek or Bledsoe Creek had already been eliminated and thus all PERC Project Alternatives considered are viable.
[5] Hosted at San Bernardino Valley Water Conservation District, Oct. 31, 2024, and Jan. 15, 2025.

objective manner while using the subjective weighting given to different considerations common to each alternative (e.g., legal issues to implement or operate). Such a decision tool is referred to as a Multiple-Objectives Decision-Support-System, or MODSS.

SBVWCD developed a MODSS for the PERC Feasibility Study based on the **Multiple-Accounts Analysis** (MAA) method for natural resource projects (Mendoza, G.A. and H. Martins, 2006). The MAA provides a transparent, consistent methodology to rank project alternatives by relative priority.

The relative value placed on different characteristics of PERC Alternatives within the MAA is subjective. Therefore, these values were established by interested parties at the outset of this study effort. The relative importance of groups of project characteristics (such as costs) is set via a weighting assigned to that group. Groups are subdivided into component parts (such as capital costs and operations & maintenance costs) with their own subaccount weightings. Once the subjective decisions of importance and weighting were agreed upon, the MAA was applied uniformly and objectively to provide a ranking of the PERC Alternatives.

Because the MAA was applied across all ten PERC Alternatives and not simply the six different project sites, two project alternatives at the same site compete not just among themselves but across all PERC Alternatives. What this enables is recognition that a project alternative with higher long-term yield may rank lower in priority at its own site but may have merit to prioritize subsequently over a project at another location. At the same time, a project alternative with a lower yield and a lower priority at the same location would effectively be eliminated.

Geographic equity in implementation of the alternatives was raised as an important factor during regional workshop discussions. Although MAA Sub-Account Proximity to Groundwater Pressure Zone was incorporated as a proxy for geographic location, additional evaluation of recharge benefits across the Bunker Hill Basin may be conducted as part of funding determinations.

2 Accounts as Criteria

The MAA methodology requires categories of criteria, which are referred to as **Accounts**. For the PERC Comprehensive Feasibility Study, five Accounts were identified as important and relevant to ranking the PERC Alternatives:

1. Groundwater Recharge Aspects
2. Cost Aspects
3. Other Technical Aspects
4. Social Aspects
5. Legal Aspects

Each of the Accounts was given a subjective weighting, based on interested-party feedback, to define its relative importance to ranking. Within each of the Accounts are aspects that further drive the ranking of Alternatives. These more detailed aspects are referred to as **Sub-Accounts** (e.g., O&M Costs is a Sub-Account under the Cost Aspects Account). The five Accounts and their respective Sub-Accounts are listed in **Table 2**.

Table 2. MAA Accounts and Related Sub-Accounts

Account	Sub-Accounts
Groundwater Recharge Aspects	Groundwater Recharge Capacity
	Infiltration Rate
	Net Recharge on a 50-year "firm yield"
Cost Aspects	Capital Costs
	O&M Costs
Other Technical Aspects	Groundwater Quality Improvement for Salt & Nutrient Management Planning
	Proximity to Groundwater Pressure Zone
	Access to State Water Project Supply
	Conservation and Habitat Benefits
	Groundwater Mounding
Social Aspects	Project Job Creation
	Public Safety Hazards
Legal Aspects	CEQA
	Permits Required & Requirements
	Land Availability
	Water Rights

Under the Sub-Accounts, at the foundational level for ranking, are **Indicators**. An Indicator is a criterion that provides one performance metric for a Sub-Account. A tangible example of an Indicator would be an Alternative's *"projected net average groundwater recharge yield in acre-feet of water per year."* **There can be one or many Indicators per Sub-Account.**

Following is a description of the five Accounts, their Sub-Accounts, and Indicators that were created for PERC Feasibility Study MAA. This framework determined the weighting values assigned to each PERC Alternative.

2.1 Groundwater Recharge Aspects

The **Groundwater Recharge Aspects** Account describes the principal project objective: increasing groundwater recharge.

There are **three Sub-Accounts** that quantify an Alternative's groundwater recharge aspects:

1) Average annual recharge in acre-feet per year (AFY)
2) Infiltration-rate capacity in cubic feet per second (cfs)
3) Forecast 50-year firm yield in acre-feet (AF)

Table 3 lists the Groundwater Recharge Aspects Sub-Accounts and associated Indicators.

Table 3. Groundwater Recharge Sub-Accounts and Indicators

Groundwater Recharge Aspects		
Sub-Account	**Indicator**	**Indicator Description**
Average Annual Recharge (AFY)	Net AFY	Increase in the typical year engineered groundwater recharge from the project alternative as compared to the no-project alternative.
Infiltration-Rate Capacity	Net increase in Infiltration Rate	Increased rate at which water can be recharged as a rate capacity in cfs.
	Ease of Maintenance	Annual cost to maintain the infiltration rate capacity.
	Timeline to Implement	Number of years forecast to be necessary to generate the rate increase.
Forecast 50-year Firm Yield	AF Water Recharged	Net[6] engineered recharge estimated for project alternative on a 50-year planning horizon.

The long-term reliability of engineered groundwater recharge is referred to above as "firm yield". Firm yield depends upon two things: 1) a source of native water, and 2) the capacity to recharge it. A PERC Alternative with high recharge capacity but less reliable water source has a lower firm yield than one with a lower recharge capacity but more reliable water source. Similarly, a PERC Alternative that has high water availability, but that water rate routinely exceeds the Alternative's water-retention or water-detention capacity also has a lower firm yield. Firm yield for the PERC Alternatives is defined for the 50-year planning horizon[7] to both encompass and equilibrate long implementation timeframes and to **compare volumes of engineered recharge over a common timeline** that is equitable and statistically

[6] Existing engineered recharge project yields were subtracted from the enhancement project (e.g., Mill Creek Spreading Basins existing operational conditions)
[7] All time forecasts assume a contemporaneous Go or No-Go circa July 2025 and a potential operating period from Jan 2026 through Dec 2075 for purposes of comparative costs and recharge yield.

meaningful. The groundwater modeling tools, data, and assumptions used to estimate recharge yields and benefits are provided for each Alternative in their respective Groundwater Recharge Benefits sections in Volumes 2, 3, and 4.

2.2 Cost Aspects

Cost Aspects were simplified into two Sub-Accounts: Capital Costs and Operations & Maintenance (O&M) Costs. The availability of grant or other funding sources to cover each type of cost is taken into consideration as an Indicator. **Table 4** lists the Cost Aspects Sub-Accounts and associated Indicators.

Table 4. Cost Sub-Accounts and Indicators

Cost Aspects		
Sub-Account	**Indicator**	**Indicator Description**
Capital Costs	Capital Cost	Overall costs for an Alternative’s design, permitting, and construction on a Net Present Value (NPV) basis. The range of Alternative capital costs is estimated at $2.3M-$58M NPV using a rate of return of 4% and the projected start dates. The range of forecast costs was used to establish uniformly spaced bin sizes of $7.5M for the Indicator values.
	Grant or Other Outside Funding	Project capital costs available by percentage of total costs. A numeric % based on known funding programs from federal and state entities (e.g., new small storage projects funded at 25% with a 75% match).
O&M Costs	O&M Costs	O&M costs on a per annum basis using 2025 costs (not NPV dollars) either annually or in the aggregate over the planning horizon. O&M costs are incurred during the operational period for the project. Therefore, their relative magnitude (irrespective of when they begin and end) can appropriately help rank projects on their relative costs. The principal component of O&M costs is facility maintenance to remove fine-grained material. Cost estimates are founded on recent and relevant SBVWCD experience maintaining its existing operating facilities and include personnel, equipment maintenance, and materials handling costs. Like the capital cost range, the range of annual O&M costs was used to establish the size of the bins.

2.3 Other Technical Aspects

The Other Technical Aspects Account includes known regional environmental and natural resources aspects associated with the PERC Alternatives. The Sub-Accounts were systematically developed early in the MAA process during the October 2024 and January 2025 workshops with project partner and interested party consensus. The Indicators were developed in close coordination with interested-party personnel knowledgeable on issues of water quality and water supply resiliency.[8] From this collaborative process, four Sub-Accounts with corresponding Indicators were identified (**Table 5**).

Table 5. Other Technical Aspects Sub-Accounts and Indicators

Other Technical Aspects		
Sub-Account	**Indicator**	**Indicator Description**
Potential for Groundwater Quality Improvements for Salt & Nutrient Management Planning	Gross Annual Average Engineered Recharge to Bunker Hill Basins A and B (MGD)	This Indicator was developed with the project partners to be considered equally between the two water-quality management zones: Bunker Hill A and Bunker Hill B. Three PERC Alternatives are in Bunker Hill A and three are in Bunker Hill B. The bulk annual average rate of recharge expressed in millions of gallons per day (MGD) was used to measure this Indicator in light of the water quality management potential from each PERC Alternative.
Conservation and Habitat Benefits	Santa Ana River Contribution	Estimated net impacts on baseflow in the Santa Ana River related to the Upper Santa Ana River HCP and its requirements (shown as positive impacts, negative impacts, or no impacts).
	Habitat Restoration	Rated terrestrial area (acres) of disturbance beneficial to threatened or endangered species such as the San Bernardino kangaroo rat.
	Species/Habitat Impacts	Estimated area (acres) of habitat losses or gains from impoundment of recharge water to threatened or endangered species, including ponded and wetted areas for habitat.
Proximity to Groundwater Pressure Zone	Distance from project alternative to a hydraulic stress low point	This indicator was developed in response to questions raised by project partners related to geographic equity of the alternatives; specifically, distance from major existing recharge facilities, wells owned by various agencies, and recent groundwater elevation readings.

[8] Special thanks to Greg Herzog at San Bernardino Valley Municipal Water District and Drew Faherty at City of Riverside Public Works for their valuable insight and input.

		In addition, engineered recharge in proximity to the area of groundwater zones under hydraulic pressure (East 5th Street and North Waterman Avenue in San Bernardino) may reduce the risk of a loss in aquifer storage potential from clay dehydration.

2.4 Social Aspects

The Social Aspects Account focuses on direct impacts on people. Again, these were developed in conjunction with project partners and interested parties. The Social Aspects Account addresses and includes two issues: job creation (from project construction and maintenance), and physical safety hazards (associated with the site). **Table 6** lists the Social Aspects Sub-Accounts and associated Indicators.

Table 6. Social Aspects Sub-Accounts and Indicators

Social Aspects		
Sub-Account	**Indicator**	**Indicator Description**
Job Creation	Number of Jobs Forecast from Construction	Rated in relative FTE based on the capital costs and duration of construction.
	Number of Jobs Forecast from Project Operations	Rated in annual FTE based on the magnitude and overall frequency of water supply operations and cleaning operational projections of annual frequency for oversight and management.
Public Safety Hazards from Project	Drowning Risks	Rated on the ponded water depth in feet to threshold level (e.g., waist depth). Access to all projects is assumed irrespective of the presence of physical barriers such as fences or offsets from paved access.

Note that PERC Alternatives are <u>not</u> deemed to provide flood risk-reduction or water stage mitigation in regard to safety hazards as that is not a part of their function; their potential to increase flood risk is addressed in the technical studies and is governed by San Bernardino County Flood Control District with its state and federal agency partners in flood risk analysis and mitigation. Thus, no consideration of broader-scale risks to human life or property from a maximum probable flood analysis is included in this MAA.

2.5 Legal Aspects

PERC Alternatives invoke several legal issues when planning for implementation. There are several permits that may be required for an Alternative to be implemented and operated. Issues of land availability are also considered. Additionally, the benefits to support exercising and perfecting existing water rights and water rights filings are taken into account.

Table 7 lists the Legal Aspects Sub-Accounts with their respective Indicators. Most permit requirements were set as Indicators, while the CEQA requirement was placed into its own Sub-Account, given its primacy and potential magnitude both financially and temporally. Consideration of permit requirements (including CEQA) is also factored into the timeline projections in **Table 21** and influences capital costs and anticipated recharge yield.

Table 7. Legal Aspects Sub-Accounts and Indicators

Legal Aspects		
Sub-Account	**Indicator**	**Indicator Description**
CEQA	Type of Filing	CEQA filings rated in seven increments ranging from a contested and defensible Environmental Impact Report (EIR) to a project type that can be designated as Categorically Exempt under CEQA rules with variations on an Initial Study with a Negative Declaration for Impacts to a Mitigated Negative Declaration.
Permits Required/ Requirements	USFWS ESA	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	CDFW CESA 2081	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	CDFW LSA/1600	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	RWQCB 401	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	USACE 404	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	USACE 408	Yes/No criterion; but if Yes, then rated on rated difficulty in obtaining permit.
	California DSOD	Jurisdictional Dam criteria
	SBCFCD	SBCFCD permit requirements for PERC Alternatives can be for “major” or “minor” construction. Additional permit requirements for maintenance within the maximum probable flood zone (i.e., not levee-protected) will be considered as a relative scoring for timing.

Land Availability	Property Ownership by Partner Agencies	Yes/No criterion; but if No, then rated on the expected degree of difficulty in acquiring property access.
Water Rights	Support for utilization of water rights not yet Licensed	Engineered recharge rating for maximum diversion rate (cfs) and/or maximum estimated annual recharge volume (AFY).

2.6 Account Weights

Significance values and a range of weights were assigned to the Accounts and Sub-Accounts as presented in **Table 8.** The weighting values reflect the overall significance of each Account to prioritizing PERC Alternatives for implementation.

Table 8. General Ranges of Weighting Values

Significance	Account and Sub-Account Weighting Values	Indicator Weighting Values
Low Value	0.05 to 0.2	1
Moderately Low Value	0.2 to 0.4	2
Moderate Value	0.4 to 0.6	3
Moderately High Value	0.6 to 0.8	4
High Value	0.8 to 1.0	5

Sub-Accounts are given fractional weighting values within an Account. The number of Sub-Accounts and their weightings within each Account are independent of other Accounts. For example, what comprises the Cost Aspects scoring via weightings of Sub-Accounts (Capital Costs and O&M Costs) is completely independent of what comprises the Social Aspects scoring and weighting for its Sub-Accounts (Job Creation and Public Safety Hazards). Similarly, judgements of an Indicator's significance are independent. This three-tiered approach to project prioritization creates an objective ranking system:

1. **Accounts**: Groups of criteria identified by the interested parties (e.g., Cost Aspects)
2. **Sub-Accounts**: Specific details that provide desired information within a group of criteria (e.g., Capital Costs and O&M Costs)
3. **Weighting**: Weights assigned to Accounts and Sub-Accounts

The common set of interested-party-driven weights is grounded in consistent application. **Table 9** presents the weightings assigned to each Account, Sub-Account, and Indicator for the PERC Project Alternatives.

Table 9. MAA Weights Matrix

Account	Account Weight	Sub-Accounts	Sub-Account Weight	Indicator	Indicator Weight
Groundwater Recharge Benefits	**0.9**	Groundwater Recharge Benefit	0.5	Acre-Feet per Year (AFY)	1
		Infiltration Rate Capacity Increase	0.9	Net Increase in Infiltration Rate Capacity (cfs)	4
				Ease of Maintenance (FTE)	3
				Timeline to Implement (years)	5
		Firm Yield on 50-Year Horizon	1	AF over 50 years	5
Cost Aspects	**0.6**	Capital Cost	1	Capital Cost Net-Present Value (NPV)	5
				Grant or Outside Funding Sources (%)	3
		O&M Cost	0.5	O&M Costs (2025$)	2
Other Technical Aspects	**0.25**	Groundwater Quality Improvements	0.5	Annual Increase in Recharge from Project (MGD)	5
		Conservation and Habitat Benefits	0.3	Santa Ana River Contribution	5
				Habitat Restoration	2
				Species/Habitat Impacts	2
		Proximity to Groundwater Pressure Zone	0.7	Distance to Pressure Zone (yards)	5
		Access to SWP Supply	0.5	Direct, Indirect, or No Access	5

Account	Account Weight	Sub-Accounts	Sub-Account Weight	Indicator	Indicator Weight
		Groundwater Mounding	0.1	Rate Limiting Mounding *(Liquefaction Issue)*	2
Social Aspects	**0.1**	Project Job Creation	0.5	Number of Jobs Forecast for Construction (FTE/months)	2
				Number of Jobs Forecast from Operational Needs (FTE)	3
		Public Safety Hazards of Project	0.5	Ponded Water Depth (feet)	5
Legal Aspects	**0.25**	CEQA	0.7	CEQA Filing Type (e.g., NOE)	4
		Permits Required/ Requirements	0.7	USFWS Permit Requirements	2
				CDFW CESA 2081 Permit Requirements	4
				CDFW LSA /1600 Permit Requirement	2
				USACE/RWQCB 401 Permit Requirement	3
				USACE 404 Permit Requirement	3
				USACE 408 Permit Requirement	4
				CA DSOD Jurisdictional Dam	4
				SBCFCD	3
		Land Availability	0.5	Property Ownership by Partner Agencies (Y/N)	3

Account	Account Weight	Sub-Accounts	Sub-Account Weight	Indicator	Indicator Weight
		Water Rights	0.1	Support for water rights not yet Licensed	5

3 Indicator Scoring

Evaluating project characteristics and scoring Alternatives based on their feasibility study findings is the core of the MAA methodology. Indicators are the objective scoring values that reference a common ratings scale within each Sub-Account. The range of values for any given Indicator (e.g., Capital Cost) are assigned values from +7 (best in class) to 1 (worst performance). This, shown in **Table 10**, enables vastly different project criteria to be brought together into the MAA.

Table 10. Indicator Scores and Relative Project Performance

Indicator Scoring	Relative Project Performance
+7	Best in Class
+6	Good
+5	Above Average
4	Average
3	Worse than Average
2	Poor Performance
1	Worst Performance

Note that scores are relative within <u>one Indicator</u>. A "Worst Performance" score (1) does not mean that a project is not worthwhile. It means that the project, when compared to others, has the least merit for that single Indicator. For example, the Alternative with the most difficult CEQA permitting process (i.e., rigorous and complete draft to final EIR) would be assigned Worst Performance (1), while an Alternative that is categorically Exempt would be assigned Best in Class (7). Similarly, the costliest project would have the Worst Performance (1) rating for Capital Costs. This method of common scoring values for all Indicators allows for numerical comparison among irregular project aspects. Dissimilar components, such as infiltration-rate (cfs) and CEQA permitting level-of-effort, can be scored and weighted with a uniform process to all the PERC Alternatives.

For each Alternative, the Indicator values for each aspect of each Sub-Account result in Sub-Account score results. The Sub-Account and Account weights then produce an overall score for the Alternative, as well as individual Account scores. The Alternative with the highest overall score may be considered the highest priority project. There may also be prioritization based upon individual scores (such as the length of time necessary to increase recharge capacity) among projects with similar overall scores.

PERC Alternatives Feasibility

A total of ten PERC Alternatives at six Sites were evaluated for the *PERC Comprehensive Feasibility Study*. Three watersheds supply native water to the sites and associated PERC Alternatives, as shown in **Table 11.** A map of the final PERC Alternative locations was provided as Figure 1.

Table 11. PERC Watersheds, Sites, and Alternatives

Watershed	Site	PERC Alternative
East Twin Creek Watershed	Waterman Recharge Basins	Waterman Grading Alternative
	Twin Creek Recharge Basins (TCRB)	TCRB Small Grading Alternative
		TCRB Large Grading Alternative
	Lynwood Recharge Basins	Lynwood Operational Alternative
Plunge Creek Watershed	Oak Creek Recharge Basins (OCRB)	OCRB Construction Alternative
	Plunge Creek Recharge Basins (PCRB)	PCRB Interim Construction Alternative
		PCRB Ultimate Construction Alternative
Mill Creek Watershed	Mill Creek Recharge Basins (MCRB)	MCRB Grading Alternative 1
		MCRB Grading Alternative 2
		MCRB Grading Alternative 3

This section provides a brief overview of each Alternative with the Indicator values used for MAA calculation.

1 East Twin Creek Watershed Alternatives

East Twin Creek Watershed is a source of water for three groundwater recharge locations: Waterman, Twin Creek, and Lynwood Recharge Basins. SBVWCD developed four PERC Project Alternatives to potentially expand recharge at the existing sites:

- Waterman Grading Alternative
- TCRB Small Grading Alternative
- TCRB Large Grading Alternative
- Lynwood Operational Alternative

Volume 2 of the *PERC Comprehensive Feasibility Study* includes Detailed Feasibility Analyses for each above-listed Alternatives.

PERC Cooperation and Joint Implementation

The East Twin Creek PERC Alternatives were developed with the understanding that SBCFCD's Operations and Maintenance Manual (Tetra Tech, 2014) requires peak stormflows to be bypassed for flood safety reasons. The Alternatives were reviewed with SBCFCD during technical studies supporting the PERC Comprehensive Feasibility Study from March 2022 to March 2025. The development process was supported by several cooperative agreements:

- Planning Memorandum of Understanding (MOU) between SBCFCD and SBVWCD entered February 9, 2021.
- San Bernardino County Board of Supervisors Resolution dated April 26, 2022 supported SBVWCD joint use of SBCFCD facilities for water conservation and groundwater recharge that is consistent with flood control operations and safety objectives.
- Contract No. 23-580, "Joint Groundwater Recharge and Facilities Planning Agreement," for SBVMWD and SBCFCD approved by the San Bernardino County Board of Supervisors on June 13, 2023:
  - Directed joint use of existing flood control facilities for engineered recharge by SBVMWD where it is compatible with safety objectives.
  - Established a Joint Implementation Committee between SBVMWD and SBCFCD with representatives of additional partner agencies.

SBVWCD participated in meetings of the Joint Implementation Committee which served as a forum for all partners to discuss PERC Project Alternatives.

1.1 Waterman Grading Alternative

The **Waterman Grading Alternative** includes structural improvement of the existing Waterman Creek Diversion Channel (WCDC) at the entrance of the Waterman Recharge Basins and grading improvement of internal basins to promote groundwater recharge. The general project layout is shown in **Figure 4**.

A summary of the proposed modifications is provided below. Preliminary design details, including plan and profile views, are provided with the detailed analyses in Volume 2.

1. **Replace Channel Gates:** Remove/replace radial gates as specified.
2. **Install Diversion Control:** Split inflow with a concrete wall between the radial gates. Regrade the land on either side to create a flow path away from each gate.
3. **Regrade Basin Areas:** Regrade existing basins to consolidate to 8 basins from the current 13.
4. **Control East to West Movement of Water:** Build piped interties east-west in the subsurface. Outfit with slide gates for operational isolation to drain and clean basins.
5. **Control Water Level:** Control movement of water between grade levels via concrete drop inlets with piped outlets to the next level down, enabling operation of deeper and larger basins.

No modifications are proposed for the FEMA-certified levees. The Waterman Grading Alternative indicator values are provided in **Table 12**.

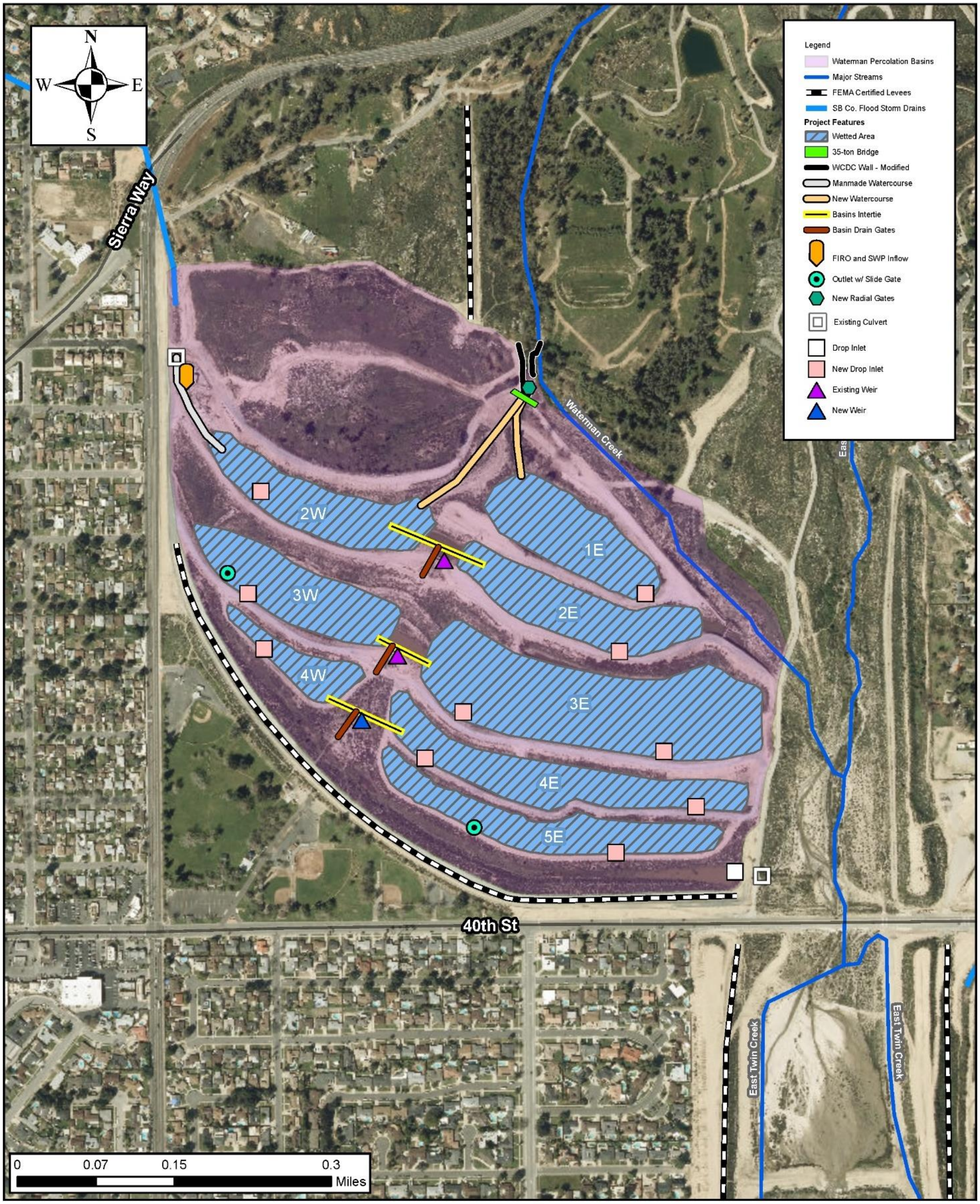

Figure 4. Waterman Recharge Basins Grading Alternative Design

Table 12. Waterman Grading Alternative Indicator Values

Waterman Grading Alternative			
Account	**Subaccounts**	**Indicators**	**Waterman Grading Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	Net AFY	2,171
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	83.89
		Ease of Maintenance (FTE)	0.10
		Timeline to Implement (years)	7.50
	Recharge benefit on a “firm yield” 50-year horizon	AF	92,264
Cost Aspects	Capital Costs	Capital Costs NPV	$21,886,000
		Grant Sources	0%
	O&M	O&M in 2025 $	$95,885
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	2.5
	Conservation and Habitat Benefits	Santa Ana River Contribution	2.90
		Habitat Restoration	0.00
		Species/ Habitat Impacts	0.00
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	7,050
	Access to SWP Supply	Direct, Indirect, or No Access	Direct
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	No
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	70.0
		Number of Jobs Forecast for Operational Needs	0.00
	Public Safety Hazards of Project	Ponded Water Depth (ft)	18.0

Waterman Grading Alternative			
Account	**Subaccounts**	**Indicators**	**Waterman Grading Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type (e.g. NOE)	IS-MND1
	Permits Required/ Requirements	USFWS Permit Requirements	River-HCP
		CDFW CESA 2081 Permit	River-HCP
		CDFW LSA 1600 Permit	River-HCP
		USACE/RWQCB 401 Permit	River-HCP
		USACE 404 Permit	Typical
		USACE 408 Permit	Typical
		DSOD Jurisdictional Dam	Typical
		City of San Bernardino Consent Decree Area Permit	Typical
		SBCFCD	Major
	Land Availability	Property Ownership by Partner Agencies (Y/N)	N
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	83.89

1.2 TCRB Small Grading Alternative

The TCRB Small Grading Alternative is a proposed modification within the existing TCRB footprint aimed at increasing engineered groundwater recharge from East Twin Creek flows. The project focuses on leveraging and restoring existing infrastructure without modifying surrounding USACE flood-control features (i.e., flood levees and associated gates). The general project layout is shown in **Figure 5**.

The Small Grading Alternative involves regrading Hold 2 and repairing Berm 2, removing a non-functional low-flow culvert, and reinforcing the flow diffuser at Berm 1. The revised grades are designed to promote more effective water impoundment and sediment movement to maintain infiltration capacity. The TCRB Small Grading Alternative indicator values are provided in **Table 13**.

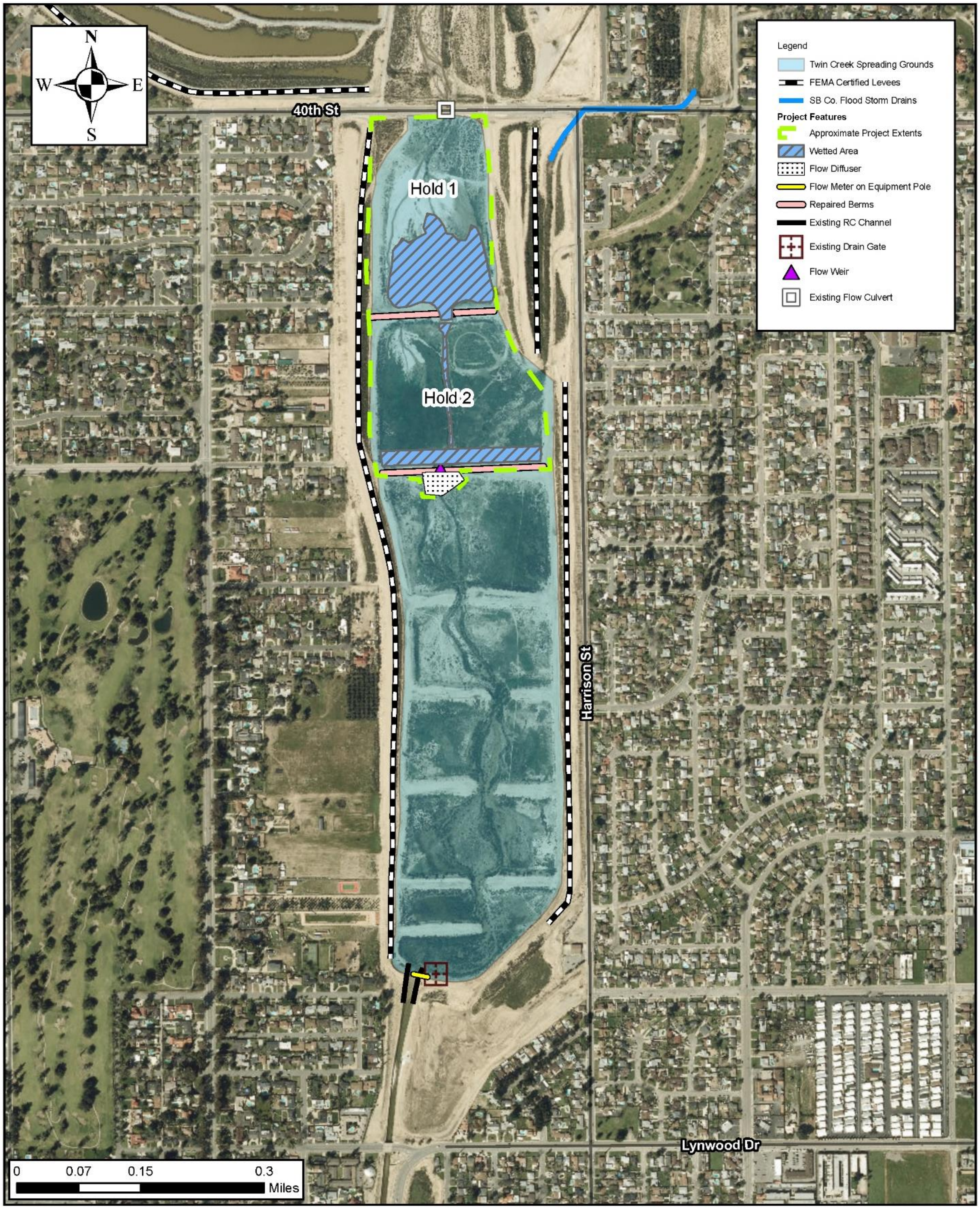

Figure 5. TCRB Small Grading Alternative Overview

Table 13. TCRB Small Grading Alternative Indicator Values

TCRB Small Grading Alternative			
Account	**Subaccounts**	**Indicators**	**TCRB Small Grading Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	480
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	12.55
		Ease of Maintenance (FTE)	0.05
		Timeline to Implement (years)	5.40
	Recharge benefit on a "firm yield" 50-year horizon	AF	22,405
Cost Aspects	Capital Costs	Capital Costs NPV	$10,822,000
		Grant Sources	0%
	O&M	O&M in 2025 $	$29,048
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	0.7
	Conservation and Habitat Benefits	Santa Ana River Contribution	0.50
		Habitat Restoration	0.00
		Species/ Habitat Impacts	0.00
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	6,270
	Access to State Water Project Supply	Direct, Indirect or No Access	Indirect
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	No
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	40.0
		Number of Jobs Forecast from Operational Needs	0.04
	Public Safety Hazards of Project	Ponded Water Depth (ft)	2.5

TCRB Small Grading Alternative			
Account	**Subaccounts**	**Indicators**	**TCRB Small Grading Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type (e.g. NOE)	Categorical
	Permits Required/ Requirements	USFWS Permit Requirements	River-HCP
		CDFW CESA (2081) Permit Requirements	River-HCP
		CDFW LSA /1600 Permit Requirement	River-HCP
		USACE/RWQCB 401 Permit Required	River-HCP
		USACE 404 Permit Required	Typical
		USACE 408 Permit Required	Time-Consuming
		CA DOSD Jurisdictional Dam	None-Required
		City of San Bernardino Consent Decree Area Permit	None-Required
		SBCFCD	Major
	Land Availability	Property Ownership by Partner Agencies (Y/N)	N
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	12.55

1.3 TCRB Large Grading Alternative

The TCRB Large Grading Alternative revises the grade lines and base elevations within the Flood-Leveed area for East Twin Creek to enhance groundwater recharge. The proposed design focuses on creating sheet flow into and across water Holds, improving infiltration-rate capacity, with self-maintenance of that infiltration-rate capacity without the need for routine sediment removal. The general project layout is shown in **Figure 6**.

The smoothly graded design of the TCRB Large Grading Alternative is intended to ***eliminate the need for routine basin cleanout*** as the Holds would be self-cleaning to maintain recharge capacity. Basin cleaning is currently an expensive, time-consuming, chronic challenge for SBCFCD in the TCRB. They are running out of places to put the sediments requiring removal. The TCRB Large Grading Alternative indicator values are provided in **Table 14**.

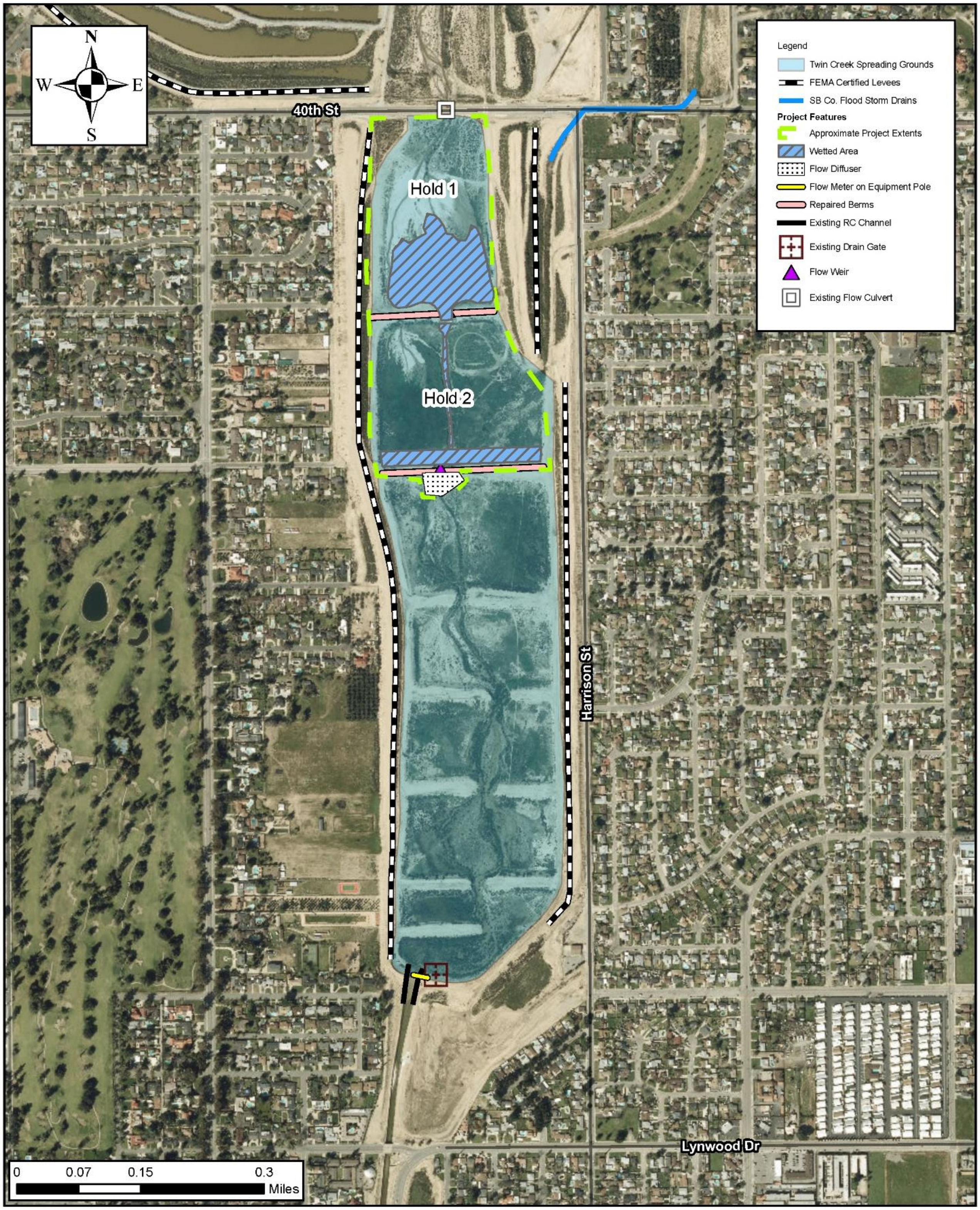

Figure 6. TCRB Large Grading Alternative Overview

Table 14. TCRB Large Grading Alternative Indicator Values

TCRB Large Grading Alternative			
Account	**Subaccounts**	**Indicators**	**TCRB Large Grading Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	1,900
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	54.53
		Ease of Maintenance (FTE)	0.05
		Timeline to Implement (years)	16.30
	Recharge benefit on a “firm yield” 50-year horizon	AF	67,914
Cost Aspects	Capital Costs	Capital Costs NPV	$57,834,000
		Grant Sources	0%
	O&M	O&M in 2025 $	$27,621
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	1.9
	Conservation and Habitat Benefits	Santa Ana River Contribution	2.10
		Habitat Restoration	0.00
		Species/ Habitat Impacts	0.00
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	5,150
	Access to State Water Project Supply	Direct, Indirect or No Access	Indirect
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	No
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	190.0
		Number of Jobs Forecast from Operational Needs	0.03
	Public Safety Hazards of Project	Ponded Water Depth (ft)	3

TCRB Large Grading Alternative			
Account	**Subaccounts**	**Indicators**	**TCRB Large Grading Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type	EIR
	Permits Required/ Requirements	USFWS Permit	River-HCP
		CDFW CESA 2081 Permit	River-HCP
		CDFW LSA /1600 Permit	River-HCP
		USACE/RWQCB 401 Permit	River-HCP
		USACE 404 Permit	Typical
		USACE 408 Permit	Very-Time-Consuming
		DSOD Jurisdictional Dam	None-Required
		City of San Bernardino Consent Decree Area Permit	None-Required
		SBCFCD	Barriers
	Land Availability	Property Ownership by Partner Agencies (Y/N)	N
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	54.53

1.4 Lynwood Operational Alternative

The **Lynwood Operational Alternative** modifies existing facilities owned and operated by SBCFCD to automate control of storm water detention and release and increase the amount of recharge from the East Twin Creek watershed. A secondary objective is to enable evaluation of whether engineered groundwater recharge closer to the Pressure Zone can slow or stop the decline in the groundwater level within the Pressure Zone. The general project layout is shown in **Figure 7**.

Two grading modifications are required for the Lynwood Operational Alternative:

1. **Grade above the East Twin Creek flood levee drain-gate:** Drain gate operation requires excavation and grading of the surrounding area to the base of the gate's structural wing walls. Redeposition of sediment in front of the drain gate from peak stormflow events will likely require routine excavation to maintain gate function.

2. **Raise the invert elevation of the drop inlets at Basin Nos. 2 and 3:** The existing wing walls would be raised 2.4 feet to match the invert elevation of the backwall and front-wall. New concrete would be integrated to create a taller trapezoidal drop inlet. During design development, these proposed invert elevations for the wingwalls to match the existing front-wall and backwall were found to maintain freeboard of 3-feet or more from current top of berm in each basin. This meets typical water hold berm design and operation general requirements. Thus, no regrading of the berm heights was found to be necessary during conceptual design development for the alternative.

The Lynwood Operational Alternative indicator values are provided in **Table 15**.

Figure 7. Lynwood Operational Alternative Overview

Table 15. Lynwood Operational Alternative Indicator Values

Lynwood Operational Alternative			
Account	**Subaccounts**	**Indicators**	**Lynwood Operational Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge Benefit	AFY	687
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	23.42
		Ease of Maintenance (FTE)	0.15
		Timeline to Implement (years)	1.25
	Recharge benefit on a “firm yield” 50-year horizon	AF	33,847
Cost Aspects	Capital Costs	Capital Costs NPV	$2,303,000
		Grant Sources	0%
	O&M	O&M in 2025 $	$47,453
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge	687.27
	Conservation and Habitat Benefits	Santa Ana River Contribution	0.85
		Habitat Restoration	0.00
		Species/Habitat Impacts	0.00
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	4,100
	Access to State Water Project Supply	Direct, Indirect, or No Access	Indirect
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	Yes
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	10.0
		Number of Jobs Forecast from Operational Needs	0.17
	Public Safety Hazards of Project	Ponded Water Depth (ft)	10.0

Lynwood Operational Alternative			
Account	**Subaccounts**	**Indicators**	**Lynwood Operational Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type	Categorical
	Permits Required/ Requirements	USFWS Permit	River-HCP
		CDFW CESA 2081 Permit	River-HCP
		CDFW LSA /1600 Permit	River-HCP
		USACE/RWQCB 401 Permit	River-HCP
		USACE 404 Permit	Typical
		USACE 408 Permit	Typical
		DSOD Jurisdictional Dam	None-Required
		City of San Bernardino Consent Decree Area Permit	None-Required
		SBCFCD	Major
	Land Availability	Property Ownership by Partner Agencies (Y/N)	N
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	23.42

2 Plunge Creek Watershed Alternatives

Plunge Creek Watershed is a large and productive watershed that historically has not been used for engineered recharge. As a part of PERC planning, San Bernardino Valley Water Conservation District (SBVWCD) assessed existing concepts previously developed in the region for potential recharge of native water flows (Scheevel, 2016). As a result, SBVWCD designed and constructed the Plunge Creek Conservation Project in September 2020 to spread water using "soft engineering" techniques to direct water into the historic high-flow braided channels of Plunge Creek at low flows to generate habitat benefits and to "sink" more water in the Upper Santa Ana River Wash. The PERC Comprehensive Feasibility Study expands the potential for groundwater recharge by evaluating sites both upstream (Oak Creek) and downstream (Plunge Creek at Orange Street) of the Plunge Creek Conservation Project.

Plunge Creek

There are three sub-watersheds above the Oak Creek and Plunge Creek PERC Alternative Sites, including:

- Elder Creek Sub-Watershed
- Plunge Creek Sub-Watershed
- Oak Creek Sub-Watershed

The Sub-Watersheds and Plunge Creek Watershed Alternatives are shown on **Figure 8**. Volume 3 of the *PERC Comprehensive Feasibility Study* includes Detailed Feasibility Analyses for each of the Plunge Creek Watershed Alternatives.

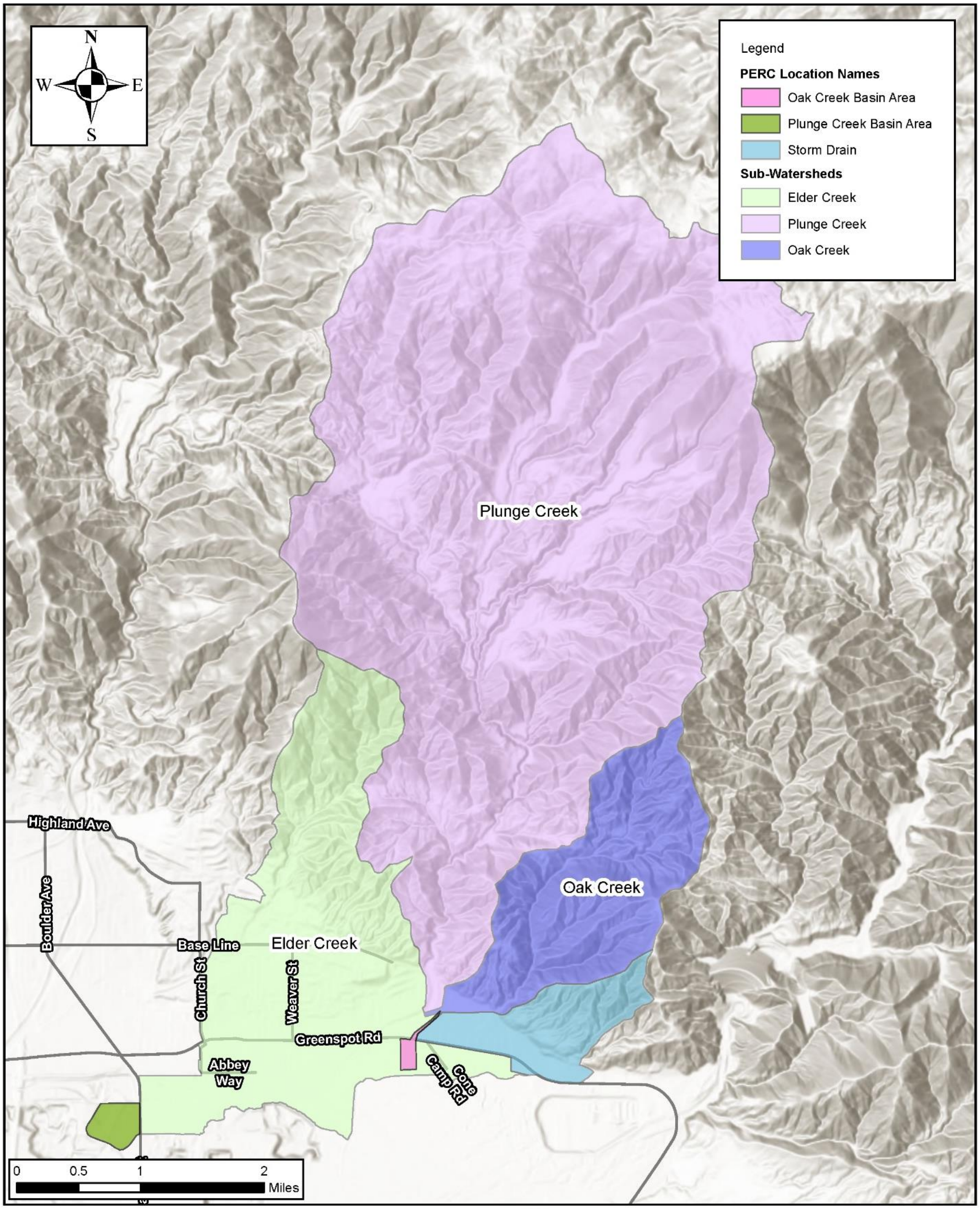

Figure 8. Watershed Areas above proposed PERC Project Sites at Oak Creek and Plunge Creek

2.1 OCRB Construction Alternative

The **OCRB Construction Alternative** would create a *new location* for engineered recharge in the Upper Santa Ana River's eastern tributaries. The project site is situated on lands upslope of lower Plunge Creek below Greenspot Road, allowing excess surface water that overflows and exits the new basins to flow downslope into the existing Plunge Creek Conservation Project downstream. The water-spreading action from this project creates the added benefit of improved habitat.

The proposed OCRB Construction Alternative design consists of the following:

- Two recharge basins in series (Basin 1 and Basin 2)
- Diversion from Oak Creek Channel
- Diversions from two existing storm drains in Greenspot Road
- Turnout from Foothill Pipeline (for FIRO flows, if available)

The Oak Creek and Storm Drain diversion lines would be combined in a vault with a single outfall line to Basin 1. The single outfall line would include a sensor for flow measurement. When overtopping, flow from Basin 1 will cross a spillway into Basin 2. The proposed OCRB Construction Alternative also includes a turnout from the existing 78" water transmission line (FIRO diversion), should FIRO become an available water source for recharge.

The general project layout is shown in **Figure 9**. The OCRB Construction Alternative indicator values are provided in **Table 16**.

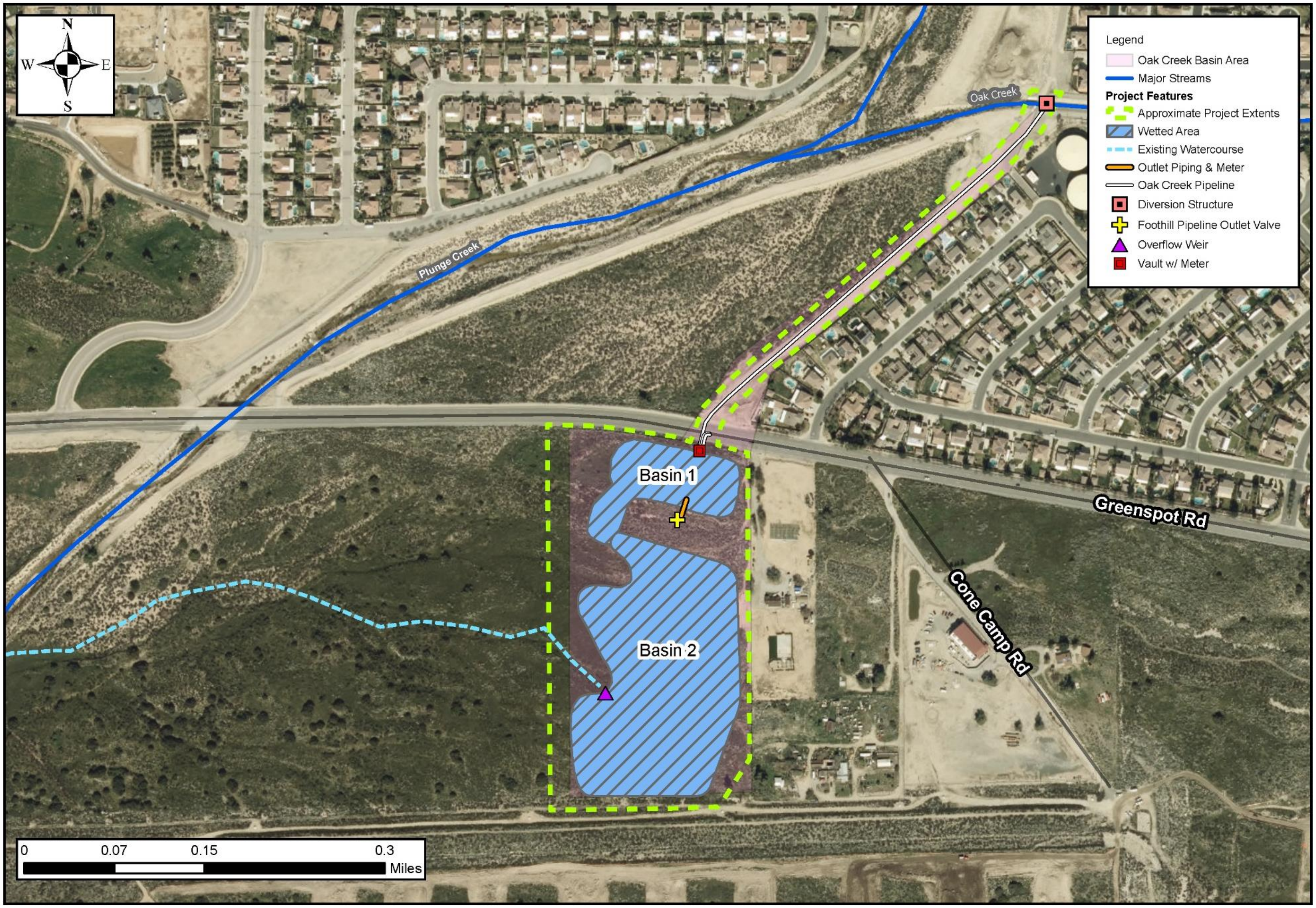

Figure 9. OCRB Construction Alternative Overview

Table 16. OCRB Construction Alternative MAA Indicator Values

OCRB Construction Alternative			
Account	**Subaccounts**	**Indicators**	**OCRB Construction Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	1,020
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	23.3
		Ease of Maintenance (FTE)	0.07
		Timeline to Implement (years)	3.5
	Recharge benefit on a “firm yield” 50-year horizon	AF	54,242
Cost Aspects	Capital Costs	Capital Costs NPV	$18,446,000
		Grant Sources	25%
	O&M	O&M in 2025 $	$83,077
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	1.04
	Conservation and Habitat Benefits	Santa Ana River Contribution	0.9
		Habitat Restoration	32
		Species/ Habitat Impacts	27.0
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	13,500
	Access to SWP Supply	Direct, Indirect, or No Access	Direct
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	No
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	60
		Number of Jobs Forecast for Operational Needs	0.23
	Public Safety Hazards of Project	Ponded Water Depth (ft)	14.0

OCRB Construction Alternative			
Account	**Subaccounts**	**Indicators**	**OCRB Construction Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type	EIR
	Permits Required/ Requirements	USFWS Permit	River-HCP
		CDFW CESA 2081 Permit	River-HCP
		CDFW LSA 1600 Permit	River-HCP
		USACE/RWQCB 401 Permit	River-HCP
		USACE 404 Permit	Standing Permit
		USACE 408 Permit	None-Required
		DSOD Jurisdictional Dam	None-Required
		City of San Bernardino Consent Decree Area Permit	None-Required
		SBCFCD	None-Required
	Land Availability	Property Ownership by Partner Agencies (Y/N)	Y
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	23.3

2.2 PCRB Interim Construction Alternative

The Plunge Creek Recharge Basins (PCRB) Interim Construction Alternative consists of three recharge basins, a diversion from Plunge Creek, and a storm drain system to convey diverted runoff to the proposed basins. It is designed to be implemented in the *near-term* and its benefits will be realized sooner than most other PERC Alternatives. The general project layout is shown in **Figure 10**.

The PCRB Interim Construction Alternative consists of three recharge basins, a diversion from Plunge Creek, and a storm drain system to convey diverted runoff to the proposed basins. Two diversion alternatives are being considered – a pneumatically operated gate, or a grated drop structure. The PCRB Interim Construction Alternative indicator values are provided in **Table 17**.

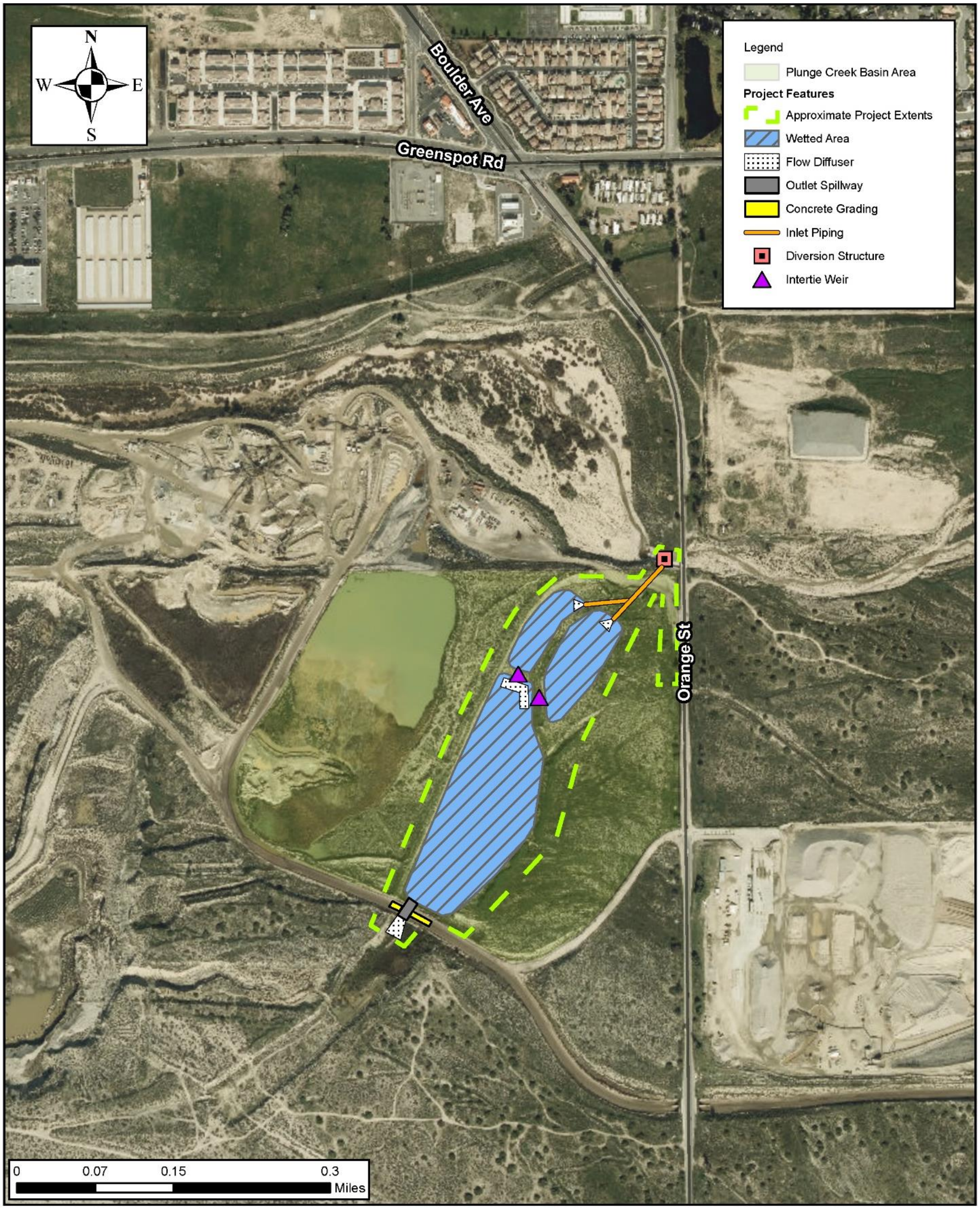

Figure 10. PCRB Interim Construction Alternative Overview

Table 17. PCRB Interim Construction Alternative Indicator Values

PCRB Interim Construction Alternative			
Account	**Subaccounts**	**Indicators**	**PCRB Interim Construction Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	1,790
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	23.50
		Ease of Maintenance (FTE)	0.10
		Timeline to Implement (years)	2.5
	Recharge benefit on a “firm yield” 50-year horizon	AF	40,874
Cost Aspects	Capital Costs	Capital Costs NPV	$16,393,000
		Grant Sources	25%
	O&M	O&M in 2025 $	$67,437
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	1.6
	Conservation and Habitat Benefits	Santa Ana River Contribution (cfs)	0
		Habitat Restoration (acres)	8
		Species/ Habitat Impacts (acres)	4
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	7,950
	Access to State Water Project Supply	Direct, Indirect or No Access	No Access
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	Yes
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	50
		Number of Jobs Forecast from Operational Needs	0.21
	Public Safety Hazards of Project	Ponded Water Depth (ft)	14

PCRB Interim Construction Alternative			
Account	**Subaccounts**	**Indicators**	**PCRB Interim Construction Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type	IS-MND2
	Permits Required/ Requirements	USFWS Permit	River HCP & Wash Plan
		CDFW CESA (2081) Permit	River HCP & Wash Plan
		CDFW LSA /1600 Permit	River HCP
		USACE/RWQCB 401 Permit	River HCP
		USACE 404 Permit	Yes
		USACE 408 Permit	None
		DSOD Jurisdictional Dam	Yes
		City of San Bernardino Consent Decree Area Permit	None
		SBCFCD	Yes
	Land Availability	Property Ownership by Partner Agencies (Y/N)	Yes
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	23.5

2.3 PC Ultimate Construction Alternative

The PCRB Ultimate Construction Alternative consists of one large basin, a diversion from Plunge Creek, and a storm drain system to convey diverted runoff to the proposed basin. It is designed to be implemented in the *distant future*, after mining operations are assumed to have excavated the proposed basin area. The general project layout is shown in **Figure 11**.

The PCRB Ultimate Construction Alternative consists of one large basin, a diversion from Plunge Creek, and a storm drain system to convey diverted runoff to the proposed basin. Like the Interim Alternative, two diversion alternatives are being considered for the Ultimate Alternative: a pneumatically operated gate, or a grated drop structure. The PCRB Ultimate Construction Alternative indicator values are provided in **Table 18**.

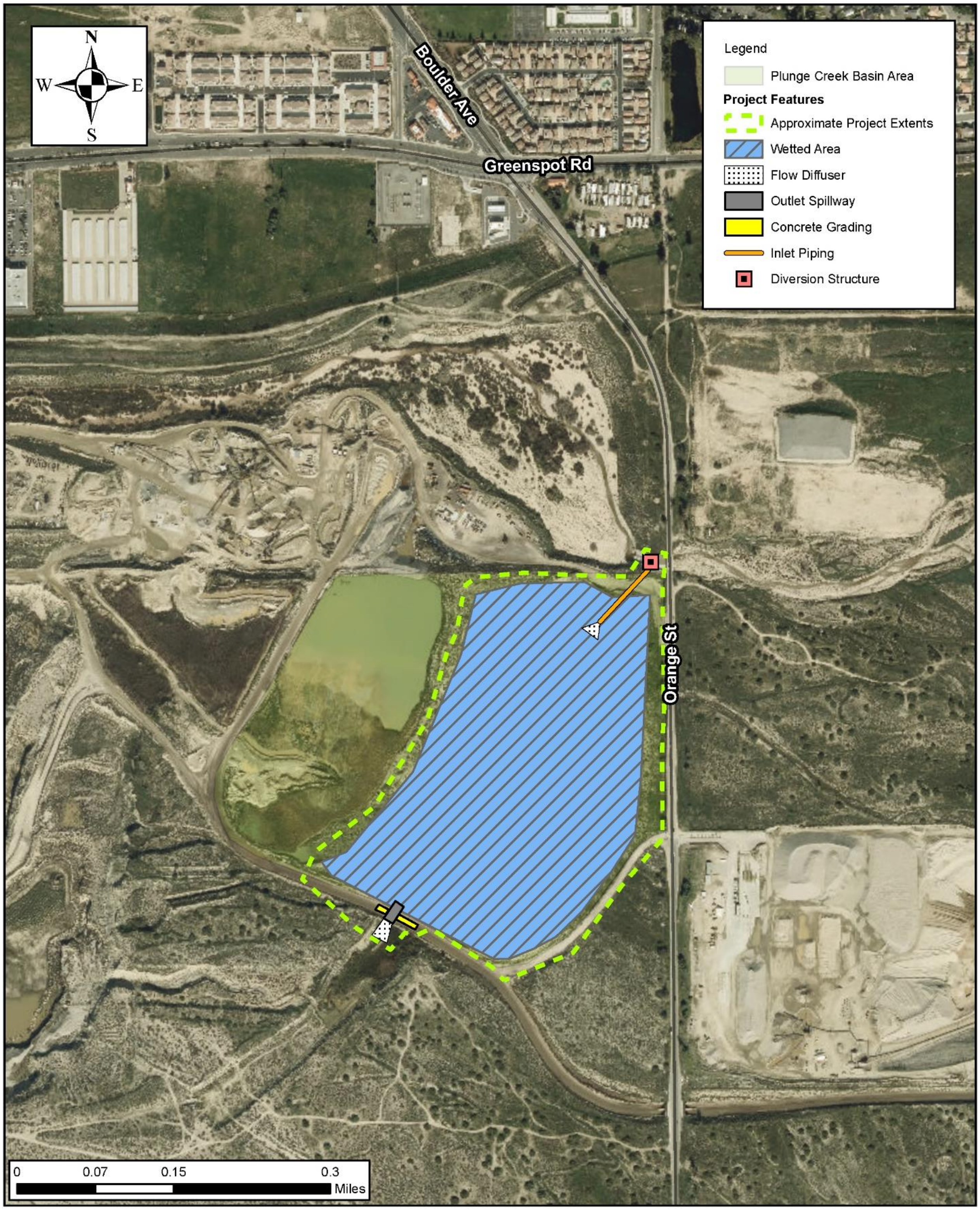

Figure 11. PCRB Ultimate Construction Alternative Overview

Table 18. PCRB Ultimate Construction Alternative Indicator Values

PCRB Ultimate Construction Alternative			
Account	**Subaccounts**	**Indicators**	**PCRB Ultimate Construction Alternative Values**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	3,656
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	80.00
		Ease of Maintenance (FTE)	0.20
		Timeline to Implement (years)	38.5
	Recharge benefit on a “firm yield” 50-year horizon	AF	49,351
Cost Aspects	Capital Costs	Capital Costs NPV	$8,170,000
		Grant Sources	25%
	O&M	O&M in 2025 $	$120,319
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	3.3
	Conservation and Habitat Benefits	Santa Ana River Contribution (cfs)	0
		Habitat Restoration (acres)	43
		Species/ Habitat Impacts (acres)	13
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	7,800
	Access to State Water Project Supply	Direct, Indirect or No Access	No Access
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	Yes
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	30
		Number of Jobs Forecast from Operational Needs	0.28
	Public Safety Hazards of Project	Ponded Water Depth (ft)	80

PCRB Ultimate Construction Alternative			
Account	**Subaccounts**	**Indicators**	**PCRB Ultimate Construction Alternative Values**
Legal Aspects	CEQA	CEQA Filing Type	IS-MND1
	Permits Required/ Requirements	USFWS Permit	River HCP & Wash Plan
		CDFW CESA (2081) Permit	River HCP & Wash Plan
		CDFW LSA /1600 Permit	River HCP
		USACE/RWQCB 401 Permit	River HCP
		USACE 404 Permit	Yes
		USACE 408 Permit	None
		DSOD Jurisdictional Dam	Yes
		City of San Bernardino Consent Decree Area Permit	None
		SBCFCD	Yes
	Land Availability	Property Ownership by Partner Agencies (Y/N)	Yes
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	80

3 Mill Creek Watershed Alternatives

Mill Creek, in San Bernardino County, is a 17.8-mile-long stream that is a major tributary of the Santa Ana River. It originates in the San Bernardino Mountains and flows towards its confluence with the Santa Ana River, which is located just downstream of the upper Santa Ana Canyon mouth and SBVWCD's Mill Creek Recharge Basins (MCRB). **Figure 12** depicts the Mill Creek Watershed and its geography relative to the MCRB facilities.

There are three PERC Project Alternatives for the MCRB, known as Grading Alternatives 1, 2, and 3. All Alternatives propose improvements to the existing basins, addition of new basins, and construction of a bypass channel for maintenance.

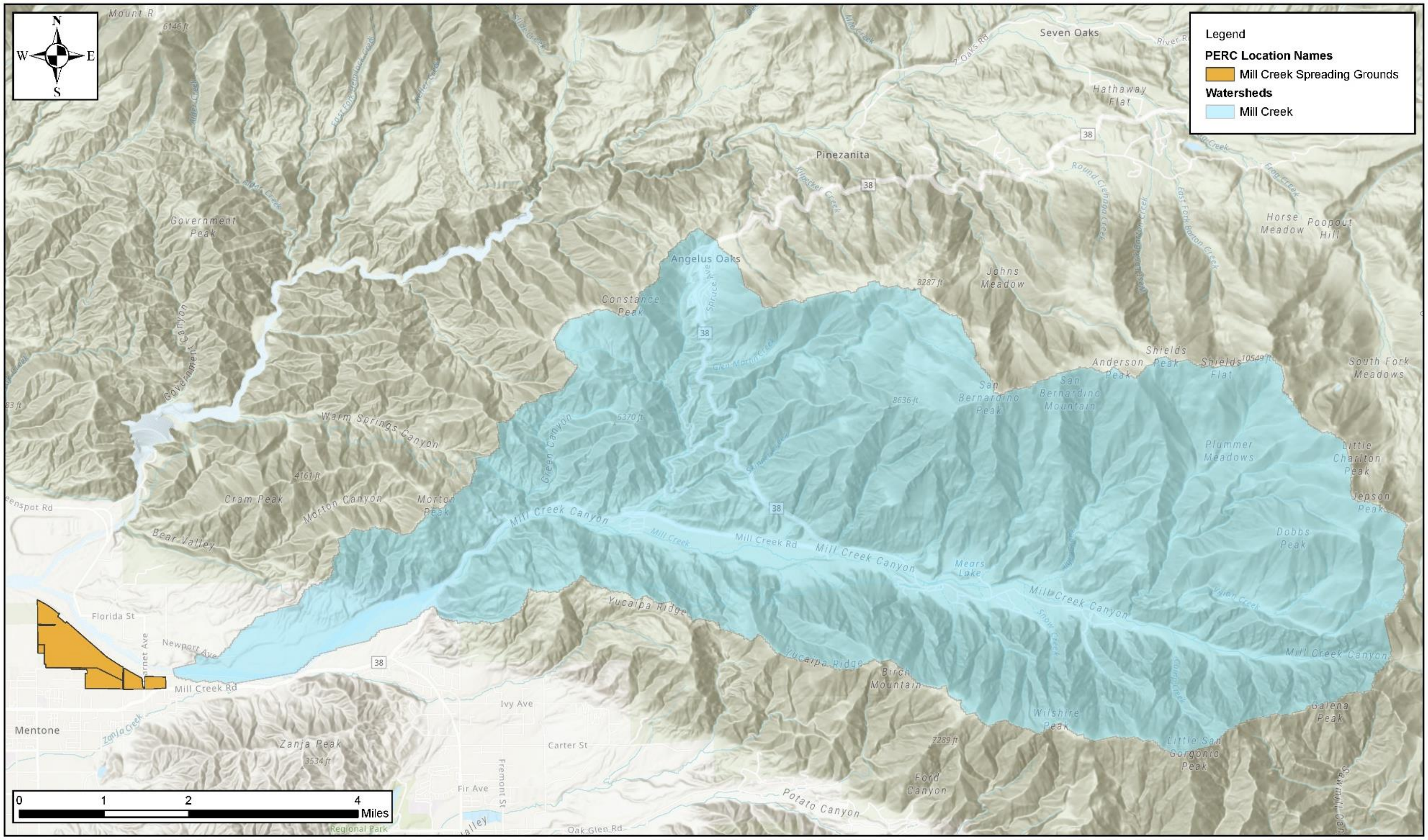

Figure 12. Mill Creek Watershed and MCRB

3.1 MCRB Grading Alternative 1

The existing Mill Creek recharge facilities include 60 retention basins. Additional locations also retain water during large overflow events but are not considered part of the typical operations. The current system has three main flow inlet locations: South Intake (Mill Creek), North Intake (Mill Creek), and the Redlands Aqueduct.

MCRB Grading Alternative 1 includes improvements to 29 existing basins and the addition of 3 new basins. Many of the existing smaller basins are proposed to be combined and regraded into larger basins. A summary of these modifications is provided in **Table 19** below.

Table 19. MCRB Grading Alternative 1 Modification Summary

Modification	Basin Numbers
Increase Volume	1, 2, 3, 4, 6s, 7, 8, 9, 10, 11, 13, 14w, 15w, 16n, 16s, 18, 22, 23, 24, 29, 34, 35
Combine and Increase Volume	36-37, 38-40, 42-43, 44-45, 46-47, 50-51, 52-53
New Basins	1a, 1b, 1c

Figure 13 shows the proposed improvements for Alternative 1. This figure also shows the locations for diversion structures, the South Canal and its proposed connections to various basins, and improved basin outlet structures. It is anticipated that 45 new inlet structures, 8 sluice gates, and 6 diversion gates will be constructed as part of Alternative 1.

3.2 MCRB Grading Alternative 2

Alternative 2 includes all the improvements of Alternative 1 (Table 3) in addition to three new basins (24e, 41, 41s), and two additional modifications to existing basins (29, 31).

Figure 14 shows the proposed improvements for Alternative 2. Improvements that are not included in Alternative 1 are highlighted in orange. It is anticipated that 49 new inlet structures, 8 sluice gates, and 6 diversion gates will be constructed as part of Alternative 2.

3.3 MCRB Grading Alternative 3

Alternative 3 includes all the improvements of Alternative 2 in addition to four new basins (SW1, SW2, SW3, SW4). **Figure 15** shows the proposed improvements for Alternative 3. Improvements that were not included in Alternatives 1 or 2 are highlighted in orange. It is anticipated that 56 new inlet structures, 8 sluice gates, and 6 diversion gates will be constructed as part of Alternative 3.

Figures 14, 15, and 16 are simplified overviews of the conceptual-level Alternatives. More detailed plans are included in Volume 4.

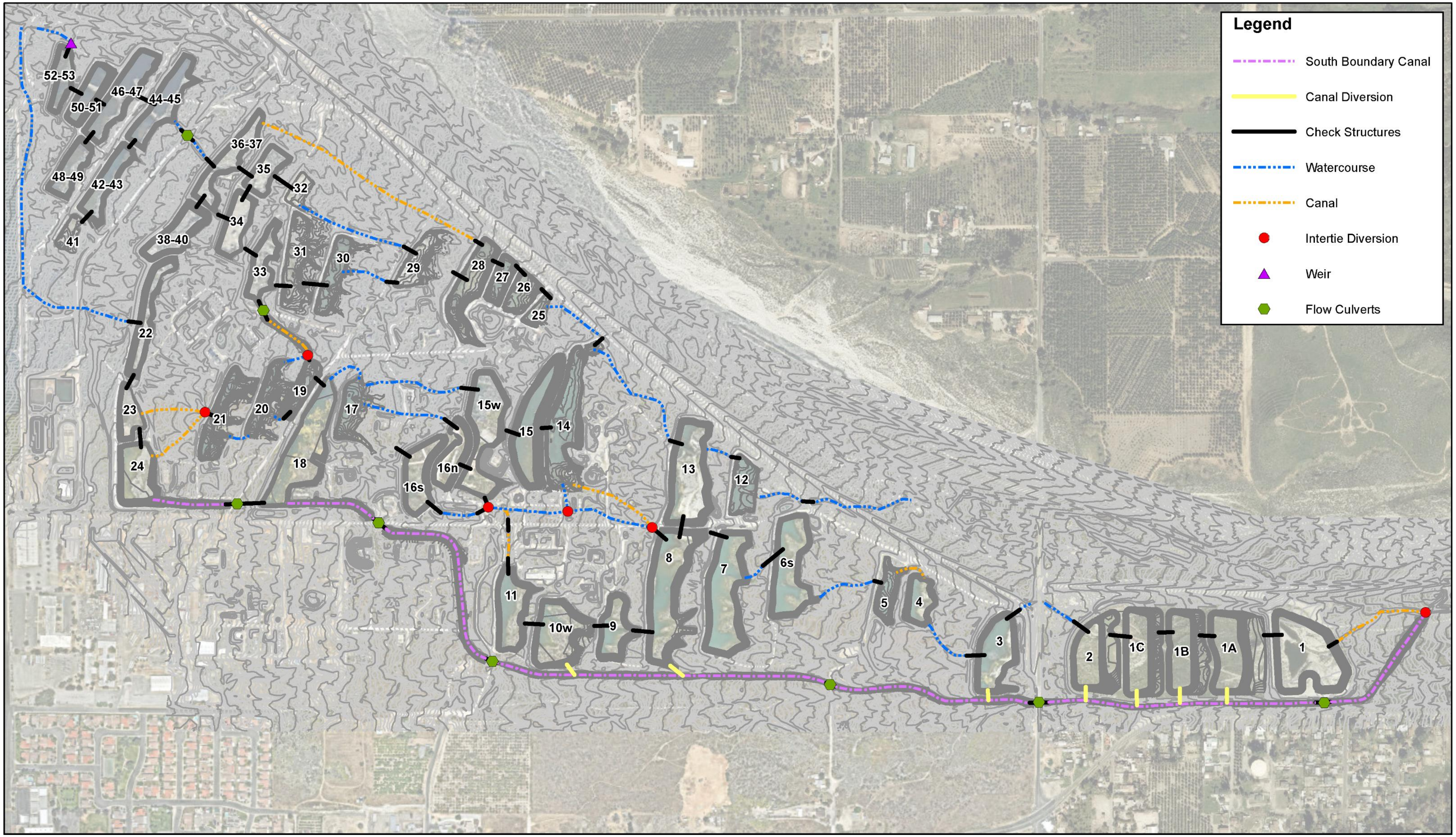

Figure 13. MCRB Grading Alternative 1 Overview

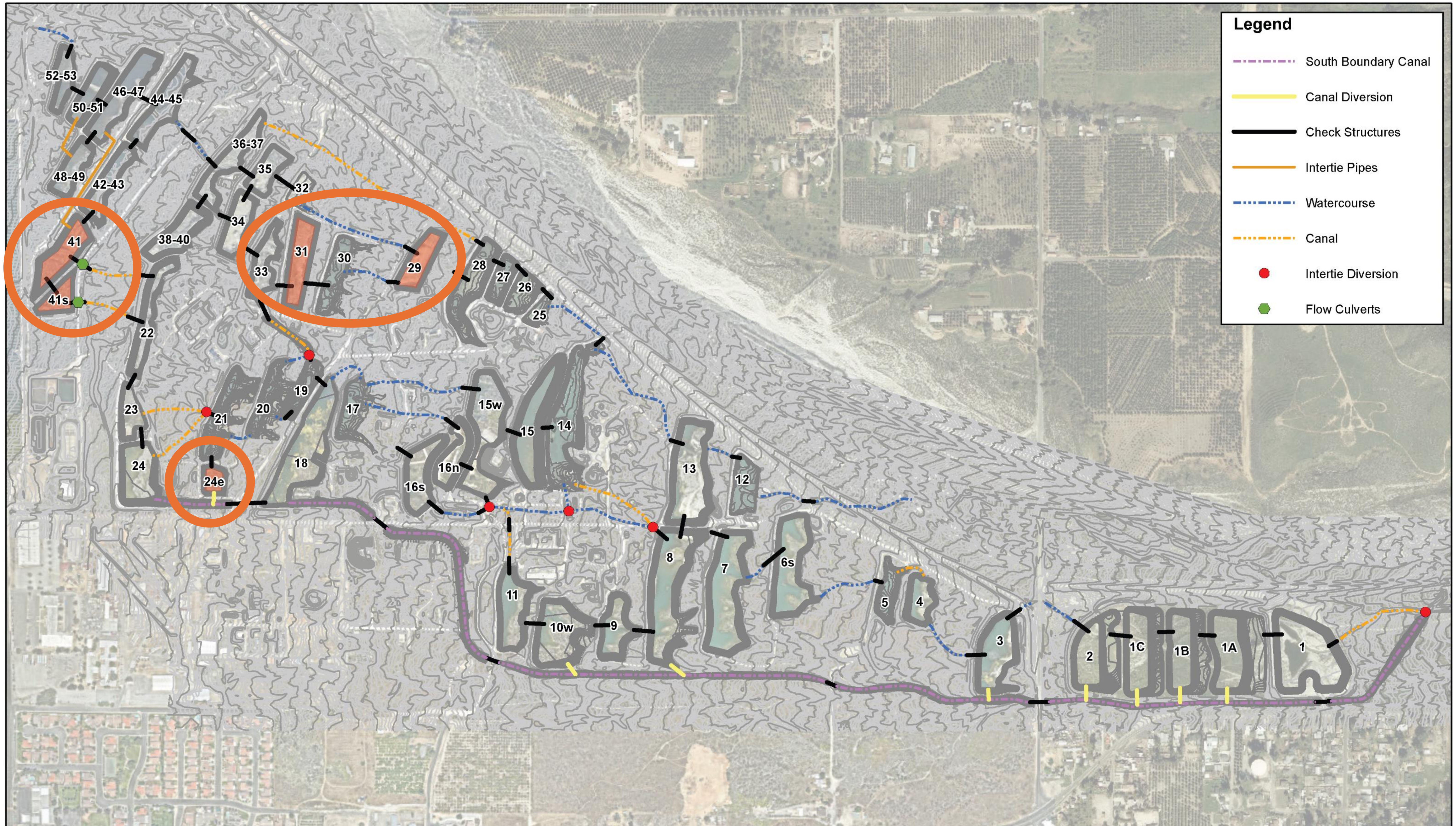

Figure 14. MCRB Grading Alternative 2 Overview

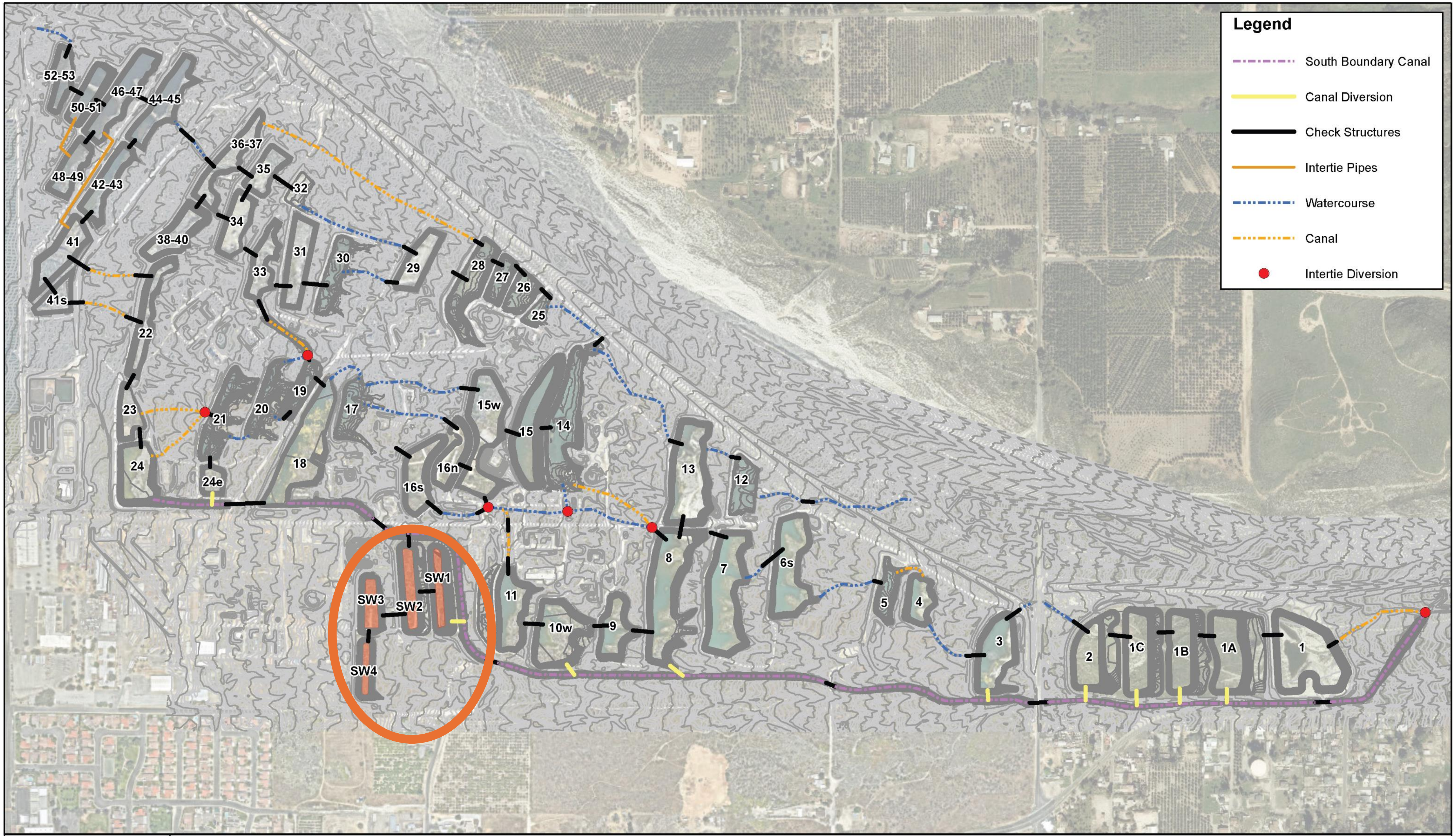

Figure 15. MCRB Grading Alternative 3 Overview

Table 20 shows the MAA Indicators and their respective MCRB Grading Alternative Values.

Table 20. MCRB Interim Construction Alternative MAA Indicator Values

MCRB Grading Alternatives 1, 2, and 3					
Account	**Subaccounts**	**Indicators**	**MCRB Grading Alternatives Values**		
			Alternative 1	**Alternative 2**	**Alternative 3**
Groundwater Recharge Benefits	Groundwater Recharge-Benefit	AFY	2,248	3,087	3,751
	Infiltration-rate-capacity increase	Net Increase in Infiltration Rate Capacity (cfs)	70.3	86.6	91.4
		Ease of Maintenance (FTE)	0.59	0.66	0.73
		Timeline to Implement (years)	8.5	8.5	8.5
	Recharge benefit on a "firm yield" 50-year horizon	AF	93,286	128,105	155,664
Cost Aspects	Capital Costs	Capital Costs NPV	$73,800,000	$78,200,000	$84,000,000
		Grant Sources	20%	20%	20%
	O&M	O&M in 2025 $	$170,843	$205,068	$224,815
Other Technical Aspects	Groundwater Quality Improvements	Volume of Annual Recharge (MGD)	6.2	7.0	7.6
	Conservation and Habitat Benefits	Santa Ana River Contribution (cfs)	1.2	1.2	1.2
		Habitat Restoration (acres)	7	14	29
		Species/ Habitat Impacts (acres)	-35.3	-38.3	-42.8
	Proximity to Groundwater Pressure Zone	Distance to Pressure Zone (yds)	17,100	17,100	17,100
	Access to SWP Supply	Direct, Indirect or No Access	Direct	Direct	Direct
	Groundwater Mounding	Rate Limiting Mounding *(Liquefaction Issue)*	Yes	Yes	Yes

MCRB Grading Alternatives 1, 2, and 3					
Account	**Subaccounts**	**Indicators**	**MCRB Grading Alternatives Values**		
			Alternative 1	**Alternative 2**	**Alternative 3**
Social Aspects	Project Job Creation	Number of Jobs Forecast for Construction	250	260	280
		Number of Jobs Forecast from Operational Needs	0.99	1.15	1.28
	Public Safety Hazards of Project	Ponded Water Depth (ft)	12	12	12
Legal Aspects	CEQA	CEQA Filing Type	IS-MND1	IS-MND1	IS-MND2
	Permits Required/ Requirements	USFWS Permit	Safe Harbor	Safe Harbor	Safe Harbor
		CDFW CESA (2081) Permit	Typical	Typical	Typical
		CDFW LSA /1600	Typical	Typical	Typical
		USACE/RWQCB 401 Permit	None Required	None Required	None Required
		USACE 404	None Required	None Required	None Required
		USACE 408	Typical	Typical	Typical
		DSOD Jurisdictional Dam	None Required	None Required	None Required
		City of San Bernardino Consent Decree Area Permit	None Required	None Required	None Required
		SBCFCD	None Required	None Required	None Required
	Land Availability	Property Ownership by Partner Agencies (Y/N)	Yes	Yes	Yes
	Water Rights	Support for utilization of water rights not yet Licensed (New cfs)	70.3	86.6	91.4

4 Project Alternative Comparisons

This Project Alternative Comparisons section provides summary tables of relevant decision-making information including timing, water yields, and costs for the Alternatives for easy comparison at-a-glance.

The next section of this document, Results and Ranking, provides a comprehensive matrix that includes all of the MAA indicator values, prioritization, and ranking for every Alternative.

4.1 Timing

The timeline for each PERC Project Alternative is evaluated in terms of the project-planning horizon It is assumed that project prioritization and initiating actions will take place between July 1, 2025 and December 31, 2025.

The time to implement a PERC Alternative is estimated largely using four common factors: design, permitting, funding, and construction. The basis for each is discussed in the detailed analyses provided in Volumes 2, 3, and 4. Another consideration is the estimated period of project operation within the 50-year planning horizon of January 1, 2026 to December 31, 2075. The period of operation is specific to each Alternative and affects both the cost and recharge yield. Each of the timing factors is listed in **Table 21**.

Table 21. PERC Project Alternatives Time Forecasting in 50-year Cycle

Project Alternative	Permitting Period (months)	Design Time (months)	Capital Funding (months)	Construction Period (months)	Period of Operation Start Date[1]	Indicator Position[2]
Waterman Grading Alternative	36 (USACE 408)	12	36	12	July 1, 2033	5
TCRB Small Grading Alternative	36 (USACE 408)	6	0	4	May 1, 2029	3
TCRB Large Grading Alternative	36 (USACE 408)	15	108	18	April 1, 2040	9
Lynwood Operational Alternative	36 (USACE 408)	3	0	6	January 1, 2029	2
OCRB Construction Alternative	12	18	0	18	July 1, 2029	4
PCRB Interim Construction Alternative	18	12	0	6	July 1, 2028	1
PCRB Ultimate Construction Alternative	6	12	0	12	July 1, 2062	10
MCRB Grading Alternative 1	18	18	72	18	July 1, 2034	6
MCRB Grading Alternative 2	18	18	72	18	July 1, 2034	6
MCRB Grading Alternative 3	18	18	72	18	July 1, 2034	6

[1]Stop date equals the end of the operational period which is December 31, 2075.
[2]Indicator Position reflects the start date order relative to the study date, with 1 being the soonest and 10 being the latest. Individual indictors, such as start date, are only a single factor among many in the ranking analysis and final Alternative ranking.

4.2 Quantities of Water

The groundwater recharge benefit of a PERC Alternative is described by the following:

- Net Increase in Annual Average Yield
- Net Increase in Infiltration Rate Capacity
- Net Increase in Firm Yield on the 50-Year Planning Horizon

Table 22 presents these quantities of water for each PERC Alternative.

Table 22. PERC Project Alternatives Groundwater Recharge Quantities

Project Alternative	Groundwater Recharge Benefit	Infiltration Rate Capacity	Firm Yield on 50-Year Horizon	
Indicator Description & Units	*Net new AFY*	*Net increase cfs*	*Net increase AF*	*Indicator Position[1]*
Waterman Grading Alternative	2,171	83.89	92,264	4
TCRB Small Grading Alternative	480	12.55	22,405	10
TCRB Large Grading Alternative	1,900	54.53	67,914	5
Lynwood Operational Alternative	687	23.42	33,847	9
OCRB Construction Alternative	1,020	23.30	54,242	6
PCRB Interim Construction Alternative	1,790	23.50	40,874	8
PCRB Ultimate Construction Alternative	3,656	80.00	49,351	7
MCRB Grading Alternative 1	2,248	70.30	93,286	3
MCRB Grading Alternative 2	3,087	86.60	128,105	2
MCRB Grading Alternative 3	3,751	91.40	155,664	1

[1]Indicator Position reflects the Alternative order based on firm yield, with 1 being the highest yield and 10 being the lowest. Individual indictors, such as firm yield, are only a single factor among many in the ranking analysis and final Alternative ranking.

4.3 Costs

Another significant factor for purposes of comparing the PERC Alternatives is the implementation cost, operations & maintenance cost, as well as the ultimate cost per acre-foot of water recharged. **Table 23** presents these dollar values.

Table 23. PERC Project Alternatives Groundwater Recharge Quantities

Project Alternative	**Captial Cost**	**Annual O&M Cost**	**Capital Cost per AF of Recharge Over 50-year Horizon**	
Indicator Description & Units	*Net-Present Value (USD)*	*2025 USD*	*USD/AF*	*Indicator Position[1]*
Waterman Grading Alternative	$21,886,000	$95,885	$237	3
TCRB Small Grading Alternative	$10,822,000	$29,048	$483	6
TCRB Large Grading Alternative	$57,834,000	$27,621	$852	10
Lynwood Operational Alternative	$2,303,000	$47,453	$68	1
OCRB Construction Alternative	$18,446,000	$83,077	$340	4
PCRB Interim Construction Alternative	$16,393,000	$67,437	$401	5
PCRB Ultimate Construction Alternative	$8,170,000	$120,319	$166	2
MCRB Grading Alternative 1	$73,800,000	$170,843	$791	9
MCRB Grading Alternative 2	$78,200,000	$205,068	$610	8
MCRB Grading Alternative 3	$84,000,000	$224,815	$540	7

[1]Indicator Position reflects the Alternative order based on Capital Cost per AF of Recharge Over 50-year Horizon, with 1 being the lowest and 10 being the highest. Individual indictors, such as cost, are only a single factor among many in the ranking analysis and final Alternative ranking.

Results

The PERC Alternatives were evaluated using the MAA described in the Project Prioritization section. The ten PERC Alternatives are listed in **Table 24** with shorthand ID codes assigned to each for ease of graphing the outcomes from the MAA.

Table 24. PERC Project Alternative Codes

Project Alternative Name	Shorthand ID
Waterman Grading Alternative	WGA
TCRB Small Grading Alternative	TCS
TCRB Large Grading Alternative	TCL
Lynwood Operational Alternative	LOA
OCRB Construction Alternative	OCA
PCRB Interim Construction Alternative	PCI
PCRB Ultimate Construction Alternative	PCU
MCRB Grading Alternative 1	MC1
MCRB Grading Alternative 2	MC2
MCRB Grading Alternative 3	MC3

Each Alternative was assessed on the Indicators under the respective Sub-Accounts. The Sub-Account scores were weighted by the agreed-upon importance of each Sub-Account. The sum of the Sub-Account scores accrue to the Account score and the weighted Account scores produce the overall weighted final **Matrix score** shown as a red diamond in **Figure 16**. The higher the red diamond score, the higher the priority rating for that PERC Alternative. **Table 25** provides the Indicator values with the MAA Account and Sub-Account weights that produced the PERC Alternative priortization.

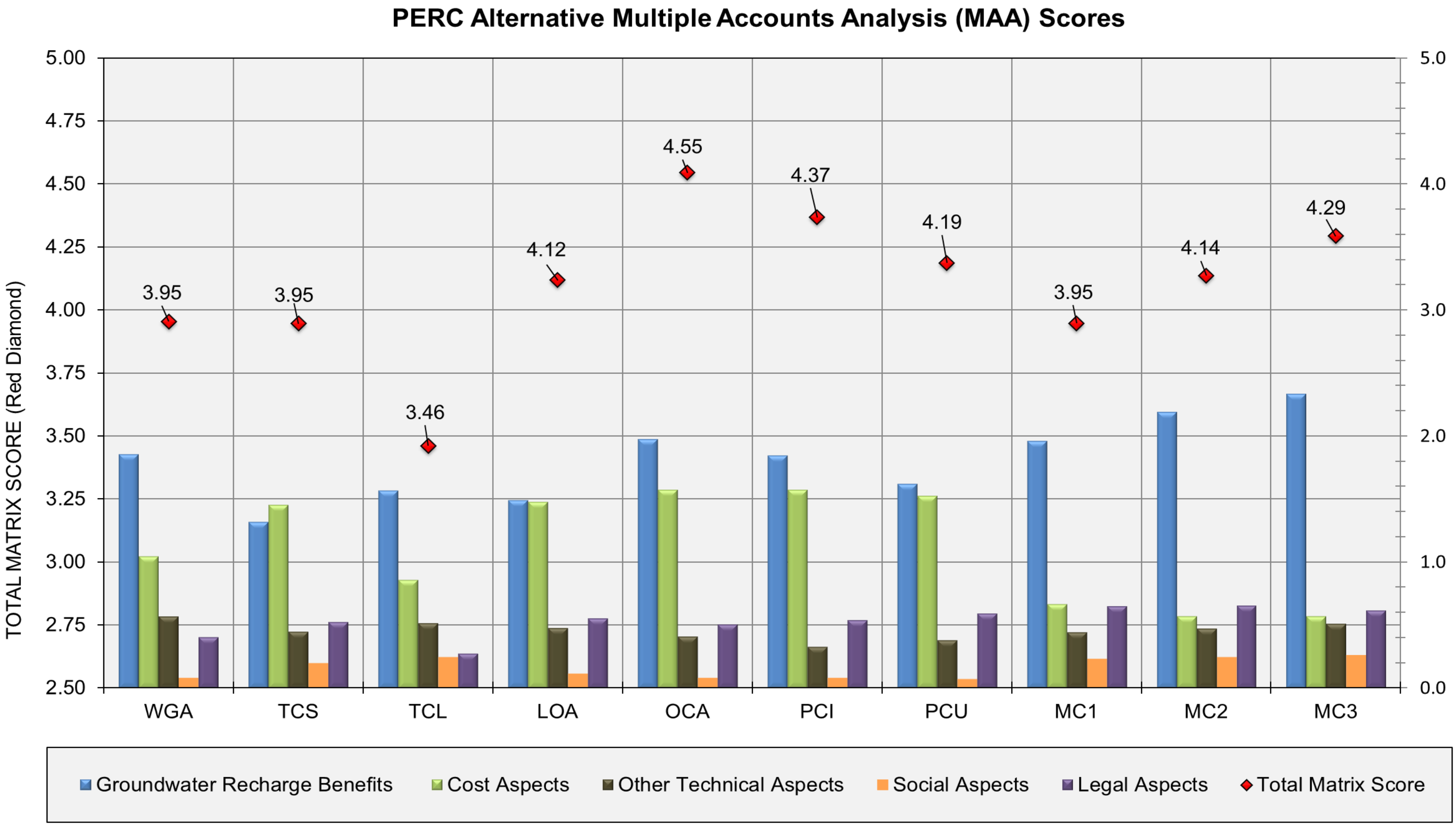

Figure 16. MAA Scoring for PERC Project Alternatives

Table 25. MAA Results by Account and Sub-Account

Account	Account Weight	Sub-Accounts	Sub-Account Weight	Indicator	Indicator Weight	Waterman Grading (WGA)		TCRB Small Grading (TCS)		TCRB Large Grading (TCL)		Lynwood Operational (LOA)		OCRB Construction (OCA)		PCRB Interim (PCI)		PCRB Ultimate (PCU)		MCRB Grading 1 (MC1)		MCRB Grading 2 (MC2)		MCRB Grading 3 (MC3)	
Groundwater Recharge Benefits	0.9	Groundwater Recharge Benefit	0.5	Net AFY	1	4	Average	1	Worst	3	Below Avg	2	Poor	3	Below Avg	2	Poor	2	Poor	4	Average	6	Good	7	Best in Class
				Subaccount Rating		**4.00**		**1.00**		**3.00**		**2.00**		**3.00**		**2.00**		**2.00**		**4.00**		**6.00**		**7.00**	
				Weighted Subaccount Value		**0.83**		**0.21**		**0.63**		**0.42**		**0.63**		**0.42**		**0.42**		**0.83**		**1.25**		**1.46**	
		Infiltration Rate Capacity Increase	0.9	Net + infiltration rate (cfs)	4	6	Good	1	Worst	4	Average	2	Poor	2	Poor	2	Poor	6	Good	5	Above Avg	6	Good	7	Best in Class
				Ease of maintenance (FTE)	3	6	Good	6	Good	7	Best in Class	5	Above Avg	6	Good	5	Above Avg	4	Average	1	Worst	1	Worst	1	Worst
				Timeline to implement (years)	5	6	Good	6	Good	4	Average	7	Best in Class	7	Best in Class	7	Best in Class	1	Worst	6	Good	6	Good	6	Good
				Subaccount Rating		**6.00**		**4.33**		**4.75**		**4.83**		**5.08**		**4.83**		**3.42**		**4.42**		**4.75**		**5.08**	
				Weighted Subaccount Value		**2.25**		**1.63**		**1.78**		**1.81**		**1.91**		**1.81**		**1.28**		**1.66**		**1.78**		**1.91**	
		Firm Yield on 50-Year Horizon	1	AF over 50 years	5	3	Below Avg	3	Below Avg	3	Below Avg	3	Below Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg
				Subaccount Rating		**3.00**		**3.00**		**3.00**		**3.00**		**5.00**		**5.00**		**5.00**		**5.00**		**5.00**		**5.00**	
				Weighted Subaccount Score		**1.25**		**1.25**		**1.25**		**1.25**		**2.08**		**2.08**		**2.08**		**2.08**		**2.08**		**2.08**	
				Combined Indicator Score for the Account		**4.33**		**3.08**		**3.66**		**3.48**		**4.61**		**4.31**		**3.78**		**4.57**		**5.11**		**5.45**	
				Weighted Score for the Account		**1.86**		**1.32**		**1.57**		**1.49**		**1.98**		**1.85**		**1.62**		**1.96**		**2.19**		**2.33**	
Cost Aspects	0.6	Capital Cost	1	Capital Cost (NPV)	5	5	Above Avg	6	Good	1	Worst	7	Best in Class	5	Above Avg	5	Above Avg	3	Below Avg	1	Worst	1	Worst	1	Worst
				Grant/outside funding (%)	3	1	Worst	1	Worst	1	Worst	1	Worst	7	Best in Class	7	Best in Class	7	Best in Class	5	Above Avg	5	Above Avg	5	Above Avg
				Subaccount Rating		**3.50**		**4.13**		**1.00**		**4.75**		**5.75**		**5.75**		**4.50**		**2.50**		**2.50**		**2.50**	
				Weighted Subaccount Value		**2.33**		**2.75**		**0.67**		**3.17**		**3.83**		**3.83**		**3.00**		**1.67**		**1.67**		**1.67**	
		O&M Cost	0.5	Annual O&M (2025 USD)	2	4	Average	7	Best in Class	7	Best in Class	6	Good	5	Above Avg	5	Above Avg	7	Best in Class	2	Poor	1	Worst	1	Worst
				Subaccount Rating		**4.00**		**7.00**		**7.00**		**6.00**		**5.00**		**5.00**		**7.00**		**2.00**		**1.00**		**1.00**	
				Weighted Subaccount Score		**1.33**		**2.33**		**2.33**		**2.00**		**1.67**		**1.67**		**2.33**		**0.67**		**0.33**		**0.33**	
				Combined Indicator Score for the Account		**3.67**		**5.08**		**3.00**		**5.17**		**5.50**		**5.50**		**5.33**		**2.33**		**2.00**		**2.00**	
				Weighted Score for the Account		**1.05**		**1.45**		**0.86**		**1.48**		**1.57**		**1.57**		**1.52**		**0.67**		**0.57**		**0.57**	
Other Technical Aspects	0.25	Groundwater Quality Improvements	0.5	Average Daily Recharge (MGD)	5	2	Poor	1	Worst	2	Poor	1	Worst	1	Worst	2	Poor	3	Below Avg	5	Above Avg	6	Good	7	Best in Class
				Subaccount Rating		**2.00**		**1.00**		**2.00**		**1.00**		**1.00**		**2.00**		**3.00**		**5.00**		**6.00**		**7.00**	
				Weighted Subaccount Value		**0.48**		**0.24**		**0.48**		**0.24**		**0.24**		**0.48**		**0.71**		**1.19**		**1.43**		**1.67**	
		Conservation and Habitat Benefits	0.3	Santa Ana River contribution	5	7	Best in Class	2	Poor	6	Good	3	Below Avg	3	Below Avg	1	Worst	1	Worst	4	Average	4	Average	4	Average
				Habitat restoration	2	1	Worst	1	Worst	1	Worst	1	Worst	5	Above Avg	2	Poor	7	Best in Class	2	Poor	3	Below Avg	5	Above Avg
				Species/habitat impacts	2	4	Average	4	Average	4	Average	4	Average	7	Best in Class	4	Average	5	Above Avg	1	Worst	1	Worst	1	Worst
				Subaccount Rating		**5.00**		**2.22**		**4.44**		**2.78**		**4.33**		**1.89**		**3.22**		**2.89**		**3.11**		**3.56**	
				Weighted Subaccount Value		**0.71**		**0.32**		**0.63**		**0.40**		**0.62**		**0.27**		**0.46**		**0.41**		**0.44**		**0.51**	
		Proximity to Groundwater Pressure Zone	0.7	Distance to pressure zone (yds)	5	5	Above Avg	6	Good	6	Good	7	Best in Class	2	Poor	5	Above Avg	5	Above Avg	1	Worst	1	Worst	1	Worst
				Subaccount Rating		**5.00**		**6.00**		**6.00**		**7.00**		**2.00**		**5.00**		**5.00**		**1.00**		**1.00**		**1.00**	
				Weighted Subaccount Value		**1.67**		**2.00**		**2.00**		**2.33**		**0.67**		**1.67**		**1.67**		**0.33**		**0.33**		**0.33**	
		Access to SWP Supply	0.5	Direct, Indirect, or No Access	5	7	Best in Class	4	Average	4	Average	4	Average	7	Best in Class	1	Worst	1	Worst	7	Best in Class	7	Best in Class	7	Best in Class
				Subaccount Rating		**7.00**		**4.00**		**4.00**		**4.00**		**7.00**		**1.00**		**1.00**		**7.00**		**7.00**		**7.00**	
				Weighted Subaccount Value		**1.67**		**0.95**		**0.95**		**0.95**		**1.67**		**0.24**		**0.24**		**1.67**		**1.67**		**1.67**	
		Groundwater Mounding	0.1	Rate limiting mounding	2	5	Above Avg	5	Above Avg	5	Above Avg	2	Poor	5	Above Avg	2	Poor	2	Poor	2	Poor	2	Poor	2	Poor
				Subaccount Rating		**5.00**		**5.00**		**5.00**		**2.00**		**5.00**		**2.00**		**2.00**		**2.00**		**2.00**		**2.00**	
				Weighted Subaccount Score		**0.24**		**0.24**		**0.24**		**0.10**		**0.24**		**0.10**		**0.10**		**0.10**		**0.10**		**0.10**	
				Combined Indicator Score for the Account		**4.76**		**3.75**		**4.30**		**4.02**		**3.43**		**2.75**		**3.17**		**3.70**		**3.97**		**4.27**	
				Weighted Score for the Account		**0.57**		**0.45**		**0.51**		**0.48**		**0.41**		**0.33**		**0.38**		**0.44**		**0.47**		**0.51**	
Social Aspects	0.1	Project Job Creation	0.5	Construction jobs (FTE)	2	3	Below Avg	2	Poor	7	Best in Class	1	Worst	3	Below Avg	3	Below Avg	2	Poor	7	Best in Class	7	Best in Class	7	Best in Class
				Operations Jobs (FTE)	3	2	Poor	1	Worst	1	Worst	1	Worst	2	Poor	2	Poor	2	Poor	5	Above Avg	6	Good	7	Best in Class
				Subaccount Rating		**2.40**		**1.40**		**3.40**		**1.00**		**2.40**		**2.40**		**2.00**		**5.80**		**6.40**		**7.00**	
				Weighted Subaccount Value		**1.20**		**0.70**		**1.70**		**0.50**		**1.20**		**1.20**		**1.00**		**2.90**		**3.20**		**3.50**	
		Public Safety Hazards of Project	0.5	Ponded water depth (ft)	5	1	Worst	7	Best in Class	7	Best in Class	4	Average	1	Worst	1	Worst	1	Worst	4	Average	4	Average	4	Average
				Subaccount Rating		**1.00**		**7.00**		**7.00**		**4.00**		**1.00**		**1.00**		**1.00**		**4.00**		**4.00**		**4.00**	
				Weighted Subaccount Score		**0.50**		**3.50**		**3.50**		**2.00**		**0.50**		**0.50**		**0.50**		**2.00**		**2.00**		**2.00**	
				Combined Indicator Score for the Account		**1.70**		**4.20**		**5.20**		**2.50**		**1.70**		**1.70**		**1.50**		**4.90**		**5.20**		**5.50**	
				Weighted Score for the Account		**0.08**		**0.20**		**0.25**		**0.12**		**0.08**		**0.08**		**0.07**		**0.23**		**0.25**		**0.26**	
Legal Aspects	0.25	CEQA	0.7	CEQA filing type	4	4	Average	7	Best in Class	1	Worst	7	Best in Class	1	Worst	3	Below Avg	4	Average	4	Average	4	Average	3	Below Avg
				Subaccount Rating		**4.00**		**7.00**		**1.00**		**7.00**		**1.00**		**3.00**		**4.00**		**4.00**		**4.00**		**3.00**	
				Weighted Subaccount Value		**1.40**		**2.45**		**0.35**		**2.45**		**0.35**		**1.05**		**1.40**		**1.40**		**1.40**		**1.05**	
		Permits Required/ Requirements	0.7	USFWS Permit	2	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	6	Good	6	Good	7	Best in Class	7	Best in Class	7	Best in Class
				CDFW CESA (2081) Permit	4	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	6	Good	6	Good	4	Average	4	Average	4	Average
				CDFW LSA /1600 Permit	2	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	5	Above Avg	4	Average	4	Average	4	Average
				USACE/RWQCB 401 Permit	3	4	Average	7	Best in Class	6	Good	7	Best in Class	4	Average	5	Above Avg	5	Above Avg	7	Best in Class	7	Best in Class	7	Best in Class
				USACE 404 Permit	3	4	Average	4	Average	4	Average	4	Average	6	Good	3	Below Avg	3	Below Avg	7	Best in Class	7	Best in Class	7	Best in Class
				USACE 408 Permit	4	4	Average	3	Below Avg	2	Poor	4	Average	7	Best in Class	7	Best in Class	7	Best in Class	4	Average	4	Average	4	Average
				DSOD Jurisdictional Dam	4	4	Average	7	Best in Class	7	Best in Class	7	Best in Class	7	Best in Class	4	Average	2	Poor	7	Best in Class	7	Best in Class	7	Best in Class
				SBCFCD	3	2	Poor	2	Poor	1	Worst	5	Above Avg	7	Best in Class	1	Worst	1	Worst	7	Best in Class	7	Best in Class	7	Best in Class
				Subaccount Rating		**4.08**		**4.76**		**4.36**		**5.28**		**5.88**		**4.68**		**4.36**		**5.80**		**5.80**		**5.80**	
				Weighted Subaccount Value		**1.43**		**1.67**		**1.53**		**1.85**		**2.06**		**1.64**		**1.53**		**2.03**		**2.03**		**2.03**	
		Land Availability	0.5	Owned by Partner Agencies	3	1	Worst	1	Worst	1	Worst	1	Worst	7	Best in Class	7	Best in Class	7	Best in Class	7	Best in Class	7	Best in Class	7	Best in Class
				Subaccount Rating		**1.00**		**1.00**		**1.00**		**1.00**		**7.00**		**7.00**		**7.00**		**7.00**		**7.00**		**7.00**	
				Weighted Subaccount Value		**0.25**		**0.25**		**0.25**		**0.25**		**1.75**		**1.75**		**1.75**		**1.75**		**1.75**		**1.75**	
		Water Rights	0.1	Water Rights Not Yet Licensed	5	6	Good	1	Worst	4	Average	2	Poor	2	Poor	2	Poor	6	Good	5	Above Avg	6	Good	7	Best in Class
				Subaccount Rating		**6.00**		**1.00**		**4.00**		**2.00**		**2.00**		**2.00**		**6.00**		**5.00**		**6.00**		**7.00**	
				Weighted Subaccount Score		**0.30**		**0.05**		**0.20**		**0.10**		**0.10**		**0.10**		**0.30**		**0.25**		**0.30**		**0.35**	
				Combined Indicator Score for the Account		**3.38**		**4.42**		**2.33**		**4.65**		**4.26**		**4.54**		**4.98**		**5.43**		**5.48**		**5.18**	
				Weighted Score for the Account		**0.40**		**0.53**		**0.28**		**0.55**		**0.51**		**0.54**		**0.59**		**0.65**		**0.65**		**0.62**	
				Total Matrix Score		**3.95**		**3.95**		**3.46**		**4.12**		**4.55**		**4.37**		**4.19**		**3.95**		**4.14**		**4.29**	

On an objective basis using the weighting matrix, **the highest priority project is the OCRB Construction Alternative** (OCA).

- The **Plunge Creek** projects are the next highest priority projects, PCI followed by PCU. The high priority for the sequential Plunge Creek projects would promote an even slightly higher priority for each given the lowered overall costs due to their co-located and retainable diversion structure, but they are still independent projects and can be considered independently.
- **Mill Creek's largest project alternative** (MC3) has effectively the third highest priority of projects that can be initiated now.

These highest priority Alternative ranks are primarily driven by their sustainable recharge rate, their annual recharge, and their firm yield from the longer-term probability of native water availability for each. Summary discussion of the Account scores follows to provide further insight into the MAA scoring outcomes.

Table 26. PERC Alternatives Final Ranking

PERC Project Alternative	MAA Total Score	Priority Ranking
OCRB Construction Alternative (OCA)	4.55	1
PCRB Interim Construction Alternative (PCI)	4.37	2
MCRB Grading Alternative 3 (MC3)	4.29	3
PCRB Ultimate Construction Alternative (PCU)	4.19	4
MCRB Grading Alternative 2 (MC2)	4.14	5
Lynwood Operational Alternative (LOA)	4.12	6
MCRB Grading Alternative 1 (MC1)	3.95	7
Waterman Grading Alternative (WGA)	3.95	8
TCRB Small Grading Alternative (TCS)	3.95	9
TCRB Large Grading Alternative (TCL)	3.46	10

The Groundwater Recharge and Cost component scores make up the largest portion of the total MAA scoring due to their higher weightings of 0.9 and 0.6, respectively.

- The next highest component of scores for each PERC Project Alternative is from the Other Technical Aspects Account and the Legal Aspects Account with weightings of 0.25.
- The Social Aspects scores are the smallest portion of the overall MAA score for each PERC Project Alternative with a weighting of 0.1.

1 Groundwater Recharge Benefits Scores

MCRB Grading Alternative 3 (MC3) has the highest overall groundwater recharge benefit inclusive of all three component Sub-Accounts: net average annual recharge increase, net infiltration rate capacity increase, and net firm yield. The **OCRB Construction Alternative** (OCA) provides infiltration rate capacity quickly and a high firm yield, effectively ranking second to Mill Creek Grading Alternative 2 or 3 (MC2 or MC3). As a result of its high groundwater recharge scoring, MCRB Grading Alternative 1 (MC1) is the third highest priority project, after discounting the PCRB Ultimate Construction Alternative (PCU) in the short-term, due to it not being available until the year 2060. Groundwater Recharge Benefits scores for all PERC Alternatives are shown in **Figure 17**.

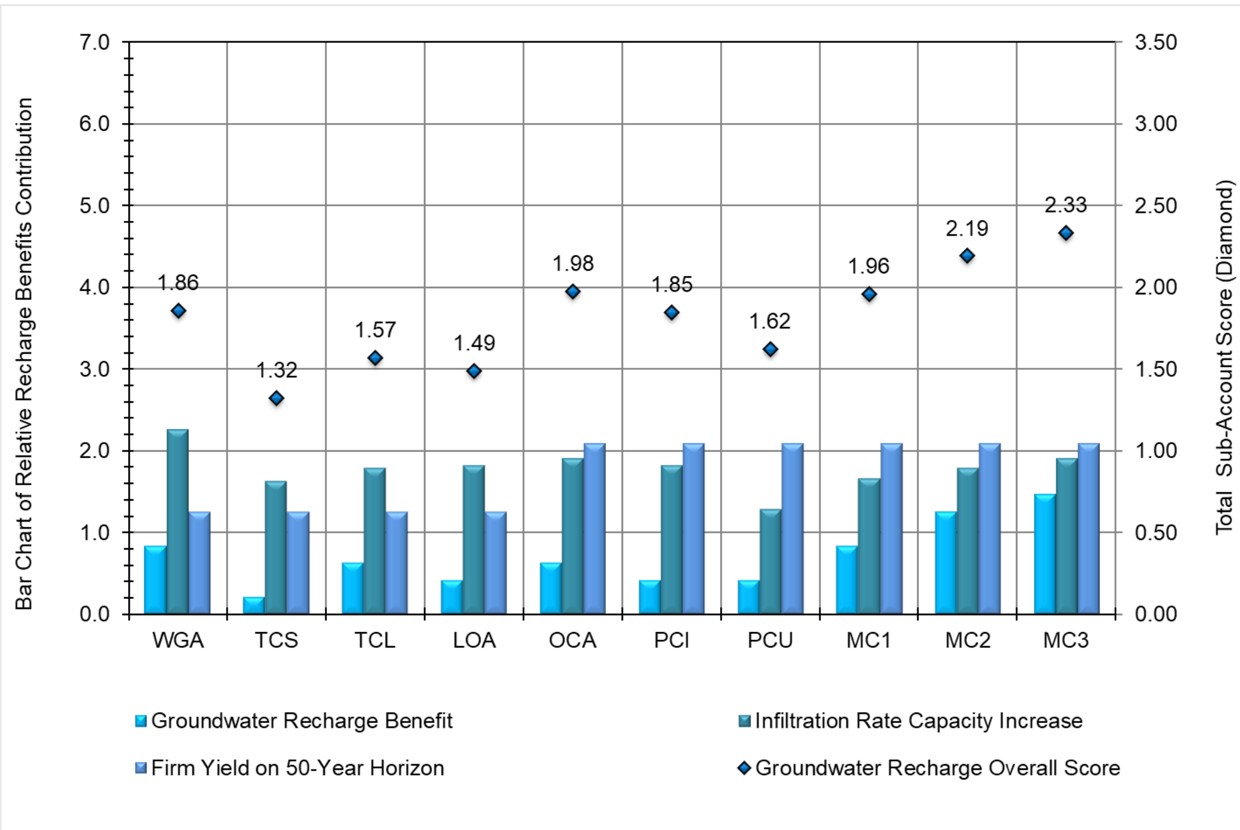

Figure 17. Groundwater Recharge Benefits Scores

According to the MAA, the logical step is to build PCRB Interim Construction Alternative (PCI), second highest priority, and then later build the Ultimate Conditions (PCU) project. There are additional considerations for the construction of a new reinforced concrete channel that would precede construction of the Plunge Creek projects which are detailed in Volume 3.

2 Cost Aspects Scores

Due to lower costs being viewed as *more favorable*, the nature of benefits weighting causes the taller green and orange bars on in **Figure 18** to represent ***higher scores***; not higher costs. The **OCRB Construction Alternative** (OCA) finishes first place in the Cost Aspects Scores, tied with the **PCRB Interim Construction Alternative** (PCI) which has many of the same cost characteristics.

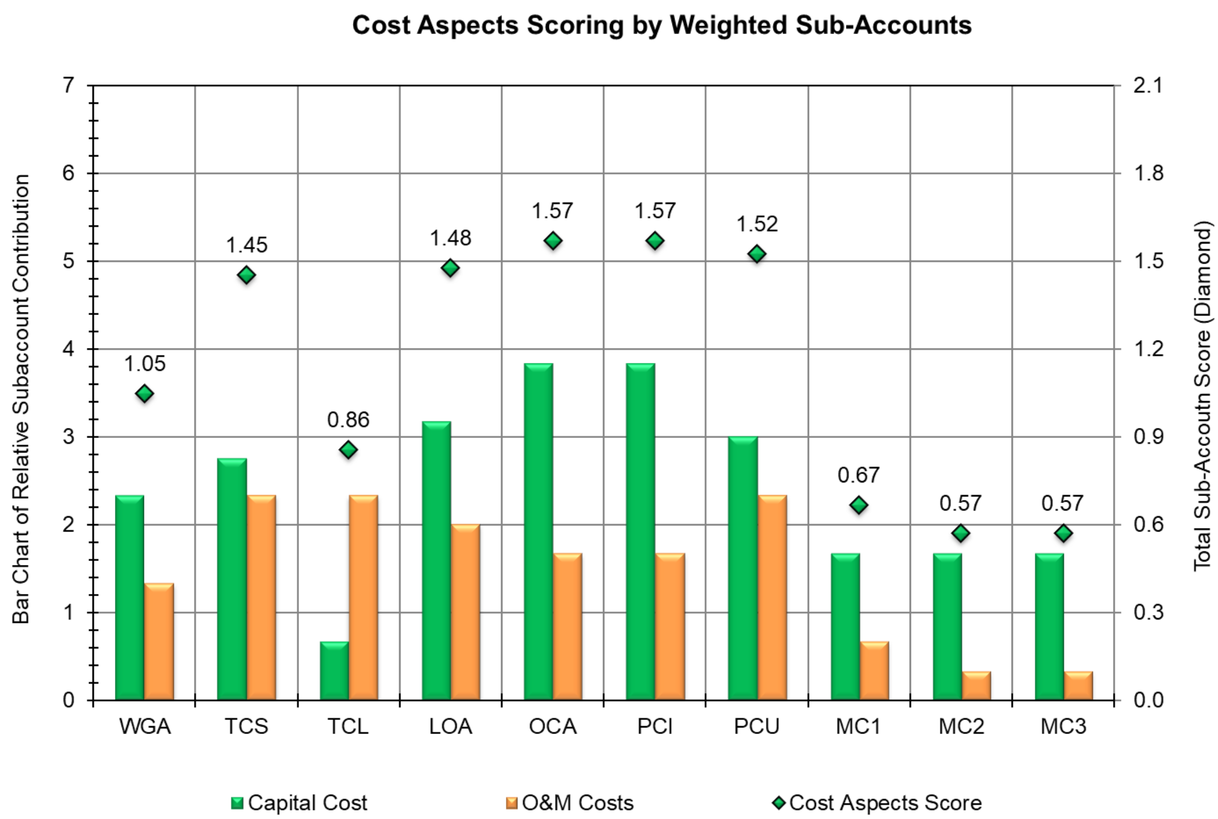

Figure 18. Cost Aspects Scores

The OCRB Construction Alternative's high score is driven by its smaller size, access to grant funding (as a new "small storage" project, it is eligible for Bureau of Reclamation grants), and its automated and generally simple O&M regimen paired with moderate sediment cleanout costs. MCRB Alternatives 2 and 3 (MC2 and MC3) have the highest cost. Notably, the TCRB Large Grading Alternative (TCL) has the highest capital cost but the lowest O&M costs due to its self-maintenance for sediment removal and its self-operation.

3 Other Technical Aspects Scores

Waterman Grading Alternative (WGA) is the leader in the Other Technical Aspects Account driven by its Sub-Account scores for the following: proximity to groundwater pressure zone, direct access to SWP supply, and groundwater quality support to the Salt & Nutrient Management Plan (SNMP). Other Technical Aspects scores for all PERC Alternatives are shown in **Figure 19**.

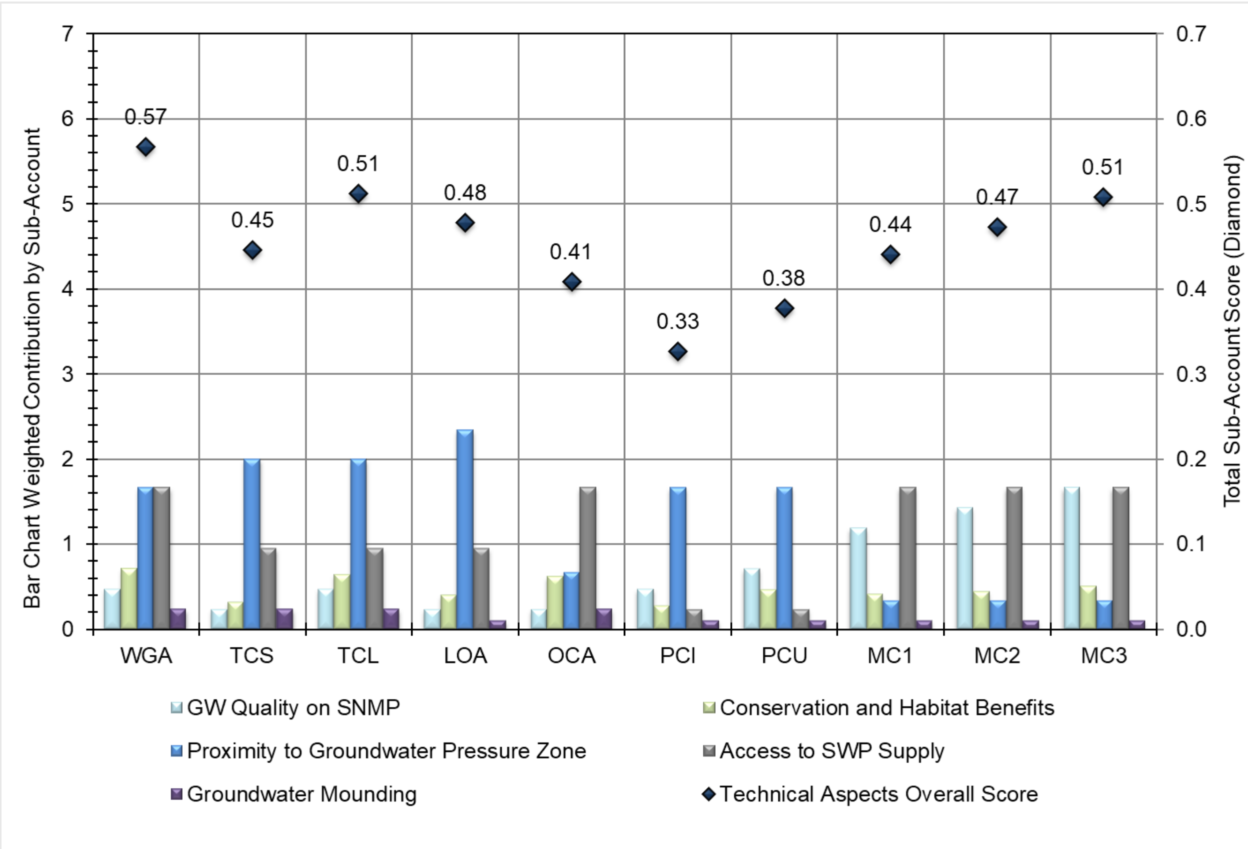

Figure 19. Other Technical Aspects Scores

Lynwood Operational Alternative has the highest score for the Proximity to Groundwater Pressure Zone Sub-Account. The highest scores for groundwater quality support for the SNMP aligns with the highest volume projects which are at Mill Creek (MC1, 2, and 3). The OCRB Construction Alternative overall scores fairly well due to both Conservation and Habitat Benefits under the Wash Plan and for its direct access to SWP supply (which also provides it direct access to FIRO supply under the Groundwater Recharge Benefits Account); it is these myriad characteristics that explain OCRB Construction Alternative as the highest priority project overall based on the total matrix scores.

4 Legal Aspects Scores

The **MCRB Grading Alternatives 1, 2, and 3** all score the highest on legal aspects because the existing facilities are outside of the floodplain with an appropriately sized and modern water diversion structure in place. Legal Aspects scores for all PERC Alternatives are shown in **Figure 20**.

The OCRB Construction Alternative has a moderate score in the Legal Aspects Account, meaning that the legal requirements for its execution via permitting are like those of other projects; this is driven by its inclusion in the River HCP broad permit coverage.

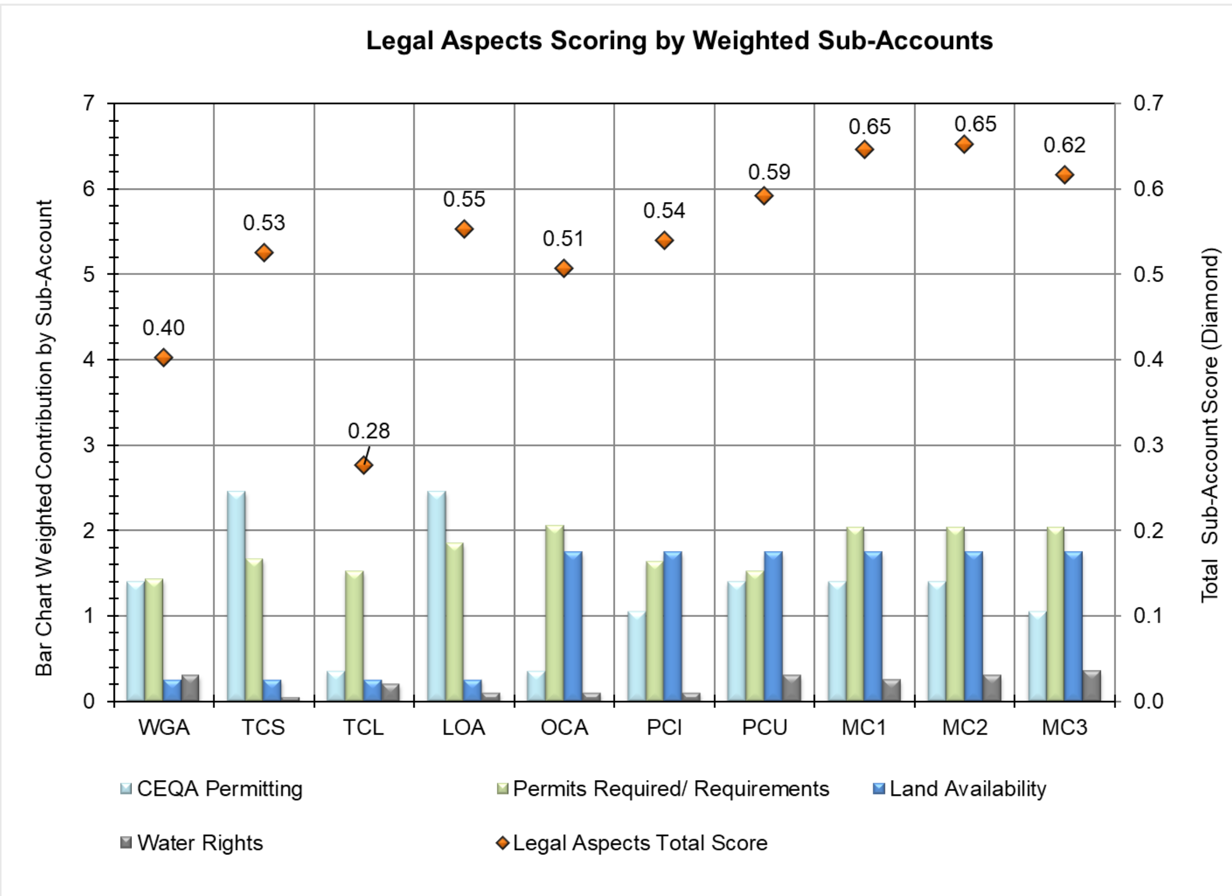

Figure 20. Legal Aspects Scores

5 Social Aspects Scores

Social Aspects scores for all PERC Alternatives are shown in **Figure 21**. The Social Aspects score is typically driven by the number of jobs created. However, for the TCRB Small and Large Grading Alternatives (TCS and TCL), it is their shallow depth of water for public safety that has them scoring well, with the Large Grading scoring higher based on the number of jobs created for its construction phase.

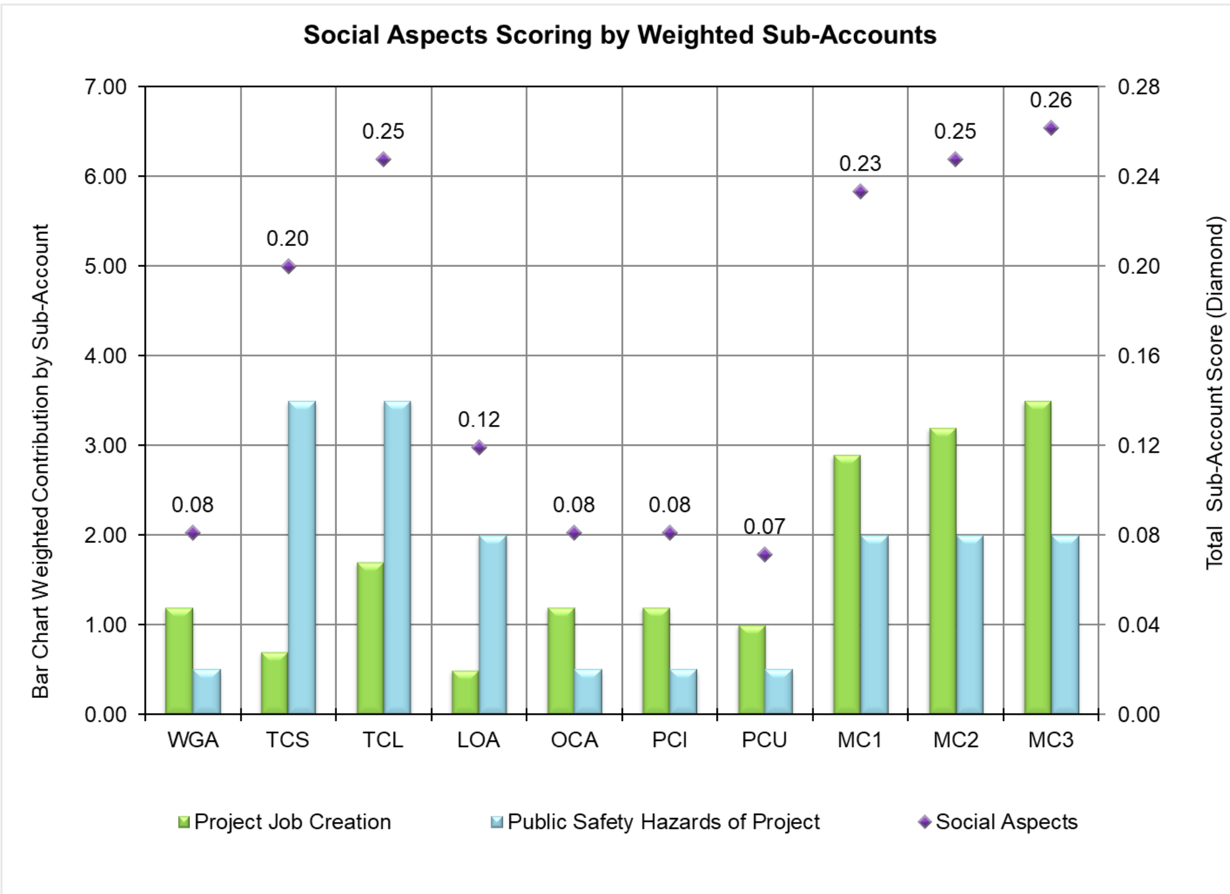

Figure 21. Social Aspects Scores

Next Steps

The MAA model was built collaboratively by the PERC Partners to objectively quantify the relative ranking of PERC Alternatives. The resulting ranks (**Table 27**) can now be referenced as the partners move on to address land access needs, capital funding needs, and to fine-tune PERC project characteristics and costs. Suggested next steps include **moving forward to the 65% design phase** for the top-ranked projects, building upon the initial study results presented in Volumes 2 through 4 as necessary. Grant funding was awarded for Mill Creek and therefore **MCRB Grading Alternative 3** should move forward immediately.

Table 27. PERC Alternative Ranking and Scores

Rank	PERC Alternative	MAA Total Score
1	OCRB Construction Alternative	4.55
2	PCRB Interim Construction Alternative	4.37
3	MCRB Grading Alternative 3	4.29
4	PCRB Ultimate Construction Alternative	4.19
5	MCRB Grading Alternative 2	4.14
6	Lynwood Operational Alternative	4.12
7	MCRB Grading Alternative	3.95
8	Waterman Grading Alternative	3.95
9	TCRB Small Grading Alternative	3.95
10	TCRB Large Grading Alternative	3.46

The above-listed suggestions are solely for consideration as potential near-term actions. Next steps will be considered by the SBVWCD Board of Directors and PERC Project Partners and taken as appropriate. Approval or adoption of this Feasibility Study ***does not*** grant blanket approval to move forward with any or all projects.

Citations

El-Swaify, S.A and Yakowitz, D.S. ed., Multiple Objective Decision Making for Land, Water, and Environmental Management, Lewis Publishers, Boca Raton, 1996, p. 743.

Mendoza, G.A. and H. Martins, 2006. Multi-criteria decision analysis in natural resource management: A critical review of methods and new modelling paradigms. Forest Ecology and Management. 230 (2006), pp. 1-22.

Tetra Tech, 2014, "Operation and Maintenance Manual East Twin Creek And Waterman Levees." Prepared for San Bernardino County Flood Control District and adopted September 25, 2014 for operation and maintenance of USACE-provided levees in accordance with Code of Federal Regulations.

Appendices

Appendix A: FIRO Calculations for PERC Alternatives

Appendix B: Multiple-Accounts Analysis Indicator Scores

Appendix A: FIRO Calculations for PERC Alternatives

One of the principal elements of the Forecast Informed Reservoir Operations (FIRO) study is to assess if forecasts of atmospheric rivers can be used to inform flexible reservoir operations at Seven Oaks Dam. Atmospheric rivers can produce massive amounts of rain or snow. Accurately predicting the location, duration and runoff volume anticipated due to atmospheric river storms is foundational to initiating and instituting FIRO.

The challenge for the PERC Feasibility Study is how to evaluate the likely timing and volume of water that might be available under a FIRO-based operation of Seven Oaks Dam. Historically, water was not stored at the Seven Oaks Dam[9] and thus there is no applicable history of water operations. To evaluate how often and how much water might be available for PERC Alternatives, SBVWCD staff undertook a statistical evaluation of the annual runoff yields in the Upper Santa Ana River as recorded by the USGS, which has a long history of daily average flow data from July 1, 1896 to present (with minor time gaps) at a nearby gage. From that data, USGS has published monthly and annual runoff. This data incorporates diversion rates above and below Seven Oaks Dam, making it an excellent source of information to evaluate historic runoff yield. The exceedance frequency of the annual runoff yield is tabulated as follows.

- An exceedance frequency of 90% signifies that in 9 out of 10 years the total runoff exceeded the volume shown in AF.
- Similarly, an exceedance frequency of 30% means that in 3 out of 10 years the total runoff exceeds the volume shown in AF.

Upper SAR Watershed Annual Yield Percent Exceedance Frequency Water Years 1898-2024	
Percentile Exceedance Frequency	USGS Estimated Annual Runoff above Seven Oaks Dam (AF)
90%	1,451
80%	2,635
70%	5,004
60%	6,336
50%	10,787
40%	15,232

[9] It was Congressionally authorized only for flood control and not water conservation or storage.

Upper SAR Watershed Annual Yield Percent Exceedance Frequency Water Years 1898-2024	
Percentile Exceedance Frequency	USGS Estimated Annual Runoff above Seven Oaks Dam (AF)
30%	25,527
20%	33,766
10%	71,615
4%	112,096
2%	131,800
1%	169,685

Annual runoff volumes were compared to the water storage volumes allocated for water management at the Seven Oaks Dam to develop a working metric for the PERC Alternatives.[10] The allocation of water storage at the Seven Oaks Dam provides for up to 16,305 AF below the Main Flood Control Pool as shown in **Figure 22**.

[10] IMPORTANT NOTE: Annual runoff volumes and flood control volumes are not related with regard to flood risk management. The comparisons herein are strictly for volume analysis for storage of how much water might be available.

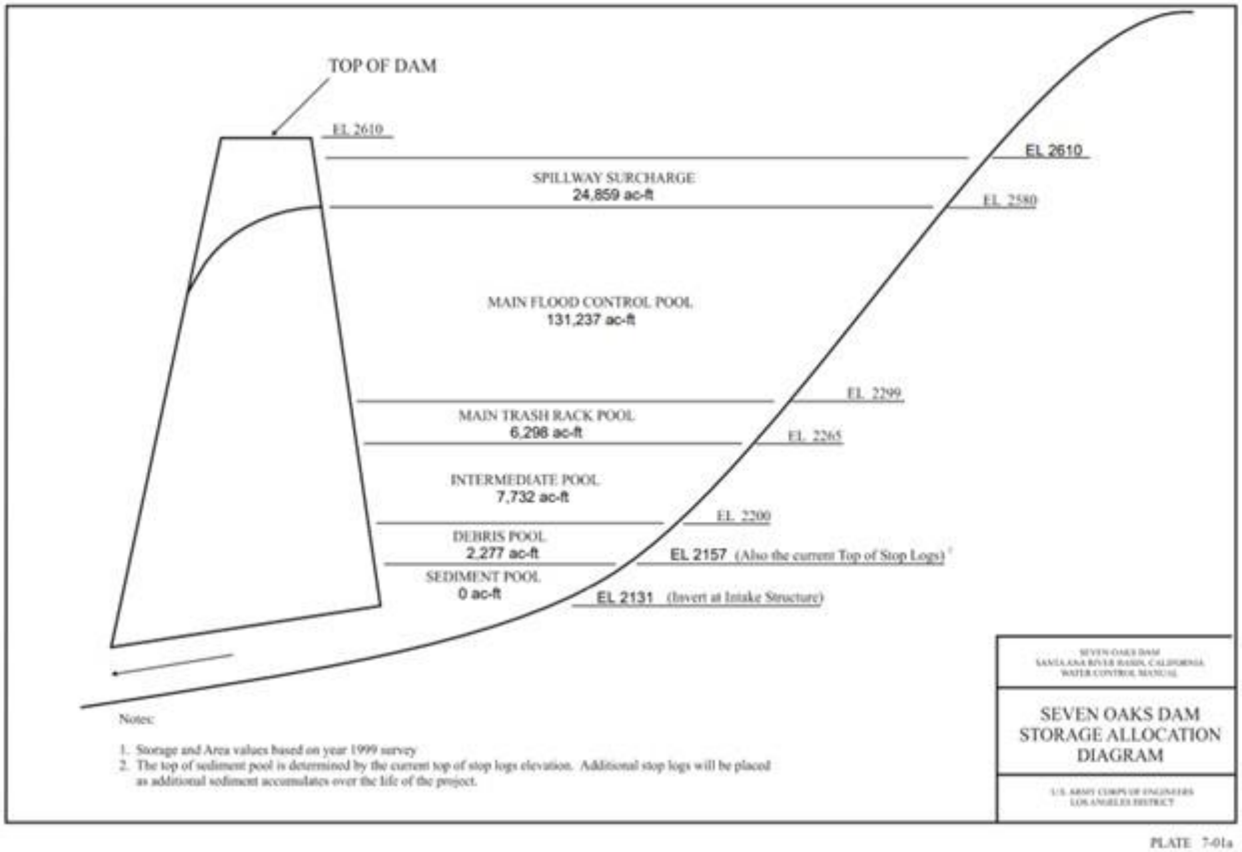

Figure 22. Water Storage Diagram for Seven Oaks Dam circa 1999

The water allocation available guided the selection of an annual runoff volume of 28,000 AF as indicative of a WY in which water could be stored at the Seven Oaks Dam for subsequent release, a "FIRO-WY". This volume of annual runoff is exceeded approximately 25% of WYs as indicated in the table (more precisely 27% of WYs, or 34 years out of 124 years). The specific years in which the runoff exceeded 28,000 AF, a FIRO-WY, were examined further to develop a projection of what quantity of water might be available for delivery in those types of WYs. The annual runoff volume in a FIRO-WY was compared to the Intermediate Pool Volume shown of 7,732 AF. The volume of the Intermediate Pool was subtracted from the overall runoff volume to represent storage regulation releases to maintain storage within the Intermediate Pool much of the time[11]. The reduced quantity of water then considered to be available for storage to release under a FIRO-regulated Seven Oaks Dam was statistically examined to identify the median volume in a FIRO-WY considered FIRO-available water. The volume of water that was estimated to be available ranged from 20,575 AF to 197,078 AF (**Table 28**).

[11] Estimator used to indicate that not all water in a FIRO-water-year would be available for release to engineered recharge and the size of the management space. For instance, the required minimum dam releases currently total 3,082.3 AFY.

Table 28. Estimated Historical "FIRO Water" or Water Available over the Intermediate Pool

Water Year	Total Annual Runoff (AF)	Estimated Water Available over the Intermediate Pool
1898	28,307	20,575
1901	43,655	35,923
1903	58,424	50,692
1904	30,624	22,892
1906	66,388	58,656
1907	113,880	106,148
1909	35,764	28,032
1911	51,040	43,308
1914	31,855	24,123
1915	58,135	50,403
1918	32,072	24,340
1922	107,292	99,560
1927	51,908	44,176
1937	71,094	63,362
1938	134,730	126,998
1941	34,895	27,163
1958	28,597	20,865
1966	30,262	22,530
1967	68,560	60,828
1969	204,810	197,078
1970	29,103	21,371
1973	31,493	23,761
1978	71,962	64,230
1979	60,017	52,285
1980	179,544	171,812
1983	111,853	104,121
1993	128,070	120,338
1995	85,718	77,986
1998	80,288	72,556
2005	103,600	95,868
2011	71,745	64,013
2019	53,067	45,335
2023	94,840	87,108
2024	59,077	51,345

The median volume of water projected to be available using this analysis is **51,815 AF**. The median volume of water projected for a FIRO-WY was forecast to be distributed from the Seven Oaks Dam at the FIRO-maximum rate of 500 cubic feet per second (cfs). At that rate, this “pool” of water could supply water for 52 days. This distribution rate was deemed to be a good fit for FIRO water to PERC projects in that they are not the first-in-line to receive FIRO water given that they require pumping and manipulation of existing infrastructure as compared to gravity-fed engineered recharge in the Santa Ana River Wash. The presumptive outcome is that FIRO water would be distributed to PERC at a high rate in these FIRO-WYs.

It is this maximum diversion rate of 500 cfs for existing infrastructure and planning, and this median estimate of water available in a FIRO-WY of 51,815 AF that was used in the recharge evaluations at the PERC Project Alternative sites. There are several FIRO-water distribution sites described below, and each has its own flowrate capacity. Each site was evaluated on the common basis of having a FIRO water supply for 52 days in a FIRO-WY and that 27% of all water years are FIRO-WYs.

There are three potential PERC project sites that can receive direct delivery of FIRO Water. They are:

1. Waterman Recharge Basins via the SBVMWD’s **Foothill Pipeline**
2. Oak Creek Recharge Basins via the SBVMWD’s **Foothill Pipeline**
3. Mill Creek Recharge Basins via either or both the SBVMWD’s **Greenspot Pipeline** and the **City of Redlands Aqueduct**

There are two additional PERC project sites that can receive a FIRO water supply indirectly. These indirect FIRO water supply sites are:

1. Twin Creek Recharge Basins via the overflow from Waterman Recharge Basins in their Existing Conditions
2. Lynwood Recharge Basins via the overflow from Waterman Recharge Basins in their Existing Conditions and then out of the Twin Creek Recharge Basins via an existing drain gate with culvert

Foothill Pipeline

Valley District's Foothill Pipeline’s primary function is delivering imported State Water Project (SWP) water from the California Department of Water Resources’ (DWR) Devil Canyon. However, due to its unique design and elevation at the Santa Ana River, the Foothill Pipeline can also function to divert FIRO program flows from the upper Santa Ana River and deliver them to PERC Project Alternatives along its alignment. The most likely diversion scenario for Santa Ana River water into the Foothill Pipeline is via SBVWCD’s Cuttle Weir below the Seven Oaks Dam diverting Santa Ana River water through Valley District’s 1A Sedimentation Basin which then outflows into a 96-inch diameter pipeline and eventually into the 78-inch diameter Foothill Pipeline. The capacity of the Foothill Pipeline is shared.

Thus, this mechanism could only be used provided there is unused capacity for the Foothill Pipeline during a period for FIRO supplies of water. There are other mechanisms for FIRO water diversion into the Foothill Pipeline from the upper Santa Ana River that provide operational flexibility.

Greenspot Pipeline

The Greenspot Pipeline is a 36-inch diameter pipeline constructed in the 1970s that is operated by SBVMWD. It can pick up gravity flow above the Seven Oaks Dam with sufficient transmission pressure to reach the SBVWCD's Mill Creek Spreading Basins, or it can pick up flows below the Seven Oaks Dam and be pressurized at the Greenspot Pump Station to distribute Santa Ana River water in a FIRO water supply over to the SBVWCD's Mill Creek Spreading Basins. The outlets for the Greenspot Pipeline to Mill Creek Spreading Basins include the Zanja/Tate metering station directly into the facility and the Crafton/East Weir outlet that gravity drops water that can be diverted at SBVWCD's Point of Diversion (POD) from Mill Creek. Both FIRO Water delivery locations introduce water at the upper-end of Mill Creek Spreading Basins providing operational flexibility to where the water is spread out for groundwater recharge. This FIRO Water supply delivery mechanism has been provided with an overall pipe and pump capacity rating of 50 cfs by SBVMWD.

Redlands Aqueduct

The current Redlands Aqueduct can pick up Santa Ana River water below the Seven Oaks Dam and under gravity flow to the lower end of the Mill Creek Spreading Basins along the aqueduct's route to the Hinckley Water Treatment Plant. Supply of FIRO water to the lower end of the Mill Creek Spreading Basins has less operational flexibility, as discussed in Volume 4, regarding the PERC Project Alternatives at the SBVWCD's Mill Creek facility. This FIRO Water supply delivery mechanism has been provided with a pipe capacity rating of 10 cfs by SBVMWD to allow for shared infrastructure usage during a FIRO water supply period.

Flow Rates in FIRO Water Years

Because the FIRO water supply was evaluated as a 52-day supply in what would categorically be a wet WY, SBVWCD and its consulting engineers recognized that a good working estimate of flow rate was needed. The target became a watershed's period typical runoff such as the average March flow rate in a wet WY. These native flow rates are described for each local watershed and are added to the FIRO delivery flow rate to generate a FIRO hydrograph that was hydraulically analyzed. For example, in the Waterman Creek watershed, the historic gage data for March in the 34 years that were rated as "FIRO exceedance" WYs were separated out and the statistics developed on those wet WY baseflow to identify the typical March flow in a FIRO-WY; in this example the resulting average flow rate used over the 52-day period for Waterman Creek is 20.1 cfs and that flow rate was added to the FIRO-water delivery rate to generate and model the FIRO hydrograph and its resulting infiltration rates and recharge yield.

Appendix B: Multiple-Accounts Analysis Indicator Scores

The foundational values for ranking are Indicator scores. An Indicator is a criterion that provides one performance metric for a Sub-Account. The range of values for any given Indicator (e.g., Ease of Maintenance) are assigned values from +7 (best in class) to 1 (worst performance).

This Appendix provides the calculated indicator values for every PERC Alterntaive considered in the *PERC Comprehensive Feasibility Study*. The shorthand ID codes for the PERC Alternatives in the first column are the same codes that were used in the Results section of Volume 1.

Groundwater Recharge Benefits Indicator Scores

ACCOUNT	**Groundwater Recharge Benefits**				
Subaccounts	***Groundwater Recharge-Benefit***	***Infiltration-rate-capacity increase***			***Recharge benefit on a "firm yield" 50-year horizon***
Indicator Score/ Site	Increased Annual Yield Ac-Ft/Year	Net Increase in Infiltration Rate Capacity (cfs)	Ease of Maintenance	Timeline to Implement	Firm Yield Acre Feet
WGA	4	6	6	6	4
TCS	1	1	6	6	1
TCL	3	4	7	4	3
LOA	1	2	5	7	2
OCA	2	2	6	7	3
PCI	3	2	5	7	2
PCU	7	6	4	1	2
MC1	4	5	1	6	4
MC2	6	6	1	6	6
MC3	7	7	1	6	7

Cost Aspects Indicator Scores

ACCOUNT	Cost Aspects		
Subaccounts	***Capital Costs***		***O&M***
Indicator Score/ Site	Capital Costs NPV	Grant Sources	$ for O&M NPV
WGA	5	1	4
TCS	6	1	7
TCL	1	1	7
LOA	7	1	6
OCA	5	7	5
PCI	5	7	5
PCU	6	7	3
MC1	1	5	2
MC2	1	5	1
MC3	1	5	1

Other Technical Aspects Indicator Scores

ACCOUNT	Other Technical Aspects				Other Technical Aspects (continued)		
Subaccounts	***Groundwater Quality Improvements - Salt & Nutrient Mgt. Planning***	***Conservation and Habitat Benefits***			***Proximity to Groundwater Pressure Zone***	***Access to State Water Project Supply***	***Groundwater Mounding***
WGA	2	7	1	4	5	7	5
TCS	1	2	1	4	6	4	5
TCL	2	6	1	4	6	4	5
LOA	1	3	1	4	7	4	2
OCA	1	3	5	7	2	7	5
PCI	2	1	2	4	5	1	2
PCU	3	1	7	5	5	1	2
MC1	5	4	2	1	1	7	2
MC2	6	4	3	1	1	7	2
MC3	7	4	5	1	1	7	2

Social Aspects Indicator Scores

ACCOUNT	Social Aspects		
Subaccounts	***Project Job Creation***		***Public Safety Hazards of Project***
WGA	3	2	1
TCS	2	1	7
TCL	7	1	7
LOA	1	1	4
OCA	3	2	1
PCI	3	2	1
PCU	2	2	1
MC1	7	5	4
MC2	7	6	4
MC3	7	7	4

Legal Aspects Indicator Scores

ACCOUNT	Legal Aspects					
Subaccounts	***CEQA***	***Permits Required- Requirements***				
WGA	4	5	5	5	5	4
TCS	7	5	5	5	5	4
TCL	1	5	5	5	5	4
LOA	7	5	5	5	5	4
OCA	1	5	5	5	5	6
PCI	3	6	6	5	5	3
PCU	4	6	6	5	5	3
MC1	4	7	4	4	7	7
MC2	4	7	4	4	7	7
MC3	3	7	4	4	7	7

ACCOUNT	Legal Aspects (continued)					
Subaccounts	***Permits Required- Requirements (continued)***				***Land Availability***	***Water Rights***
WGA	4	4	4	2	1	6
TCS	3	7	7	2	1	1
TCL	2	7	7	1	1	4
LOA	4	7	7	5	1	2
OCA	7	7	7	7	7	2
PCI	7	4	7	1	7	2
PCU	7	2	7	1	7	6
MC1	4	7	7	7	7	5
MC2	4	7	7	7	7	6
MC3	4	7	7	7	7	7