TECHNICAL MEMORANDUM

TO: San Pasqual Valley Groundwater Sustainability Agency

PREPARED BY: Amber Ritchie, PG, CHG, Micah Eggleton, and Reza Namvar, PE

REVIEWED BY: Rosalyn Prickett, AICP, Nate Brown PG, CHG, and Paula Silva, PE

DATE: May 26, 2022

RE: Project Management Action (PMA) No. 7: Initial Surface Water Recharge Evaluation, Task 1: Development of Evaluation Criteria

TABLE OF CONTENTS

ACRONYMS & ABBREVIATIONS

AFY	Acre Feet per Year
CCGS	Cumulative Change in Groundwater Storage
CVSW	Cumulative Volume of Surface Water
DTW	Depth to Water
DWR	Department of Water Resources
ET	Evapotranspiration
FIRO	Forecast Informed Reservoir Operations
GDE	Groundwater Dependent Ecosystem
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GW	Groundwater
MT	Minimum Threshold
MWD	Municipal Water District
MS4	Municipal Separate Storm Sewer System
NO3-N	Nitrate as Nitrogen
O&M	Operations and Maintenance
PMA	Project and Management Action
RMW	Representative Monitoring Well
SMC	Sustainable Management Criteria
SPV	San Pasqual Valley
SPV GSP Model	SPV GSP Integrated Groundwater/Surface Water Flow Model
TDS	Total Dissolved Solids
USGS	United States Geological Survey
WY	Water Year

1. INTRODUCTION

The San Pasqual Valley Groundwater Sustainability Agency (GSA) – comprised of the City of San Diego (City) and the County of San Diego (County) – approved and submitted to the California Department of Water Resources (DWR) the San Pasqual Valley Groundwater Sustainability Plan (GSP) in January 2022 (City of San Diego and County of San Diego, 2021). The GSP provides guidance and quantifiable metrics to ensure the continued sustainable management of groundwater resources within the San Pasqual Valley Groundwater Basin (Basin) over the 20-year implementation horizon. To accomplish this, the GSP includes a hydrogeological conceptual model, monitoring requirements, sustainability criteria, and several projects and management actions. The projects and management actions (PMAs) included in the GSP are intended to create opportunities for sustainable groundwater management in the Basin that respond to changing conditions and help prevent undesirable results. The Basin is currently sustainably managed, and no PMAs are needed to achieve sustainability. However, PMAs can improve understanding of the groundwater system to maintain sustainability into the future.

This technical memorandum is the first of several that focuses on PMA No. 7, which aims to complete an Initial Surface Water Recharge Evaluation. The GSA will use the Initial Surface Water Recharge Evaluation to determine the benefits to the Basin and feasibility of implementation of potential recharge projects. A preliminary assessment (see Appendix N of the San Pasqual Valley GSP) of Sutherland Reservoir as a surface water supply was conducted as part of the scoping for PMA No. 7. Because the City owns and operates the Sutherland Reservoir located upgradient from San Pasqual Valley, the City has the authority to explore surface water recharge options that may involve Sutherland Reservoir releases. As such, the City is responsible for public outreach, costs, and coordination with necessary entities related to PMA No. 7. Ultimately, completing this Initial Surface Water Recharge Evaluation is estimated to take two years, and the resulting information will be provided in a Preliminary Feasibility Study.

The Preliminary Feasibility Study will summarize the initial evaluation of surface water recharge opportunities in San Pasqual Valley, and will include the following sections:

- Evaluation Criteria and Ranking Process (Task 1)
- Streambed Investigation (Task 2)
- Water Sources for Recharge (Task 3)
- Potential Recharge Strategies (Task 4)
- Modeling Approach and Results (Task 5)
- Potential Benefits to Groundwater Dependent Ecosystems (GDEs) (Task 6)

The purpose of this technical memorandum for Task 1 is to establish the evaluation criteria by which to determine the best surface water recharge strategy option(s) for the Basin. The following criteria will be used to rank the recharge strategies:

- Criterion 1: Reduction of Modeled Deficit in Cumulative Groundwater Storage
- Criterion 2: Maintenance of Shallower Groundwater Levels in the Basin
- Criterion 3: Reduction of Projected Groundwater Levels Below Minimum Thresholds
- Criterion 4: Efficiency of Recharge (in relation to losses through evapotranspiration [ET] and outflows)
- Criterion 5: Improvements in Groundwater Quality
- Criterion 6: Benefits to GDEs
- Criterion 7: Cost of Implementation and Maintenance
- Criterion 8: Feasibility of Implementation and Maintenance

The following subsections provide details of the proposed recharge strategies, as well as additional context and descriptions for each evaluation criterion and the metric(s) used to rank and score the strategies. Baseline and proposed recharge strategies will be developed to produce the data required to estimate metrics for each strategy. The recharge strategies will be compared against the baseline to rank and ultimately score them.

Note that the scoring rubric for each criterion will be determined after the simulations have been completed, because the criteria must be appropriate for the scale of differentiation between the strategy results. For example, relatively minor differences (e.g., a few acre-feet per year [AFY]) in cumulative change in groundwater storage (CCGS) across all four strategies would lend itself to forced rank scoring, which ranks the strategies in numerical order from 1 to 4 based on the metric (e.g., 1 = smallest, 4 = largest). Greater differences (e.g., hundreds to thousands of AFY) between the strategies may be better scored according to a category ranking approach, which would rank the strategies on a defined scale (e.g., 1 for <500 AFY, 2 for 500 to 1,000 AFY, etc.). As described in Section 5, a criterion weighting exercise will be completed with the Core Team to establish the relative importance of each criterion.

2. RECHARGE STRATEGIES

The Initial Surface Water Recharge Evaluation will consider four strategies, as follows:

- Strategy 1: Forecast-informed, preemptive releases from Sutherland Reservoir
- Strategy 2: Stormwater detention in small drainages
- Strategy 3: Check dams in selected tributary creeks
- Strategy 4: Stream channel modifications to increase infiltration capacity

Completion of Tasks 2 (Streambed Investigation), 3 (Water Sources for Recharge), and 4 (Potential Recharge Strategies) identified in the Preliminary Feasibility Study will help to define the recharge strategies necessary for further modeling and evaluation. Through the work completed on these tasks, each strategy will have a project description that includes the annual volume of additional recharge (which may be calculated as a long-term average), mapped location of anticipated groundwater recharge, and a description of the recharge facility. The annual volume of additional recharge from each strategy will be computed by the version of the San Pasqual Valley Groundwater Sustainability Plan Integrated Groundwater/Surface Water Flow Model (SPV GSP Model) that will be updated with information from Task 2 (Streambed Investigation) of the Preliminary Feasibility Study.

As described in the San Pasqual Valley GSP, there are significant contributing catchments upstream from and outside of the Basin and SPV GSP Model domain. Surface water inflows from the contributing catchments are accounted for via boundary conditions in the SPV GSP Model, as shown in **Figure 1**. Three United States Geological Survey (USGS) gage locations exist in the vicinity of the SPV GSP Model domain; two of which coincide with domain boundary of the SPV GSP Model and one is located east of the domain. These gages provide measured streamflow rates for use in the SPV GSP Model, as shown in **Figures 1** and **2**. Three other catchments do not have stream gages. These stream inflows are estimated for the historical period by aggregating the modeled runoff in the contributing watersheds on a monthly scale upgradient from the inflow points to the model domain.

2.1 Strategy 1: Forecast-Informed, Preemptive Releases from Sutherland Reservoir

By tracking and adjusting the timing and quantity of releases from Sutherland Reservoir, recharge may be strategized to maximize the effectiveness of groundwater recharge in the Basin. Forecast Informed Reservoir Operations (FIRO) is a reservoir-operations strategy that better informs decisions to retain or release water by integrating additional flexibility in operation policies and rules with enhanced monitoring and improved weather and water forecasts. Historically, large storm systems and atmospheric rivers have provided critical water supply to Sutherland Reservoir. By tracking and forecasting these events, larger surpluses in storm flow could potentially be captured with releases timed to maximize the recharge of extra water created by these storm events. This recharge strategy will be defined by evaluating historical data on Sutherland Reservoir operations and releases, with the intent that a FIRO approach may be feasible for recharging the Basin should this strategy be retained for further evaluation.

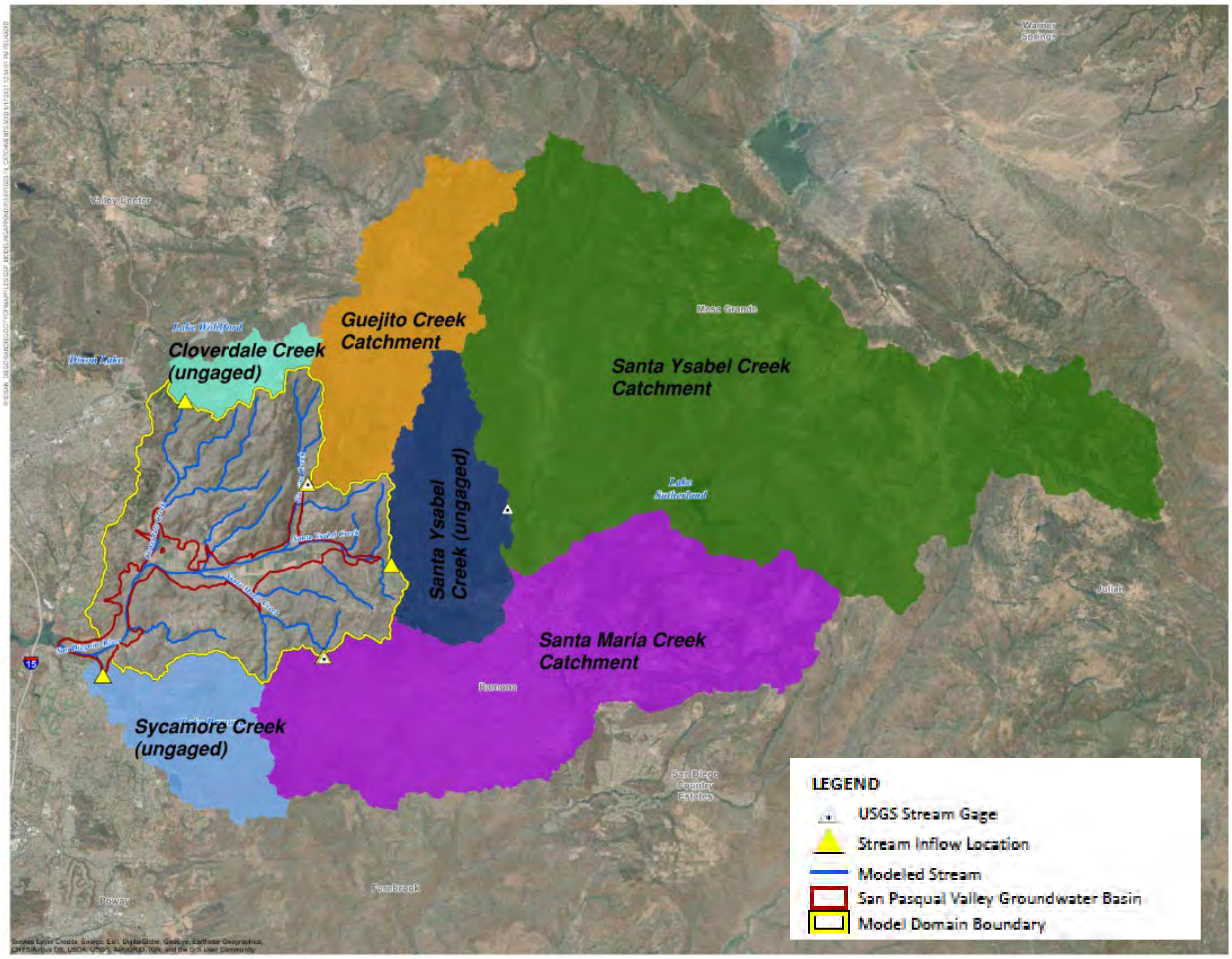

Figure 1: San Pasqual Valley Greater Watershed and Catchments

2.2 Strategy 2: Stormwater Detention in Small Drainages

Retaining stormwater during peak flow events in small drainages would allow stormwater to be dispersed and allowed to infiltrate. Extended releases from upstream detentions would potentially improve water availability for downgradient water users. Onsite control of these peak flows by creating smaller subcatchments to temporarily store excess stormwater would improve stormwater management and allow more surface area for surface water recharge within the Basin. This recharge strategy will be defined by evaluating stormwater flows at suitable locations for detention structures and subcatchments.

2.3 Strategy 3: Check Dams in Selected Tributary Creeks

A check dam is a small, sometimes temporary, barrier constructed across a swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity. Check dams constructed across selected creeks could also increase infiltration to groundwater due to decreases in streamflow velocity during storm events. This recharge strategy will be defined by evaluating precipitation and streamflow at selected tributaries. Monitoring data from the existing USGS stream gages during both low flow and peak flow (storm) events will be utilized to identify the tributary location(s) and preliminarily design of the check dams.

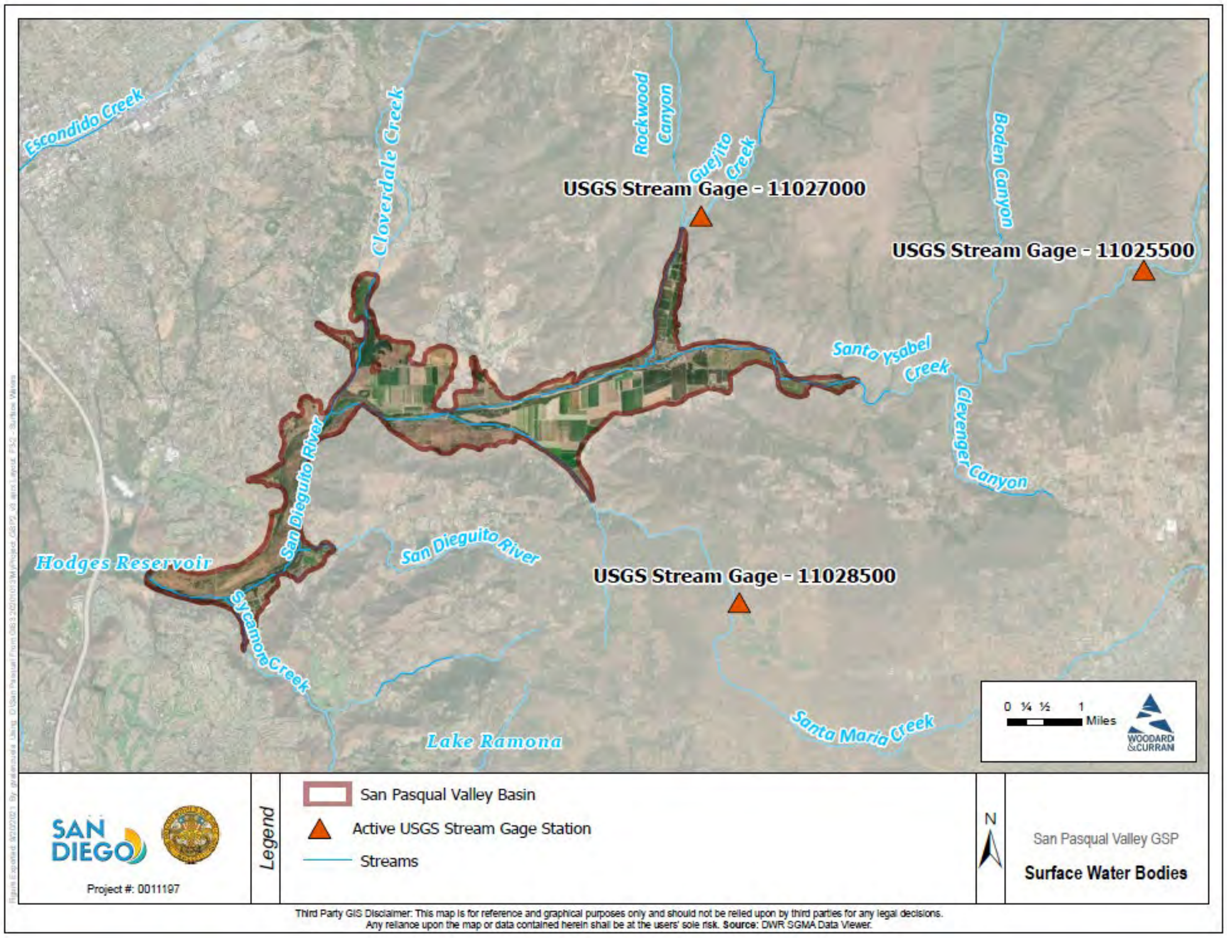

Figure 2: USGS Streamflow Gages in and around the San Pasqual Valley

2.4 Strategy 4: Stream Channel Modifications to Increase Infiltration Capacity

In addition to check dams, other channel modifications could be implemented to increase the infiltration capacity. Examples of modifications to increase infiltration capacity include channel scouring to replace low-permeability sediments of streambed material with higher-permeability sands and gravels, slowing streamflows by widening or extending stream meanders, and other approaches that would encourage greater streamflow retention and infiltration. This recharge strategy will be defined by evaluating monitoring data from the existing USGS stream gages and stream channel geometries and infiltration characteristics from Task 2 of the Preliminary Feasibility Study for the Initial Surface Water Recharge Evaluation.

3. EVALUATION CRITERIA

The overall goal of the PMAs identified in the San Pasqual Valley GSP is to avoid undesirable results, which are defined in Section 8 of the GSP. Each recharge strategy will be modeled and evaluated based on the eight criteria described in Table 1 and the following subsections (Sections 3.1 through 3.8). As a first step, a baseline simulation will be established using the updated SPV GSP Model (following integration of new streambed information collected in Task 2). This baseline strategy will provide modeled groundwater elevations, depths to water, and water budget data. Recharge strategy metrics will be computed and compared against these baseline metrics. Thus, the only difference between the input files of the baseline simulation and each recharge strategy simulation will be the intended change in parameters and boundary conditions related to the recharge strategy. All other assumptions regarding water year (WY) type and hydrology will remain unchanged. Conducting the evaluation in this manner will help isolate and quantify the modeled effect of implementing the recharge strategy and allow one to assess the evaluation criteria.

The SPV GSP Model in its current form has monthly stress periods, but the updated version of the SPV GSP Model for use with this recharge evaluation will include selected subperiods with daily stress periods to evaluate the recharge strategy. Because the updated SPV GSP Model will include additional stress periods, model runtimes of several hours to days for each simulation is a possibility. In an effort to efficiently perform the modeling to support the evaluation of the recharge strategies, the 15-year historical simulation period of WYs 2005 through 2019 will be used. This period contains a variety of WY types and will be adequate for developing the modeling workflow and conducting the initial analyses.

After the workflow process is developed and the initial results are reviewed and considered reasonable, it is anticipated the model will be run using the higher-priority recharge strategies that could be adequately assessed using monthly stress periods with up to a 67-year simulation period including WYs 2005 through 2071. This simulation period includes the historical and projected periods with climate change already incorporated into the projection portion of the simulation period, as described in the GSP. **Figure 3** illustrates the water budget reference volume for water budget values presented in the GSP. This reference volume includes the alluvium and residuum within the DWR-defined Basin. The water budgets prepared for the GSP focused on the Basin as a whole, per DWR requirements. However, because the eastern half of the Basin is where most of the groundwater recharge from streams occurs, a subarea water budget will also be prepared for the eastern portion of the Basin for the recharge evaluations.

For strategies that extend beyond the SPV GSP Model domain, CWASim may also be utilized to estimate some of the proposed metrics. CWASim is a GoldSim model originally developed for the San Diego County Water Authority by CH2M (now Jacobs) in support of the 2013 Regional Facilities Optimization and Master Plan Update. The CWASim model is a systems model that contains regional reservoirs, along with natural and constructed water conveyance facilities.

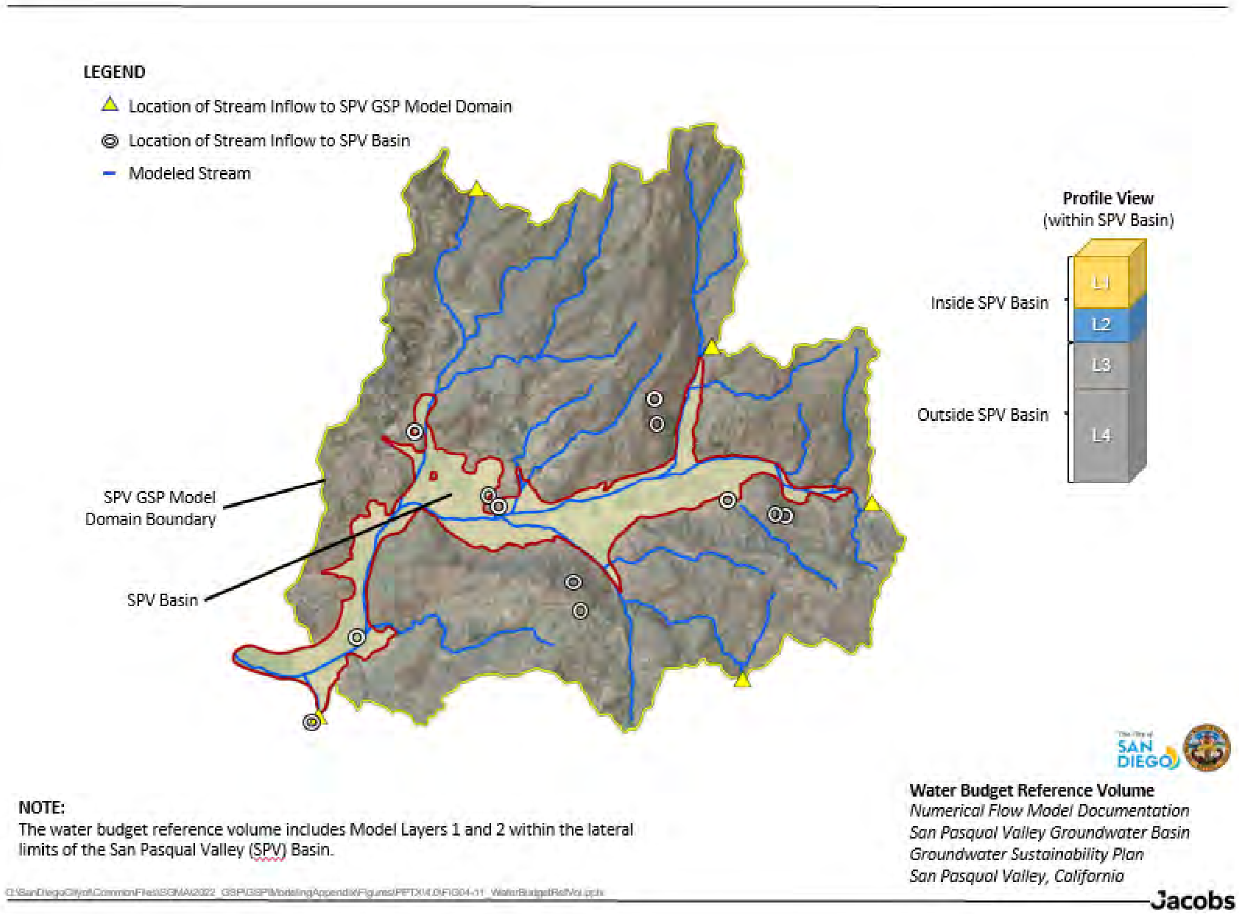

Figure 3: Water Budget Reference Volume

The western and eastern portions of the Basin have distinctly different DTW and GDE characteristics (refer to Section 8 of the GSP). For water budgeting purposes, this Surface Water Recharge Evaluation will consider that area (western edge of the confluence of Santa Ysabel Creek and Santa Maria Creek) as the subarea division (see **Figure 4**). Computing water budgets by subarea is appropriate because stream recharge generally occurs in the eastern half of the Basin and groundwater levels at domestic wells in the eastern half of the Basin are critical to protect during GSP implementation. Having too large of a water budget reference volume could tend to "wash out" the modeled benefits from implementing a recharge strategy and give a false impression that the strategy is not worth pursuing.

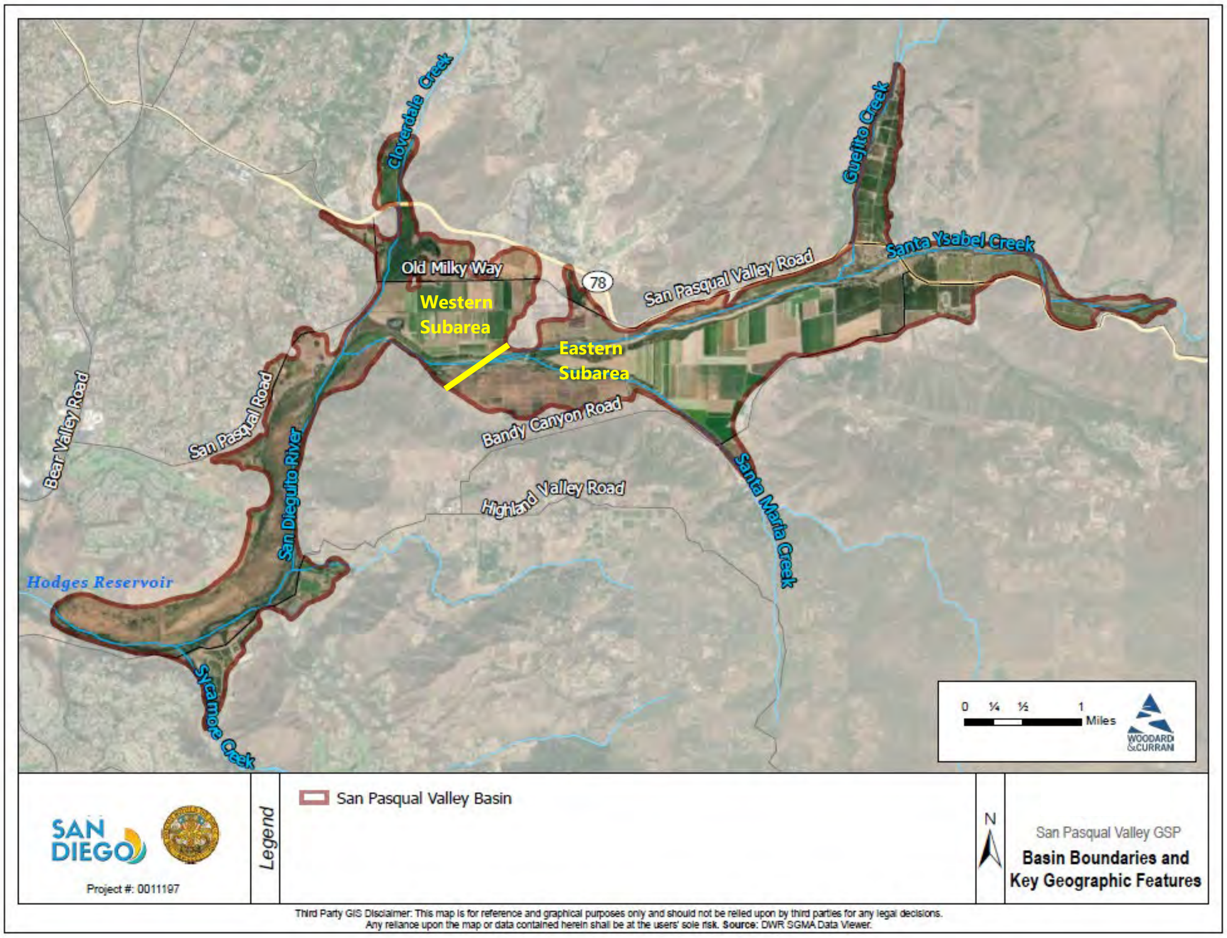

Figure 4: San Pasqual Valley Basin – Subareas

3.1 Criterion 1: Reduction of the Modeled Deficit in Cumulative Groundwater Storage

Criterion 1 ranks each of the four recharge strategies on its effectiveness to reduce the modeled deficit in cumulative groundwater storage in the Basin, as described in the GSP. Although the Basin is currently sustainable, based on the sustainability indicators established in the GSP, the groundwater budgets computed by the SPV GSP Model during preparation of the GSP indicate an average deficit in the cumulative change in groundwater storage ranging from -245 AFY under historical conditions (WYs 2005 through 2019) to -53 AFY under current conditions (i.e., WYs 2015 through 2019). This deficit range represents 0.6 to 3 percent of the average of the groundwater inflows and outflows during the current and historical periods and is more likely than not, within the uncertainty of the estimates of the water budgets.

For each recharge strategy, the updated SPV GSP Model will be used to compute a water budget. The difference between the monthly and annual water budget volumes in the baseline and recharge-strategy simulations will be used to quantify the effect of the recharge strategy on the historical water budget. The metric for ranking each strategy for its effectiveness in improving water supply reliability will be on reduction of the deficit in the modeled cumulative change in groundwater storage. Tables and/or charts showing groundwater storage volume through time will be presented for the baseline simulation and each recharge strategy to facilitate evaluating which recharge strategies result in greater groundwater storage (and therefore, the greatest reduction on the deficit in the modeled cumulative change in groundwater storage). The reduction of modeled deficit in cumulative groundwater storage will be calculated as cumulative change in groundwater storage in a proposed strategy minus cumulative change in groundwater storage in the baseline. The results of each strategy will be compared and ranked.

3.2 Criterion 2: Maintenance of Shallower Groundwater Levels

Criterion 2 ranks each of the four recharge strategies on its ability to maintain groundwater levels throughout the Basin. The historical observed groundwater levels in the Basin indicate that groundwater flow is east to west seasonally and for all water years. The seasonal high occurs in spring; with the seasonal low in fall. As of the first Annual Report for Water Years 2020/21 and 2021/22, groundwater levels do not exceed the minimum thresholds (MTs) or planning thresholds (PTs) in any of the representative monitoring network wells. However, the effect of future hydrology on groundwater levels is uncertain. Therefore, evaluating different surface water recharge strategies is an important step toward improving water supply reliability during GSP implementation.

WY 2021 groundwater gradients in the Basin show a reducing depth to groundwater towards the western part of the Basin, with an average difference of 65 feet in groundwater levels between the eastern and western portions of the Basin, as shown in **Figure 5**.

The metric for ranking each strategy for its effectiveness in providing enhanced groundwater recharge will be based on increases in modeled groundwater elevations at the RMWs. Groundwater-level hydrographs will be presented for the baseline simulation and each recharge strategy to facilitate evaluating which recharge strategies result in higher groundwater elevations at the RMWs. The maintenance of shallower groundwater levels will be calculated as the average depth to water (DTW) difference in the RMWs in a proposed strategy relative to the baseline. The results of each strategy will be compared and ranked.

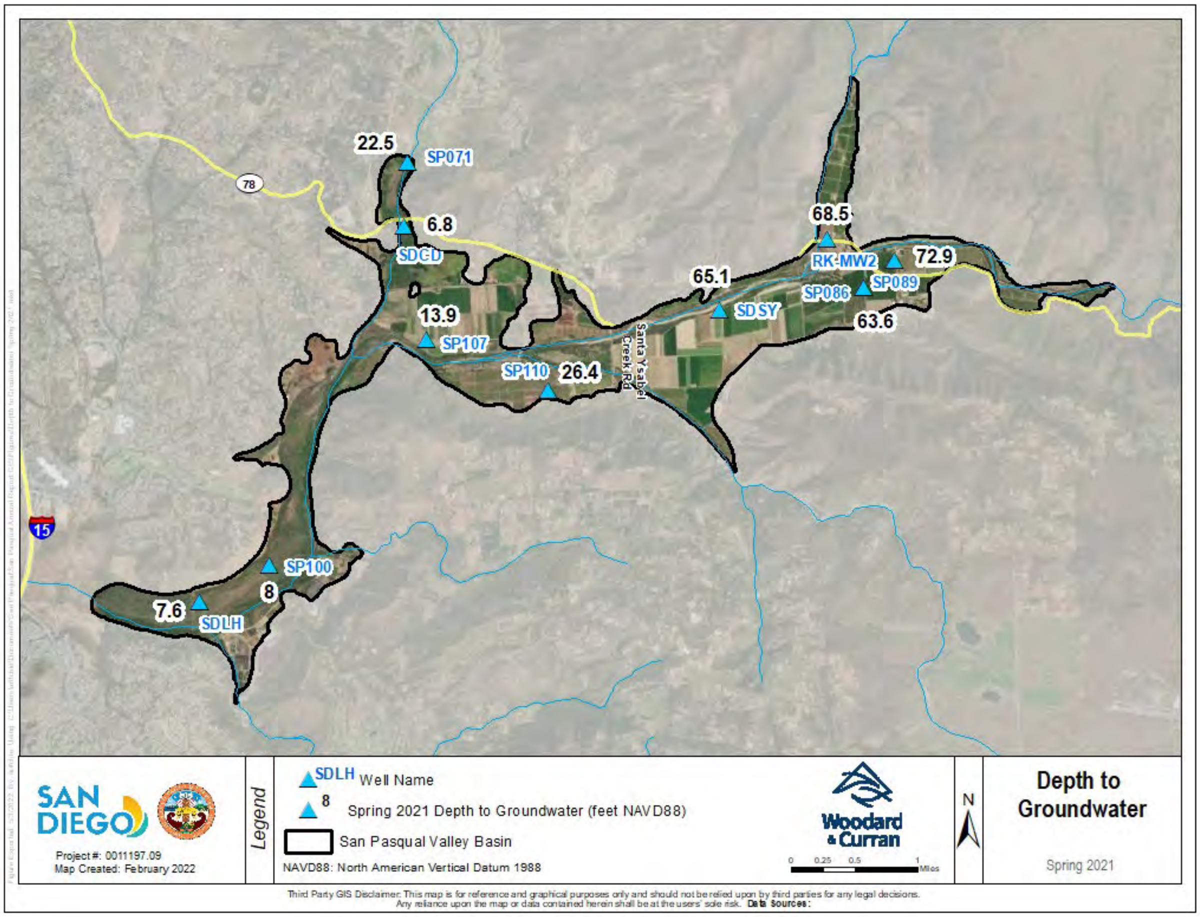

Figure 5: Groundwater Levels, Spring 2021

3.3 Criterion 3: Reduction of Projected Groundwater Declines to MTs

Criterion 3 ranks each of the four recharge strategies based on its potential to keep modeled hydrographs at the groundwater level RMWs from going below MTs. Modeled groundwater levels at the RMWs under each recharge strategy will be ranked according to the ability of the modeled levels to stay above MTs. Groundwater levels that stay above the MTs will avoid the undesirable results defined in the GSP for chronic lowering of groundwater levels, reduction of groundwater storage, and depletions of interconnected surface water (in the western subarea).

The metric for ranking each strategy for its reduction in occurrences of groundwater levels below MTs will be based on modeled groundwater levels at RMWs as compared with the established MTs for each RMW. Groundwater-level hydrographs will be presented for the baseline simulation and each recharge strategy to facilitate evaluating which recharge strategies result in fewer instances of modeled groundwater levels below MTs. The number of occurrences of groundwater levels below the MTs in each proposed strategy will be compared to the projected number of occurrences of groundwater levels below the MTs in the baseline. The results of each strategy will be compared and ranked.

3.4 Criterion 4: Efficiency of Recharge

Criterion 4 ranks each of the four recharge strategies based on its ability to increase groundwater storage relative to the volume of water made available for the groundwater recharge strategy, as shown in Equation 1:

$$Efficiency\ of\ Recharge = \frac{Volume\ Increase\ in\ Groundwater\ Storage}{Volume\ of\ Water\ Made\ Available\ for\ the\ Groundwater\ Recharge\ Strategy} \quad (1)$$

The efficiency of recharge quantifies the net benefit of implementing the recharge strategy from a groundwater storage perspective, with consideration of increased water losses from increased infiltration. The net benefit approach is appropriate because, as previously stated, increasing groundwater inflows in the eastern portion of the Basin will increase groundwater outflows in the western end of the Basin. So not all of the infiltrated water from a recharge strategy would be available for groundwater use because of increased groundwater outflows to ET and subsurface outflow (i.e., losses). Recharge efficiencies will be presented for each recharge strategy to facilitate evaluating which recharge strategies would have the greatest potential for the most efficient improvement to groundwater storage.

The efficiency of recharge will be calculated as the cumulative change in groundwater storage (CCGS) divided by the cumulative volume of surface water made available for groundwater recharge (CVSW) in a proposed strategy relative to the baseline. The CVSW will be calculated as the total amount of surface water that is released, diverted, or captured as part of each recharge strategy (before loss to ET in conveyance to the Basin). The results of each strategy will be compared and ranked.

3.5 Criterion 5: Improvements in Groundwater Quality

Recharge strategies that result in less loading of total dissolved solids (TDS) or nitrate as nitrogen (NO3-N) to the groundwater may improve groundwater quality within the Basin. To evaluate the relative benefits of each of the four recharge strategies with respect to groundwater quality, Criterion 5 will calculate mass loading of TDS and NO3-N to the Basin. The model-simulated recharge associated with each surface water source will be multiplied by its measured TDS and NO3-N concentrations. The result for each constituent will be summed and then divided by the total recharge from all surface water sources to obtain flow-weighted-average concentrations for TDS and NO3-N for each recharge strategy.

Groundwater quality maps included in the Annual Report for WYs 2020 and 2021 (Woodard & Curran, 2022) are shown in **Figure 6.** Capture and recharge of surface water in some portions of the watershed may have differing effects on groundwater quality at the RMWs shown in the figure. This criterion will qualitatively evaluate potential impacts to groundwater quality by comparing changes in source water quality with and without recharge strategies.

The recharge strategies will be evaluated and scored based on the differences among the resulting flow-weighted, average TDS and NO3-N concentrations relative to baseline conditions. Strategies with lower average NO3-N or TDS concentrations than baseline indicate the potential for groundwater quality improvement. Conversely, strategies with higher average NO3-N or TDS concentrations relative to baseline indicate the potential for further degradation of water quality. The results of each strategy will be compared and ranked.

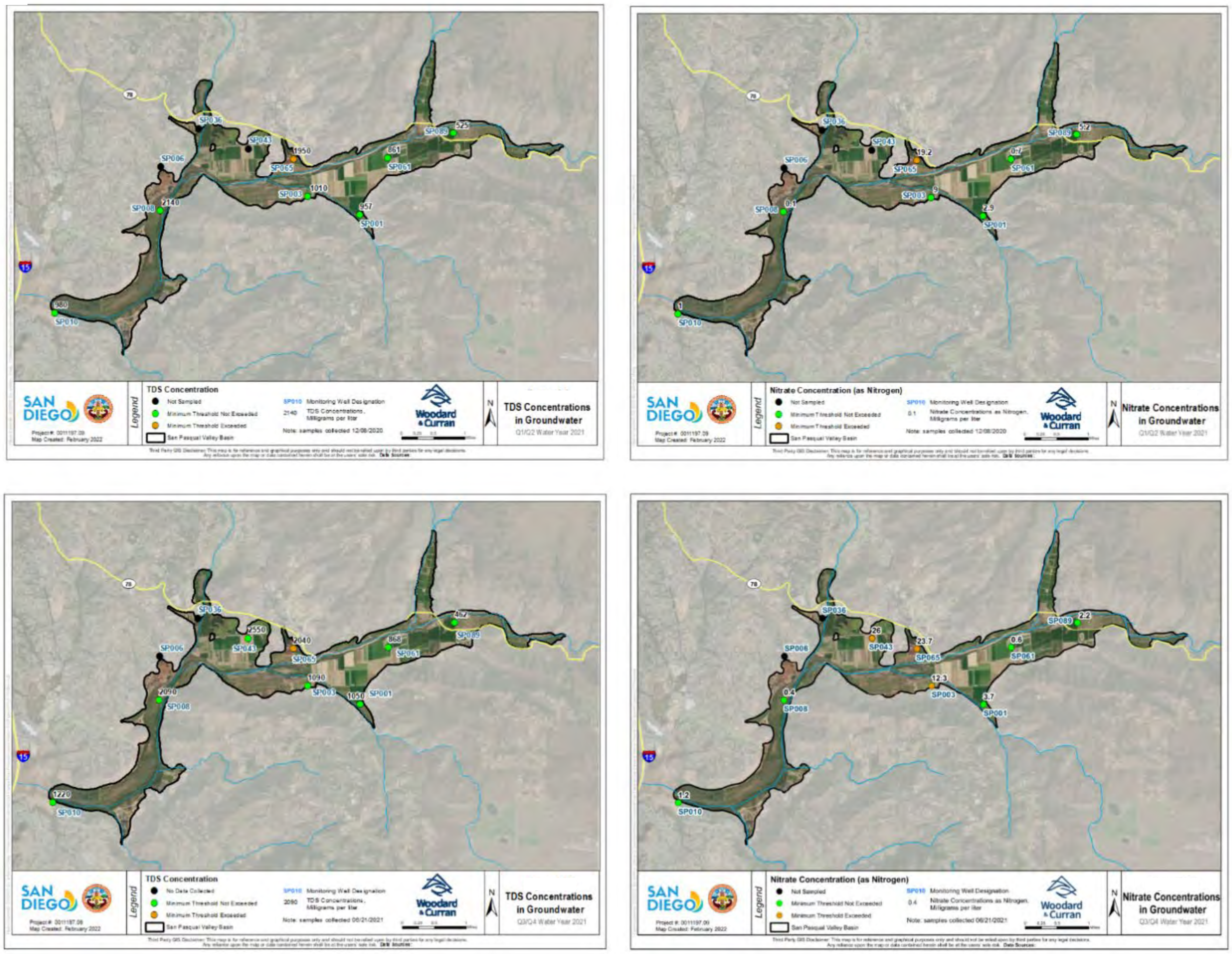

Figure 6: Groundwater Quality Results, Spring 2021

3.6 Criterion 6: Benefits to GDEs

Criterion 6 ranks each of the four recharge strategies on its benefits to GDEs in the Basin. Potential GDEs largely consist of dense riparian and wetland communities along mapped drainage systems where monitoring well data indicate the average depth to groundwater of no more than 30 feet below ground surface (bgs). These GDEs are most prominent in the western portion of the Basin where groundwater is shallowest (see **Figure 7**). Many of the potential GDEs observed appear to rely on surface flows or stormwater runoff, as well as groundwater. The potential non-GDE vegetation largely exists in dry upland areas dominated by shallow-rooted grasses and invasive species. Areas that include wetland and riparian phreatophytes (i.e., deep-rooted plant species) along drainageways, where the average depth to groundwater is typically deeper than 30 feet bgs, were classified as wetland and riparian communities.

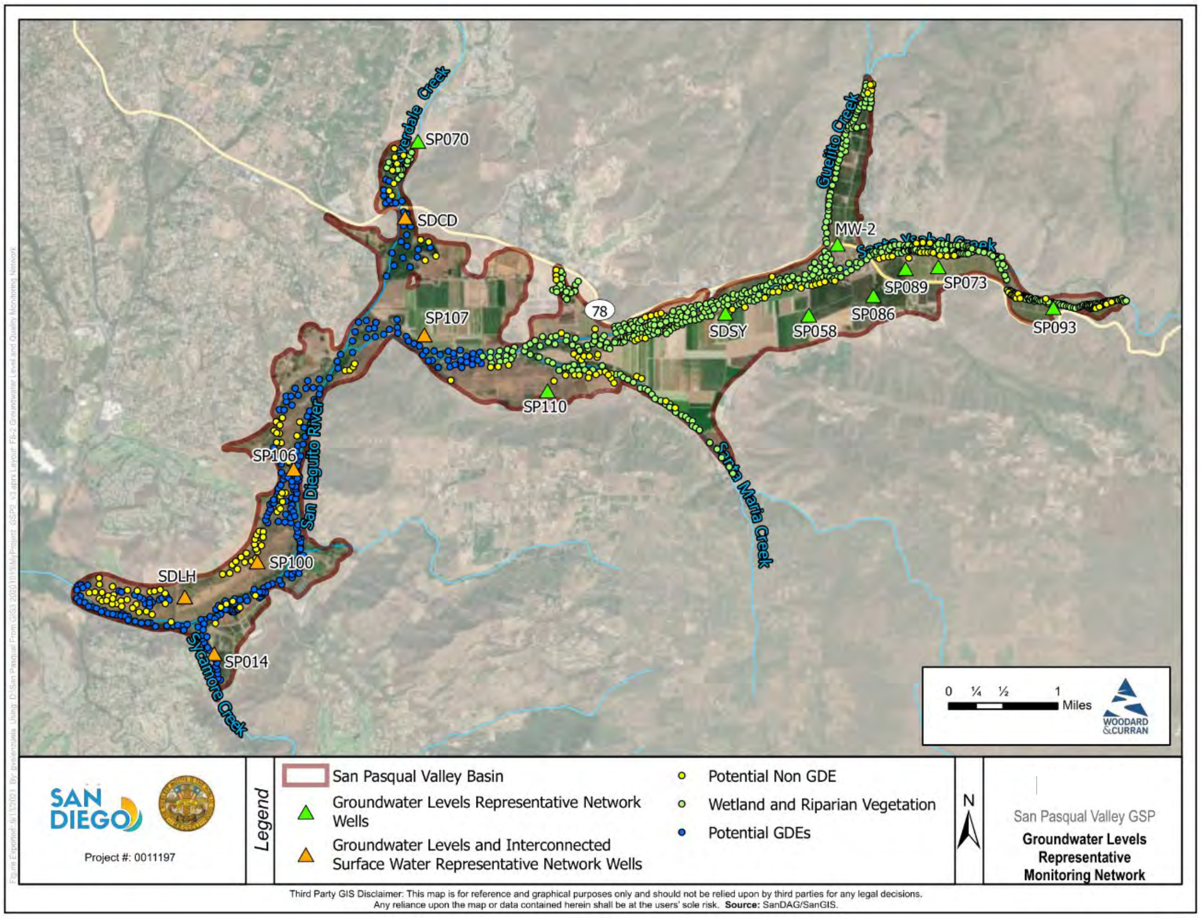

Figure 7: Groundwater Dependent Ecosystems in the Basin

Strategies will be scored based on their maintenance and/or improvement of GDE access to groundwater from baseline conditions. Established GDE's should have protected groundwater levels that do not draw down to depths where root zones can no longer access groundwater in the western portion of the Basin. Scoring for this criterion will award points if the RMWs near GDEs have greater consecutive days of groundwater access within rooting depths due to the surface water recharge activities. Outputs may include charts of water levels at the monitoring wells near the GDEs under each strategy to compare and contrast the impact of each strategy.

The potential benefits to GDEs will be calculated as the average number of consecutive days that simulated DTW extends below the target rooting depths for the GDEs RMWs in a proposed strategy relative to the baseline. The results of each strategy will be compared and ranked.

3.7 Criterion 7: Cost of Implementation and Maintenance

Criterion 7 ranks each of the four recharge strategies on its cost of implementation and maintenance. The cost to implement each strategy will vary depending on the size and type of facilities, operational changes needed on existing facilities, and the ongoing operation and maintenance (O&M) activities. Projects often require a one-time capital outlay that can vary widely depending on the size of the project and could be prohibitive to implementation. However, these projects could provide different recharge benefits and have different long-term O&M costs that should also be considered. Unit cost considers costs over time per unit of supply, and allows for comparison of projects with varying costs and volumes.

The unit cost of implementation and maintenance will be calculated in acre-foot per year (AFY) for a proposed strategy relative to the baseline. The AFY calculation will be based on the CCGS for the strategy relative to baseline. The results of each strategy will be compared and ranked.

3.8 Criterion 8: Feasibility of Implementation and Maintenance

Criterion 8 ranks each of the four recharge strategies based on the feasibility of its implementation and maintenance when considering the legal, institutional, and regulatory requirements. For example, some strategies may require permits, regulatory approval, environmental studies or delineations, or other requirements before implementation. Although the preliminary costs of implementing each recharge strategy are captured in the criterion described in Section 3.7, these feasibility factors can increase the effort, labor, and time needed to implement each strategy.

In this criterion, the City may consider each strategy's effect on municipal supplies, both upstream and downstream. For example, releases from Sutherland Reservoir may reduce the amount of water supply available for municipal use from that reservoir, while capture and infiltration of wet weather flows in the Basin may reduce the amount of outflow (and associated municipal use) of water supply from Hodges Reservoir. Calculating and understanding these volumes may be helpful in comparing the strategies.

This qualitative evaluation is necessary to capture some of the key non-quantifiable factors that the City must consider. The feasibility of implementation and maintenance will consider the number and difficulty of permits, institutional challenges, and schedule for a proposed strategy relative to the baseline. The results of each strategy will be compared and ranked.

3.9 Summary

Table 1 provides a summary of each criterion, data source, metric, and evaluation approach that will be used to rank the four potential recharge strategies.

Table 1: Summary of Surface Water Recharge Evaluation Criteria

Criterion	Data Source	Metric	Evaluation Approach	Scoring	Weighting (%)
Criterion 1: Reduction of Modeled Deficit in Cumulative Groundwater Storage	• SPV GSP Model[a]	• Cumulative change in groundwater storage (CCGS)	• Calculated as CCGS (strategy) minus CCGS (baseline)	• Forced rank (e.g., 1 = smallest, 4 = largest) or possibly a category rank (e.g., 1 for <500 AFY, 2 for 500 – 1,000 AFY, etc.) • Approach to be finalized after model runs have been completed	To be determined (TBD)
Criterion 2: Maintenance of Shallower Groundwater Levels in the Basin	• SPV GSP Model[a]	• Depth to water (DTW) at representative monitoring wells (RMW)	• Average difference of DTW between the strategy and baseline simulation at RMWs • Calculated as the sum of DTW [strategy] minus DTW [baseline] for each RMW divided by the number of simulation days, divided by the number of RMWs	• Forced rank (e.g., 1 = smallest, 5= largest]) or category rank (e.g., 1 for <10 feet, 2 for 10 – 20 feet, etc.) • Approach to be finalized after model runs have been completed	TBD
Criterion 3: Reduction of Projected Groundwater Levels Below Minimum Thresholds	• SPV GSP Model[a]	• Modeled groundwater levels at all RMWs	• Number of occurrences of DTW below MTs (baseline) minus number of occurrences of DTW below MTs (strategy)	• Forced rank or category rank based on the differences relative to baseline (lower counts ranked higher) • Approach to be finalized after model runs have been completed	TBD

Criterion	Data Source	Metric	Evaluation Approach	Scoring	Weighting (%)
Criterion 4: Efficiency of Recharge	• SPV GSP Model[a] • CWASim[b] • Possibly other hydrologic/hydraulic models	• Ratio of volume of CCGS to the cumulative volume of surface water (CVSW) made available for groundwater recharge	• Calculated as the difference in CCGS between the strategy and baseline simulations divided by CVSW [strategy])	• Forced rank or category rank based on the differences in the recharge efficiency (higher efficiencies would be ranked higher) • Approach to be finalized after model runs have been completed	TBD
Criterion 5: Improvements in Groundwater Quality	• SPV GSP Model[a] • Measured total dissolved solids (TDS) and nitrate as nitrogen (NO3-N) concentrations in source water	• Potential change in source water flows and concentrations of TDS and NO3-N with the strategy versus baseline flows and concentrations	• Differences among the flow-weighted average TDS and NO3-N concentrations for the surface water recharge supply for each strategy relative to baseline. • Flow-weighted, average concentration calculated as: (Concentration [A] x GW recharge [A] + Concentration [B] x GW recharge [B] + Concentration [C] x GW recharge [C] + ...) divided by (GW recharge [A]+ GW recharge [B]+ GW recharge [C] ...) • A, B and C, refer to the surface water sources that recharge groundwater	• Forced rank or category rank based on the differences in the flow-weighted concentrations to baseline with individual scoring for TDS and NO3-N, which will be summed to one score for overall ranking (lower averaged concentrations ranked higher)	TBD
Criterion 6: Benefits to GDEs	• SPV GSP Model[a] • GDE Pulse[c]	• Depth to water at GDE RMWs as compared with the root-zone depth of GDEs relative to baseline	• Revised estimates of target rooting depths will be determined for the GDE RMWs as an outcome of Task 6 • Compute the average number of consecutive days the modeled DTWs occur below target rooting depths for the GDE RWMs relative to baseline • Calculated as the sum of the consecutive days the modeled DTW persists below target rooting depths for each RMW divided by the total simulation days, divided by the number of GDE RMWs, as compared with baseline	• Forced rank or category rank based on the range of differences among the strategies (fewer average consecutive days would be ranked higher) as compared with baseline • Approach to be finalized after model runs have been completed	TBD

Criterion	Data Source	Metric	Evaluation Approach	Scoring	Weighting (%)
Criterion 7: Cost of Implementation and Maintenance	• City of San Diego • County of San Diego • Woodard & Curran • Jacobs	• Capital and maintenance costs	• Cost per AF of recharge relative to baseline • Calculated as the preliminary cost (Class 5[d] cost estimates with maintenance costs amortized over the simulation period) for each strategy	• Forced rank or category rank based on the range of costs • Approach to be finalized after preliminary costs have been developed	TBD
Criterion 8: Feasibility of Implementation and Maintenance	• City of San Diego • County of San Diego • Woodard & Curran • Jacobs	• Identified permits, institutional challenges, and schedule for each strategy	• Qualitative assessment based on the number and difficulty of permits, institutional challenges, and schedule	• Force or category rank based on difficulty of implementation (higher ranking for projects that are easier to implement)	TBD
TOTAL CRITERIA WEIGHTING					**100**

[a] Refers to the SPV GSP Model described in Appendix I of the GSP (City of San Diego, 2021). This Surface Water Recharge Evaluation will update the SPV GSP Model with new information acquired in Task 2.

[b] A GoldSim model originally developed for the San Diego County Water Authority by CH2M (now Jacobs) in support of the 2013 Regional Facilities. Optimization and Master Plan Update (CH2M and Black & Veatch, 2014). The CWASim model was also used in the San Diego Watershed Basin Study completed in partnership between the City of San Diego Public Utilities Department and the Bureau of Reclamation (City of San Diego and Reclamation, 2017).

[c] GDE Pulse tool available from The Nature Conservancy (https://gde.codefornature.org/#/home).

[d] Class 5 cost estimate is considered a rough order of magnitude (ROM) estimate, typically used for the initial screening projects for capital expenditure planning.

4. CRITERIA WEIGHTING

An additional key element to the scoring of recharge strategies based on this multi-criteria evaluation approach is the weight given to each criterion, where weight reflects the relative importance of the criteria. The Core Team and stakeholders will discuss the relative importance of the proposed criteria and participate in a weighting activity during the June 8, 2022 stakeholder workshop. The criteria weights will be developed following the stakeholder workshop using a matched pairs weighting method, considering the input from all workshop participants. The goal of the criteria weighting is to accurately reflect the priorities of the San Pasqual Valley GSA, the adopted GSP, and Basin stakeholders.

The results of this exercise will provide a weighting percentage to be applied to the scores determined through the evaluation discussed above (see Table 1). **Figure 8** will show the relative weighting of each evaluation criterion. These scores will then be added together to obtain a total weighted score for each strategy that represents the overall performance of each strategy.

To be inserted following weighting activity

Figure 8: Results of Weighting Activity

5. REFERENCES

American Meteorological Society. Cited 2020: Forecast-informed reservoir operations. Glossary of Meteorology. Available online at http://glossary.ametsoc.org/wiki/Forecast-informed_reservoir_operations.

San Diego County Water Authority. 2014. Final 2013 Regional Water Facilities Optimization and Master Plan Update. Prepared by CH2M HILL, Inc. (CH2M) and Black & Veatch. March.

City of San Diego and County of San Diego. 2021. Final San Pasqual Valley Groundwater Basin Groundwater Sustainability Plan. Prepared by Woodard & Curran. September.

City of San Diego and County of San Diego. 2022. San Pasqual Valley Basin Groundwater Sustainability Plan Annual Report for Water Years 2020 and 2021. Prepared by Woodard & Curran. March.