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memorandum

date	September 10, 2018
to	Stephanie Gaines, County of San Diego
cc	
from	Hennessy Miller, Lindsey Sheehan, P.E., David Pohl, Ph.D., P.E., ESA
subject	San Diego Stormwater Capture and Use Feasibility Study – Cost Analysis (FINAL)

The San Diego Stormwater Capture and Use Feasibility Study (SWCFS) is designed to provide a regional analysis of the feasibility of planning, constructing, operating, and managing facilities that capture and use stormwater. The goals of the SWCFS include:

- Quantify the range of stormwater that could be potentially captured and stored on public lands and used in the San Diego region;
- Identify the opportunities and constraints for a range of stormwater capture and use examples for use as a management tool in the development and planning of similar projects; and,
- Prioritize the potential stormwater use alternatives on screened public parcels on a short-, mid- and long-term timeline basis.

The quantification goal is achieved by first screening applicable public parcels using a set of criteria that is specific to each stormwater use alternative. This is a more refined analysis than was conducted for the San Diego Region Stormwater Resource Plan (SWRP) (ESA, 2017a) by applying specific parcel screening criteria that accounted for site and technical constraints and modeling more of these sites for specific use alternatives. Eight stormwater use alternatives were identified during methods development.

Example stormwater capture and use projects were analyzed for opportunities and constraints. The project examples were obtained from existing SWRP and Integrated Regional Watershed Management Plan (IRWMP) project lists and input from the SWCFS Technical Advisory Committee (TAC). These examples were developed to provide a tool for managers to evaluate what types of projects may be feasible for a parcel that is under consideration for a stormwater capture and reuse project. Informed by the parcel analysis, managers may use both the parcel analysis and the example projects to conduct a project specific and more detailed assessment of the opportunities and constraints for each individual parcel at a project-level, even if the parcel was not identified in this study.

Prioritization will identify the short-term potential use alternatives that have fewer constraints to implementation. These short-term opportunities provide for potential regional planning for these types of projects. Through this analysis, regional constraints to implementing stormwater capture and use will be identified. The SWCFS can be a tool to guide the region over time to address those constraints that can be overcome, such as regulatory constraints and clarity. Overcoming these constraints or "gates" will allow some of short and potentially mid-term projects and alternatives to move forward towards implementation.

In coordination with the TAC, the County of San Diego is developing the SWCFS through a multi-step process. The first step was an extensive data collection effort, documented in the first technical memorandum (ESA 2017b). Next, the methods to quantify the potential stormwater capture and use and identify potential projects opportunities and constraints were developed and documented in the second technical memorandum (ESA 2017c). The quantification results were then presented in the Modeling Approach and Results Technical Memorandum (ESA 2018)[1]. This report summarizes the methods and presents the results of the conceptual-level cost analysis. The final step will be the prioritization of the public parcel alternatives for the region.

Conceptual costs were developed by both the case study example projects and the parcels identified in the quantification analysis. The costs developed for the example projects will help further develop the opportunities and constraints for these types of projects. The costs developed for the parcels will provide an additional factor for the parcel project prioritization, which will be the final step of this study. However, it is important to note that the costs used within this memo are used to prioritize use alternatives at a high-level, only to support planning and water management efforts. Actual project costs will vary depending on watershed or sewershed, infrastructure technology, treatment requirements, and other project-specific variables. This memo provides a range of costs to try to cover this variability, but actual costs for projects should be analyzed and refined on a project by project basis.

Section 1 of this memo presents the methods of this conceptual-level cost analysis. Section 2 provides the results and conclusions of the analysis with example project costs included in Attachment A.

1. Cost Analysis Methods

1.1 Parcel Analysis Quantities

As described in ESA 2018, a parcel analysis was completed to identify the most feasible public parcels for a stormwater capture and use project. A subset of the identified parcels (67 parcels) were modeled in ESA 2018 to determine the volume of stormwater that could be captured and used. Conceptual quantities were developed for each of these parcels, including basin or vault acreage and depth and distance to end use. These projects and quantities provided the basis for the cost analysis.

1.2 Unit Costs

The unit costs were determined based on a review of the literature (Grey et. al. 2013), costs of built projects, and the RSMeans costing program. Professional judgement was used to select the most applicable cost where multiple

[1] http://www.projectcleanwater.org/download/swcfs-analysis-results/

unit costs for individual items were identified. The feasibility-level cost estimates were developed for comparative purposes, so more refined cost analysis should be completed at the project-level.

1.2.1 Unit Costs from the Literature

To estimate costs for infiltration and biofiltration basins, Grey et. al. 2013 provides a review of the literature on stormwater best management practices (BMP) or project costing. The paper provides unit costs for infiltration basins, infiltration pavers, and biofiltration facilities using costs per square foot of impervious area, per gallon of design volume, and per square foot of BMP. A subsequent study (Western Riverside Council of Governments 2016) found that the costs based on literature values do not necessarily scale up with the size of the BMP, resulting in some of these costs being unrealistically high. To narrow the range of costs while still being conservative, infiltration pavers costs, which were an outlier, were dropped from the analysis and the price per gallon of design volume was used (and converted to price per acre-foot (ac-ft)).

Additionally, references were used for the cost of treatment for recycled and potable water. These references included Raucher and Tchobanoglous (2014), Cooley and Phurisamban (2016), and the California Urban Water Agencies White Paper (2016), "The Potential for Stormwater as a Water Supply".

1.2.2 Unit Costs from Example Projects

Unit costs were also estimated based on construction bids for projects that are currently or have already been built. For example, the Big Canyon Wetland Treatment and Creek Restoration project in Newport Beach received bids for constructing a stormwater treatment wetland, dry-weather flow diversions, and culvert improvements. Additional sources of data came from projects recently completed in Los Angeles (Franklin D. Roosevelt Park), Newport Beach (Big Canyon Restoration), and San Clemente (Poche Beach Bacterial Disinfection Project), using construction elements currently in place and actual costs.

1.2.3 Unit Costs from RSMeans Costing Program

Another method of developing unit costs was based on a costing program called RSMeans using the 2018 Building Construction Cost Book, the most widely used construction cost database available. RSMeans tracks labor and material cost changes to provide the most up to date and reliable information. The costs were keyed to Southern California city cost indexes, productivity rates, crew composition, and contractor's overhead and profit rates.

1.2.4 Unit Costs from Manufactured Units

A fourth method for developing unit costs was using manufactured units with defined costs. For example, concrete detention vault costs were based on planning-level information provided by Oldcastle Precast for their StormCapture® System. Material costs range from $6 - $10 per cubic foot of storage volume. A 5-percent average of the material cost was added to approximate the cost of setting the modular components.

1.3 Cost Assumptions for Each Stormwater Use Alternative

Certain assumptions were needed to develop the costs for each stormwater use alternative. For example, to be able to capture the range of possible costs for each alternative, both a low and high estimate were used for each line item assumption. The cost components and assumptions are further discussed below. Attachment B provides tables showing example project costs, which include both the low and high costing assumptions, resulting in a project cost range.

1.3.1 Alternative A, Infiltration to Groundwater Basin

1.3.1.1 Infiltration Basins

The cost analysis for infiltration basins under Alternative A included site clearing and erosion control, excavation, final grading, and re-vegetation (Table B-1). The costs included a high and low assumption for the placement of excavated material (i.e. on-site versus off-site), the distance between the MS4 outfall and infiltration basin (i.e. 0 to 250 feet), and the distance between the infiltration basin and a groundwater basin (i.e. 0 to 1 mile). The distance from the MS4 outfall to the infiltration basin would determine whether the MS4 outfall discharged directly to the infiltration basin or if 250 feet of culvert conveyance was required to route stormwater flows from the outfall to the basin. A maximum culvert distance of 250 feet was used based on the parcel analysis criteria (ESA 2018). Similarly, the distance from the infiltration basin to the closest groundwater basin could be up to 1 mile based on the parcel analysis. Costs for extracting groundwater and treating it are not included in this analysis. It is assumed that since the parcels are located near designated groundwater basins, the basins are already being utilized, so infrastructure for extraction is in place.

1.3.1.2 Injection Wells

The cost analysis for injection wells included costs associated with land clearing, excavation, installation of a dry injection well, Title 22 pre-treatment, re-grading, and re-vegetation. The quantification analysis assumed one injection well per parcel (ESA 2018). The costs included a high and low assumption for conveyance distance between the MS4 outfall, the storage basin (i.e. 0 to 250 feet) and placement of excess excavated material (i.e. on-site versus off-site). A project example of costs for injection wells is detailed in Table B-2 in Attachment B. Costs for extracting groundwater and treating it are not included in this analysis. It is assumed that since the parcels are located near designated groundwater basins, the basins are already being utilized, so infrastructure is in place.

1.3.2 Alternative B, Infiltration to Reestablish Hydrology

1.3.2.1 Infiltration Basins

The cost analysis for infiltration basins under Alternative B was almost identical to the infiltration basins under Alternative A, except costs to account for the distance between the infiltration basin and groundwater basin were not included, since Alternative B considers infiltration for hydrologic improvements, and not necessarily to a potable groundwater basin. Table B-3 in Attachment B shows an example cost analysis, which includes both the low and high costing assumptions and provides a range in total cost.

1.3.2.2 Biofiltration Basins

The cost analysis for biofiltration basins included many of same items as the Alternative B infiltration analysis, as well as additional costs uniquely associated with biofiltration, such as aggregate, media, and a draining system. High and low cost assumptions were made regarding basin length (i.e. 500 – 2,400 feet). These values represent the size of a square basin based on the average parcel size in the parcel analysis, and 1.5 times the maximum square basin. Table B-4 in Attachment B details the item and unit cost for each component included in the biofiltration analysis.

1.3.3 Alternative C, Irrigation Projects

The cost analysis for irrigation quantified the costs of site preparation, excavation, conveyance, irrigation, maintenance, and re-vegetation. The analysis evaluated low and high cost assumptions for the placement of site material (i.e. on-site versus off-site), conveyance distance between the MS4 outfall and the storage vault (i.e. 0 to 250 feet), and treatment prior to irrigation (i.e. no additional treatment following initial solids/trash removal versus high end Title 22[2] treatment). Table B-5 in Attachment B details an example cost calculation for Alternative C for both low and high costing assumptions.

1.3.5 Alternative E, Restoration and Treatment Wetland

Costs for restoration and treatment wetlands included site preparation, excavation, vault installation, backfill, and conveyance to the site. High and low assumptions for Alternative E were made for costs associated with material placement (i.e. on-site versus off-site) and conveyance distance between the MS4 outfall and storage vault (i.e. 0 to 250 feet). Table B-6 in Attachment B details an example cost evaluation for Alternative E using both the low and high assumptions.

1.3.6 Alternative F, Dry-Weather Flow Diversion to a Wastewater Treatment Plant

Costs for dry-weather flow diversion to a wastewater treatment plant for recycled water use included site preparation and excavation, installation of a dry-weather diversion pump, a one-time sewer connection fee, an annual sewer fee, and re-vegetation. Alternative F assumed low and high estimates for excavated material placement (i.e. on-site versus off-site). Unit costs for an example parcel are shown in Table B-7 in Attachment B.

1.3.7 Alternative G and H, Flow Diversion to a Wastewater Treatment Plant

Costs for Alternative G (diversion to a wastewater treatment plant for recycled water use) and Alternative H (diversion to wastewater treatment plant for potable water use) included project implementation and diversion structures. Low and high assumptions were made for excavated material placement (i.e. on-site versus off-site).

Cooley and Phurisamban (2016) provide a range of treatment costs for small (<10,000 ac-ft/year) indirect potable and non-potable reuse systems that range from $550 per ac-ft to $2,200 per ac-ft. The parcels modeled for Alternatives G and H have annual capture volumes between 0.4 and 38 ac-ft, so the treatment costs associated with such small capture volumes likely underestimate the minimum treatment cost required for potable and recycled water use. Black & Veatch (2018) developed costs for treatment that would be implemented through a one-time sewer connection fee and an annual sewer fee based on volume. Based on their analysis, the following cost scheme was developed:

- < 5 ac/ft = $30,000 connection fee, $5,000 annual fee

[2] Title 22 of California's Water Recycling Criteria refers to California state guidelines for how treated and recycled water is discharged and used. The standards also require the state's Department of Health Services to develop and enforce water and bacteriological treatment standards for water recycling and reuse. However, whether or not Title 22 would apply to irrigation projects is unclear at this time.

- 5-10 ac/ft = $75,000 connection fee, $20,000 annual fee
- > 10 ac/ft = $150,000 connection fee, $50,000 annual fee

Unit costs for an example parcel are shown in Table B-6 in Attachment B.

1.4 Other Assumptions

For all of the alternatives, it was assumed that planning, engineering, and permitting would constitute approximately 20% of the total cost, and operations and maintenance would constitute approximately 10% of the total cost (15% was assumed for Alternatives F-H where ongoing monitoring and sampling would be included). Additionally, a 20% contingency cost is included in the cost estimates in Attachment B to capture the level of uncertainty for this high-level assessment. These values are typical assumptions for conceptual-level planning.

2. Conceptual-Level Costs and Conclusions

Using the unit costs and assumptions discussed in Section 1, project costs were developed for each of the parcels modeled in ESA 2018. Then, assuming a 25-year lifespan for all projects, a cost per ac-ft of stormwater was calculated based on the total project cost (construction infrastructure) divided by the total (sum) capture volume over the assumed 25-year project lifespan. Table 1 below provides a range of the total project costs and costs per ac-ft of stormwater capture and use for each alternative.

The unit costs developed and presented in Table 1 may be compared to the cost for imported water, water provided by desalination and expected costs for in-direct potable use. These costs are shown in Table 2. It is likely that these costs may change over time due to energy cost increase or other reasons, and future studies should continue to use the most current rates for comparisons.

TABLE 1

PARCEL COST ANALYSIS BY ALTERNATIVE

Alternative	Project Type	Project Size (ac)	Total Project Cost	Cost per Volume ($/ac-ft)
Alternative A	Infiltration	0.4 – 24.7	$233,900 - $7,449,400	$240 - $89,400
	Injection	0.4 – 6.4	$757,900 - $2,316,600	$200 - $31,000
Alternative B	Infiltration	0.2 – 9.4	$205,800 - $2,677,700	$240 - $77,500
	Bio-Infiltration	0.2 – 9.4	$275,400 - $4,815,600	$380 - $138,900
Alternative C	Irrigation	0.1 – 4.7	$1,479,000 - $18,747,300	$38,000 - $638,200
Alternative D	Rain Barrels	-	$125	$2,500
Alternative E	Restoration and Treatment Wetlands	0.1 – 2.9	$185,800 - $1,451,900	$270 - $2,100
Alternative F	Dry-Weather Diversion	0.3 – 12.5	$2,501,300 - $3,267,000	$7,400- $9,600
Alternatives G and H	Wastewater Diversion	0.3 – 12.5	$1,914,300 - $11,732,100	$12,700 – $388,600

TABLE 2

COST OF ALTERNATIVE WATER SUPPLY

Water Supply Source	Cost ($/ac-ft)
Imported Water[1]	$1,546 - $1,603
Indirect Potable Use[2]	$1,100 - $2,200
Desalination[1]	$2,131 - $2,397

1. San Diego County Water Authority 2016 and 2017
2. Cooley and Phurisamban 2016.

2.1 Alternative A

2.1.1 Infiltration Basins

The total project cost for infiltration projects under Alternative A ranged from $233,900 - $7,449,400. The highest costs were for excavation and placement of excavated material and conveyance from the infiltration basin to the groundwater basin (assuming the high-end assumption of 1 mile of conveyance). Excavation costs ranged from 12 to 21 percent of the total project cost, while placement ranged from 18 to 25 percent based on either placement on-site or off-haul. When conveyance to a groundwater basin 1 mile away was considered, the cost, at $422,400, represented, on average, 30 percent of the total cost.

The high-end assumption of 250 feet for conveyance between an MS4 outfall and the infiltration basin was only 1 percent of the total cost, which was relatively insignificant. Conversely, assumptions for placement or off-haul of excavated material and distance between the infiltration basin and groundwater basin were much more significant to the final cost. The analysis indicates that projects directly above or relatively close to groundwater basins and where excavated material can be used on-site are more likely to be economically feasible.

Many of the costs (erosion control and temporary fencing, parcel clearing, excavation, and placement of site material) were directly dependent on the acreage of the infiltration basin; as basin acreage increased, total project cost increased. Interestingly, this indicates that economy of scale may not be a factor for infiltration basins.

The cost per volume for the 17 modeled parcels ranged from $240 to $89,400 per ac-ft. The large range is a result of the range in capture volumes, as well as costs. While costs scale proportionally to infiltration basin size, the capture volume does not. Using the low-end assumptions, 5 of the 16 sites resulted in costs within or below the highest existing water cost (Table 2), and with the high-end assumptions, this drops to 4 sites.

2.1.2 Injection Wells

The average cost of injection well projects ranged from $757,900 - $2,316,600. The cost of the injection well structure itself ($147,000 per well) was a large portion of the total budget at 12 – 31 percent of the total cost. However, when stormwater treatment is required prior to injection, the treatment cost represents on average, 52 percent of the total project cost.

Similar to the cost analysis for infiltration basins, the assumption of 250 feet for conveyance between an MS4 outfall and the infiltration basin resulted in a very minor cost (~1 percent of the total cost), while the decision to place excavated material on-site versus hauling it off-site has a much bigger influence on the cost. Like infiltration projects, injection well project costs scale with the area of the storage basin.

The cost per volume ranged from $200 - $31,000 per ac-ft, but was, on average, lower than the cost for the infiltration projects. This is likely the result of a higher average capture volume (79 ac-ft/year for injection wells compared to 15.6 ac-ft/year for infiltration basins). Four of the six sites resulted in costs below the cost of desalination (Table 2) under both low and high assumptions.

2.2 Alternative B

2.2.1 Infiltration Basins

Infiltration basins under Alternative B had lower costs than the basins under Alternative A, since infiltration directly to a groundwater basin is not needed. Total costs ranged from $205,800 - $2,677,700. Like infiltration basins under Alternative A, the highest costs associated with the infiltration basins under Alternative B were excavation and placement of excavated material. Average excavation costs ranged from 15 to 20 percent of the total cost, while placement ranged from 17 to 32 percent depending on whether material was placed on-site or off-hauled.

As was the case for infiltration basins under Alternative A and injection wells, the assumption of 250 feet for conveyance between an MS4 outfall and the infiltration basin resulted in a very minor cost (~4 percent of the total cost), while the decision to place excavated material on-site versus hauling it off-site has a much bigger influence on the cost. Additionally, infiltration basin project costs scale with the area of the infiltration basin.

The cost per volume ranged from $240 - $77,500 per ac-ft. Using the low-end assumptions, 11 of the 65 sites resulted in costs below the cost of desalination, and with the high-end assumptions, 9 sites had unit costs within or lower than the existing water costs found in Table 2. The higher cost per volume range is likely due to the lower average capture volumes (7 ac-ft/yr) compared to the infiltration basins under Alternative A and the injection well projects.

2.2.2 Biofiltration Basins

The biofiltration project cost analysis yielded higher total project costs than infiltration basins, due to the additional costs uniquely associated with the biofiltration system. Total costs ranged from $275,400 - $4,815,600. The highest costs items for biofiltration were those associated with soil placement (9 – 18 percent of the total cost) and the biofiltration system, including media filter (18 to 22 percent), aggregate (13 to 17 percent), and the underdrain (3 to 11 percent), all of which were sensitive to basin area.

As was the case for the previously discussed projects, the assumption of 250 feet for conveyance between an MS4 outfall and the infiltration basin resulted in a very minor cost (~2 percent of the total cost), while the decision to place excavated material on-site versus hauling it off-site has a much bigger influence on the cost. Additionally, infiltration basin project costs scale with the area of the infiltration basin. The assumption about basin length (i.e. 500 – 2,400 feet) influenced whether the underdrain was a small portion of the cost (3 percent) or a larger portion (11 percent).

The cost per volume ranged from $380 - $138,900 per ac-ft. Using the low-end assumptions, 8 of the 65 sites resulted in costs below the upper limit of existing water supply source costs (Table 2), and with the high-end assumptions, 7 sites fell below the desalination costs. However, use volumes for Alternative B were calculated assuming infiltration rates, not biofiltration rates. It is expected that potential biofiltration volumes would be greater than what was calculated for infiltration, which would mean additional sites could become more economically feasible if these volumes were considered.

2.3 Alternative C, Irrigation Projects

Total cost for irrigation projects ranged from $1,479,100 - $18,747,300. Significant project costs associated with irrigation projects were concrete vault materials and installation costs (60 – 78 percent; this includes excavation) and the irrigation system (9-11 percent). However, when stormwater treatment is required prior to irrigation, the treatment cost represents on average, 20 percent of the total project cost. As was found for other projects, the culvert conveyance from MS4 outfall to the storage vault were minor (0 – 1 percent).

The cost per volume ranged from $38,000 - $638,200 per ac-ft. All projects were above the existing water costs shown in Table 2. The average capture volume was 40 ac-ft/yr, which is greater than infiltration basins and less than injection wells. The high costs for the storage vault, irrigation system, and potential stormwater treatment makes irrigation projects more expensive than other projects, however, possible cost sharing on the irrigation system with the irrigation recipients could reduce costs. Projects within park parcels or close by will be the most economically feasible.

2.4 Alternative D, Rain Barrels

Rain barrels cost $125 before rebates when purchased at Solana Center for Environmental Innovations. Assuming a 0.002 ac-ft/yr volume and a 25-year lifespan, the cost per volume is $2,500 per ac-ft, which is slightly higher than the cost of desalination.

2.5 Alternative E, Restoration and Treatment Wetlands

Total project costs for restoration and treatment wetlands ranged from $185,800 - $1,451,900. The significant costs associated with Alternative E were erosion control and temporary fencing (13 to 19 percent of the total cost), excavation (15 to 20 percent), and the placement of site material (17 to 32 percent), all of which were associated with storage vault footprint size. Like the infiltration basins (Alternative A and Alternative B), there was a strong association between vault acreage and total project costs.

As was the case for the previously discussed projects, the assumption of 250 feet for conveyance between an MS4 outfall and the infiltration basin resulted in a very minor cost (0 – 5 percent of the total cost), while the decision to place excavated material on-site versus hauling it off-site has a much bigger influence on the cost.

The cost per volume ranged from $270 - $2,100 per ac-ft. All but two outlying projects (at $3,300 and $5,200 per ac-ft) of the 27 parcels modeled were lower than existing water supply costs (Table 2). Since restoration requires the least infrastructure, it is the least costly alternative.

2.6 Alternative F, Dry-Weather Flow Diversion to a Wastewater Treatment Plant

Total project costs for dry-weather flow diversion to a wastewater treatment plant range from $2,501,300 - $3,267,000. The highest cost item was the annual sewer fee (64 to 70 percent of the total cost). The other large cost items included excavation (7 to 8 percent of the total cost), placement (0 to 7 percent), and the one-time connection fee (8 to 9 percent). It was assumed that the sanitary sewer system would not need to be upgraded and that current capacity would be sufficient. This assumption may not be reasonable everywhere across the County. Additionally, modeling showed that even during a wet year, discharge from the parcels to the sewer system would still be less than 5 percent volumetrically of the total influent to the receiving plant. Based on this, it was assumed that the treatment plants would not require upgrades to accept stormwater. However, if sanitary sewer upgrade were necessary, the upgrade costs would make this type of project much more expensive.

The cost per volume ranged from $7,400 - $9,600 per ac-ft. Of the 5 modeled parcels, none fall within the range of existing water costs.

2.7 Alternative G-H, Flow Diversion to a Wastewater Treatment Plant

Total project costs for flow diversion to a wastewater treatment plant for recycled water use (Alternative G) and potable water use (Alternative H) ranged from $1,914,300 - $11,732,100. High-cost items included the excavation and placement of the concrete vault (76 to 79 percent of the total cost). Connection to the sewer and the annual sewer fee were around 1 percent of the total cost, which is much lower than under Alternative F, due to the lower annual volume that would be released to the sewer. As discussed above, it was assumed that neither the sewer system nor the treatment plants would require upgrades.

The cost per volume ranged from $12,700 – $388,600 per ac-ft. Of the 5 modeled parcels, all are more expensive than existing water costs.

3. References

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ATTACHMENT A

Example Projects

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: San Diego Zoo Safari Park – Green Parking Lot and Storm Water Capture and Use Project

STORMWATER USE ALTERNATIVE:
Alternative A - stormwater capture and infiltration to recharge groundwater for extraction, treatment and use for recycled water
Alternative C - storm water capture and use for irrigation

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR: 15500 San Pasqual Valley Rd, Escondido, CA 92027; San Diego Zoo Global

Description:

San Diego Zoo Global proposes to use innovative best management practices (BMPs) to capture, treat, and reuse storm water that flows from the San Diego Zoo Safari Park's 47.57-acre visitor parking lot and 5.08-acre employee parking lot. Currently a large portion (65%) of the Safari Park's visitor parking lot directs storm water runoff into a concrete culvert that conveys water into a drainage area across Highway 78 and ultimately into the San Dieguito River watershed. The employee parking lot and remaining visitor parking lot area (35% of the project acreage) are composed of dirt, allowing some storm water infiltration. Due to the soil composition, a majority of this storm water still results in runoff which creates erosion and sedimentation issues that can inhibit storm water flows into proper conveyance systems. Storm water from the parking lots carries oils and grease, heavy metals (including copper, zinc, and lead), sediment, trash, debris, and other environmental stressors. These pollutants eventually enter sensitive waterbodies that provide numerous uses including animal habitat, which negatively impacts the health of the San Dieguito River watershed and its tributaries. The proposed project will use low impact development (LID) techniques to capture, treat, and "re-purpose" 5.7 acre-ft per year (AFY) of storm water for a variety of benefits, including water supply, water quality improvements, flood control, habitat enhancement, creation of green spaces, reduction in carbon dioxide, and public education.

The Safari Park will implement BMPs to its guest and employee parking lots, enabling the quality of storm water to be improved through pollutant removal, and the volume of runoff to be reduced. Sections of permeable pavers will be installed within the parking lots. Storm water runoff will drain into these pavers, allowing the water to percolate into the ground. Any remaining storm water will be collected and redirected into biofiltration systems where it will be treated and reused for irrigation instead of flowing into the storm drain. This process will reduce the volume of storm water running off Safari Park property and reduce velocities to downstream drainages in furtherance of region-wide hydromodification goals. The filtration area will be modeled after the Proposition 50 funded Biofiltration Wetland Creation and Education Project.

Surface water quality within the San Dieguito River watershed is negatively impacted by urban runoff. Pollutants of concern in the watershed include nutrients, pathogens, salinity, pesticides, metals/metalloids, and organics. The San Pasqual Valley groundwater basin is typically recharged via infiltration of precipitation and excess irrigation waters. Data collected by the Safari Park following the first major rain event of the year showed that during storm events, sediment and nutrient-laden surface water can overflow offsite to Santa Ysabel Creek and downstream to Hodges Reservoir, exacerbating eutrophication in those surface waters. Hodges Reservoir is listed on the Clean Water Act 303(d) list of impaired waterbodies for color, manganese, nitrogen, pH, phosphorus, mercury, and turbidity. Proposed storm water management strategies will enable San Diego Zoo Global to protect local water supply and watershed habitats through the capture, treatment, infiltration, and reuse of storm water flows from the parking lots. The improvements will reduce the volume of storm water and pollutants that reach the adjacent San Dieguito River watershed, while also improving the quality of water that percolates through onsite drainages back into the groundwater basin and ultimately to downstream surface waters.

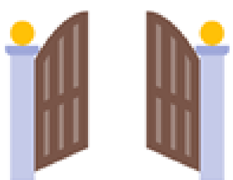
The San Diego Region recognizes the importance of protecting water quality in Santa Ysabel Creek/San Dieguito River and Hodges Reservoir, which is a drinking water reservoir with ongoing water quality issues. This project provides an opportunity to improve the quality of water in this region, while also furthering San Diego Zoo Global's long-term commitment to ensure water sustainability for the Safari Park, San Diego County, and beyond. San Diego Zoo Global has a proven track record with large-scale, grant-funded water recycling and management projects through its partnership with the California Department of Water Resources (DWR) and San Diego County Water Authority.

The proposed project will enable storm water to infiltrate into the soil, clean storm water through improved surface materials, conveyance, and biofiltration areas or other treatment systems, and reduce the amount of untreated water that flows downstream into the San Dieguito River watershed. Treated storm water would be conveyed to the Park's recycled water system or onsite ponds for irrigation. This system of capture, treatment, and reuse will reduce irrigation water demand and minimize uncontrolled storm water runoff from the Park into the San Dieguito watershed. An estimated 5.1 AFY of storm water runoff will be captured and reused within the Park for irrigation.

San Diego Zoo Global will share the project and its watershed and community benefits on engaging interpretive graphics onsite at the Safari Park (1.5 million annual visitors) and in our member publications (reaching 500,000 individuals). It will be featured in tours at the Park offered to guests, watershed groups, community members, public agencies, and corporations throughout California. San Diego Zoo Global will partner with the San Diego Unified School District to provide hands-on water education and conservation programs to students from disadvantaged Title I schools throughout San Diego. We will also work with CAL Fire and CA Department of Corrections and Rehabilitation to employ individuals to remove invasive species from the natural waterways.

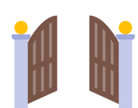
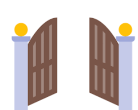
PROJECT OPPORTUNTIES AND CONTRAINTS:

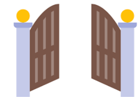
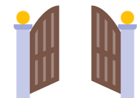
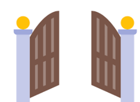
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Safari Park – Green Parking Lot and Storm Water Capture and Use Project are summarized in Table 1. For the Safari Park Storm Water Capture and Use Project, the remaining "gates" include confirming site geotechnical characteristics to verify infiltration capacity, regulatory clarify and funding. The confirmation of infiltration and recharge capacity of the project can be viewed as a short term "gate" that can be addressed in the design phase with a geotechnical investigation and design to account for the on-site infiltration rates. The regulatory clarity gate is due to the absence of clear standards for non-potable use of stormwater. The funding constraints is planned to be addressed with the application of grant funding through the Stormwater Proposition 1 grant program. Funding to address the other capital costs and the operation and maintenance costs not covered by grants will also need to find "keys to open this gate."

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Porous pavers with sub-surface storage complementary to current land use Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use	
Match Production with Demand/Need	Confirm in design the captured and treated volume can be used on-site for irrigation and ponds	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Project is scaled to meet on-site demands	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Design to refine bio-filtration design and needed infrastructure to distribute treated stormwater to storage ponds and then to further treatment or direct use for irrigation.	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project scaled to use planned on-site bio-filtration and existing treatment system and storage ponds for use of captured and filtered stormwater	

Agency Agreements		***Partnerships***	Project is located on project sponsors property San Diego Zoo Global has strong working relationships with local schools	
Water Type Incompatibility **Treatment Requirements**	Biofiltration treatment will be used for capture stormwater prior to conveyance to on-site treatment facility Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet requirements of on-site treatment facility that treats for non-potable use in ponds and irrigation	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	Grant funding needed for project implementation Grant funding will not cover the full costs of implementation and no O&M	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application planned for funding – Stormwater Prop 1 Funding- Round 1	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project has community support	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the conceptual layout. The elements and quantities include stormwater capture and infiltration from replacement of existing pavement with porous pavers in the existing parking lots. The runoff not collected and infiltrated into the pavers, will be collected and redirected into biofiltration systems where it will be treated and reused for irrigation.

Tables 2 presents the estimated quantities for the conceptual layout. These quantities have been provided by the project sponsor. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, INFILTRATION, TREATMENT AND USE

Project Component	Drainage Area	Porous Pavers (LID Retro-fit of Parking Lot)	Porous Pavers (LID Retro-fit of Parking Lot)	Porous Pavers (LID Retro-fit of Parking Lot)	Bio-filtration Facility and Additional Treartment
Description of Estimated Quantity	Size of Drainage Area (acres)	Annual Volume of Stormwater Captured (CF/yr.)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater recharged to shallow groundwater (acre- feet per yr. (AFY)	Annual volume of stormwater Treated for Use (acre- feet per yr. (AFY)
Estimated Quantities	53 acres	5.7 AFY	Assumed 10% of Stormwater Infiltrated	0.57 AFY	5.1 AFY (9.5 acres irrigated)

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Alternative Compliance Retrofit Project El Norte Parkway and Rincon Villa Drive, Escondido

STORMWATER USE ALTERNATIVE:
Alternative B - Discharge to groundwater to reestablish natural hydrology and, by extension, to restore biological beneficial uses

PROECT TYPE: Design

PROJECT LOCATION AND SPONSOR:
El Norte Parkway at Rincon Villa Drive, Escondido; City of Escondido

Description:

This concept project is located in northern Escondido along the south side of El Norte Parkway. The City of Escondido holds unused right-of-way along the road, and the surrounding area is largely residential. There is a 48-inch reinforced concrete storm drain located under Rincon Villa Drive, southwest of the project site, and the project aims to use water from the storm drain to increase supply. In this way, runoff from nearby existing development would be captured and treated by biofiltration before returning (at improved quality) to the storm drain.

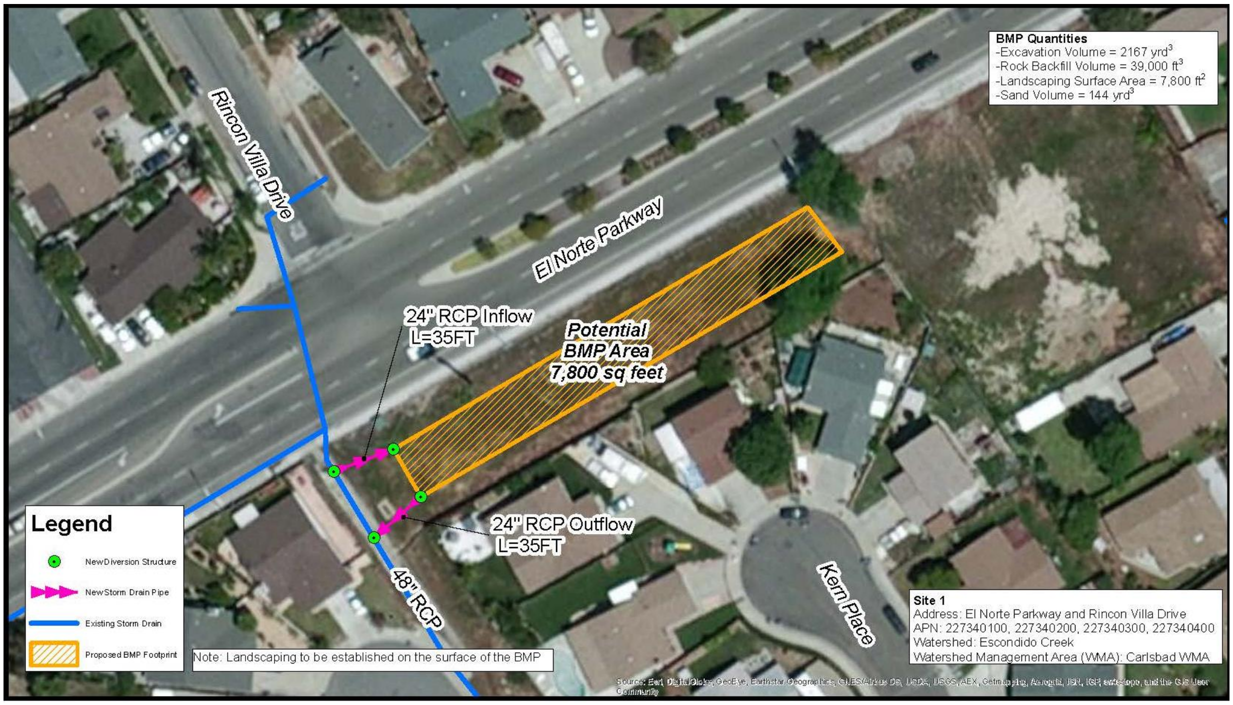
The City of Escondido is planning to implement a retrofit program under its municipal storm water permit (R9-2013-0001, as amended). Additionally, the City has the option to provide an alternative compliance program for new and redevelopment to comply with new storm water requirements. The City has conducted a hydraulic study to identify potential project locations within the City that could mitigate existing storm water flows, provide benefits to the watershed, and provide developers options for alternative compliance.

Based on The City of Escondido Creeks Hydraulic Study - Alternative Compliance and Water Quality Improvements (Baker International, 2016) (Hydrology Study), two options were evaluated for the El Norte Parkway / Rincon Villa Drive site: bioretention and underground storage & infiltration. Based on this analysis, the bioretention option, shown on Figure 1was selected for design. This site is relatively flat, but is limited by residential property on one side and El Norte Parkway on the other. Still, the site provides almost two acres of potential BMP footprint in close proximity to a major storm drain system. The designed alternative will divert water from this storm drain system to a biofiltration basin, then return filtered water to the system. The City of Escondido can partially fund this retro-fit project through the purchasing of the water quality credits from a party that needs these credits for a priority development or re-development project under an alternative compliance program.

Stormwater captured or diverted for biofiltration will be partially infiltrated into the shallow groundwater, helping to restore natural hydrology, and pollutant load reductions in both infiltrated water and water returned to the storm drain system will improve water quality. The Hydraulic Study includes estimates of the volume of stormwater captured and the volume stored and infiltrated for biofiltration.

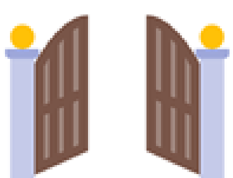
This project has undergone initial design (30% engineering design), and will still require: CEQA screening; full engineering design; identification of funding source(s) for design, construction and ongoing maintenance; and construction. This project could be developed as part of the retrofit program required under the municipal storm water permit (R9-2013-0001, as amended). Offering this as an option under alternative compliance for new and redevelopment could help with funding the construction and maintenance of the project.

Figure 1. El Norte Parkway at Rincon Villa Drive, Selected ACP Option – Stormwater Capture, Biofiltration, and Infiltration from Creek Hydraulic Study (Baker International)



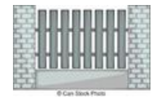
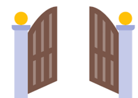
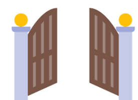
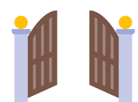
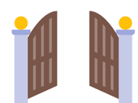
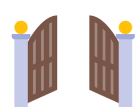
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the Alternative Compliance Retrofit Project are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration	
Match Production with Demand/Need		***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***		
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Refine bio-filtration design and design of needed infrastructure	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Costs included implementation of these elements	
Agency Agreements		***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***		
Regulatory Ambiguity		***Regulator Clarity and Flexibility***	Stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application planned for funding – Stormwater Prop 1 Funding- Round 1	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	As a low-impact project on city land, community support is not likely to be an issue	

QUANTIFICATION SUMMARY:

The critical elements of this project's stormwater capture and use process from which quantifies have been determined are shown in Figure 1. The elements include stormwater basin, inflow and outflow lines, and the neighboring storm drain line.

Table 2 presents the estimated quantities for the elements shown on Figure 1, including stormwater basin storage, annual infiltration to shallow groundwater, and estimated acre-feet per year that will be treated and returned to the storm drain system. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design-level quantities, but are applicable for feasibility-level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin
Description of Estimated Quantity	Size of Drainage Area (acres)	Basin Area, Depth and Volume (SF, ft, CF)	Design Capture Volume (DCV), 85^{th} Percentile Rainfall Event (CF)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated or used for irrigation (AFY)
Estimated Quantities (Infiltration)	130 ac	7,800 SF 2 ft 15,600 CF	166,454 CF	0.5 in/hr	TBD[1]

[1] Annual capture volume to be estimated

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Tables 3 presents the estimated feasibility-level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 25-year project lifespan, the unit cost for this example project is $---/AFY[1]. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives This project's unit costs were compared to the range of costs under Alternative Use B (Discharge to Restore Natural Hydrology), and the estimated unit cost is within the calculated range[2].

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS, OPTION 1

Project Component	Unit Costs	Quantities	Total Costs
Excavate & Stockpile	$ 10.00	2,167	$ 21,667
Rock Backfill	$ 1.45	39,000	$ 56,550
Native Planting	$ 0.50	7,800	$ 3,900
Inflow Pipe (24" RCP)	$ 150.00	35	$ 5,250
Overflow Pipe (24" RCP)	$ 150.00	35	$ 5,250
Structures	$ 10,000.00	1	$ 10,000
Irrigation	$ 0.50	7,800	$ 3,900
Sand Import (6")	$ 10.00	144	$ 1,444
Contingency (20% of Total)	$ 21,592.00	1	$ 21,592
Land Cost	$ 4.00	16,000	$ 64,000
Administration (15% of Construction)	$ 19,433.00	1	$ 19,433
Design (20% of Construction)	$ 25,911.00	1	$ 25,911
Total			$ 238,897

[1] TBD, based on input from Project Sponsor

[2] Review indicates this is true, but the assessment will be revised based on cost input from the Project Sponsor.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Alternative Compliance Retrofit Project at Mountain View Park, Escondido

STORMWATER USE ALTERNATIVE:
Alternative B - Discharge to groundwater to reestablish natural hydrology and, by extension, to restore biological beneficial uses
Alternative C - Stormwater capture for Irrigation of an on-site or nearby park, golf course, recreational area

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
1118 Citrus Ave, Escondido; City of Escondido

Description:

This concept project is located in eastern Escondido at Mountain View Park (1118 Citrus Avenue), a public park managed by the City of Escondido. The park is used for a mixture of passive and active purposes, and the surrounding area is largely residential. There is a 36-inch reinforced concrete storm drain located on the east side of the park, and the project focuses on this side of the park to take advantage of water from the storm drain to increase supply. In this way, runoff from nearby existing development would be captured, treated, and beneficially used at the park.

The City of Escondido is planning to implement a retrofit program under its municipal storm water permit (R9-2013-0001, as amended). Additionally, the City has the option to provide an alternative compliance program for new and redevelopment to comply with new storm water requirements. The City has conducted a hydraulic study to identify potential project locations within the City that could mitigate existing storm water flows, provide benefits to the watershed, and provide developers options for alternative compliance.

Based on The City of Escondido Creeks Hydraulic Study - Alternative Compliance and Water Quality Improvements (Baker International, 2016) (Hydrology Study), three options were evaluated for the Mountain View Park site: bioretention; underground storage and infiltration; and runoff storage and use for irrigation (Baker International, 2016). These options are shown on Figures 1 through 3. This site provides opportunities for bioretention and/or underground storage within an area of the park that is currently open space and a former orchard as shown on Figure 1. Steep topography and planned future trails limit the use of a greater portion of the open space area. The site still provides more than two acres of potential BMP footprint within close proximity to a major storm drain system. The objective of the project is to divert the water from the storm drain system for use in either of the three options depending on the evaluation of the cost per unit volume of stormwater treated that could then be used for potential water quality equivalent credits under an alternative compliance program. The City of Escondido can partially fund this retro-fit project through the purchasing of the water quality credits from a party that needs these credits for a priority development or re-development project under an alternative compliance program.

Capture stormwater for both the biofiltration and underground storage option is infiltrated into the shallow groundwater that with a reduction in runoff restores the natural hydrology. Additional benefits of these options include pollutant load reductions to improve water quality and reduction in runoff that reduces the potential of hydromodfication and restores natural hydrology to the nearby reach of the Escondido Creek. The option that includes underground storage and use for irrigation at the park provides the benefit of supplementing the park’s current sources of irrigation water.

The Hydraulic Study includes estimates of the volumes of stormwater captured, stored and infiltrated for the biofiltration and underground storage options, and the potential irrigation water augmentation for the third option. Based on these volumes and cost estimates the bioretention project at Mountain View Park was ranked the highest-priority among the options evaluated based on cost and equivalent acre of development mitigated; however, other beneficial use options were included, as they may be less restrictive on park use (Baker International, 2016).

This project is still in the conceptual phase and will still require: project design, including evaluation of the options in consultation with the community; verification that this is a defensible use of existing parkland; approval of the City Council; CEQA screening; full engineering design; identification of funding source(s) for design, construction and ongoing maintenance; and construction. This project could be developed as part of the retrofit program required under the municipal storm water permit (R9-2013-0001, as amended). Offering this as an option under alternative compliance for new and redevelopment could help with funding the construction and maintenance of the project.

Figure 1. Mountain View Park Option 1 – Stormwater Capture, Biofiltration and Infiltration from Creek Hydraulic Study (Baker International)

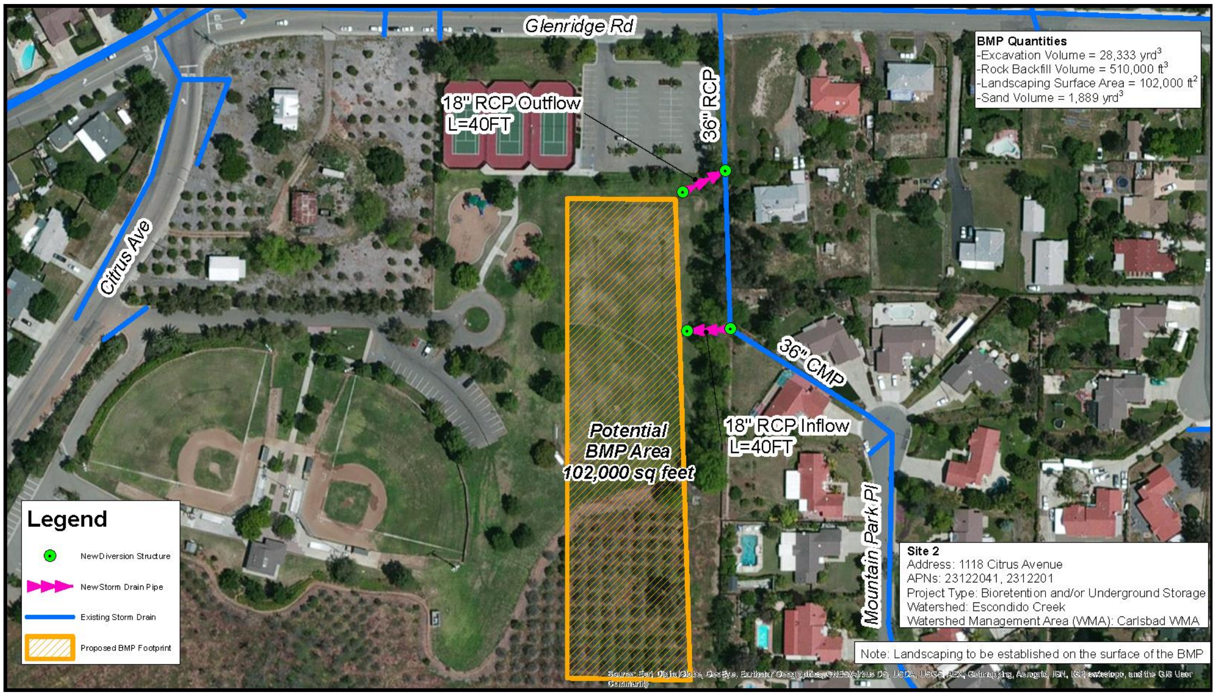


Figure 2. Mountain View Park Option 2 – Stormwater Capture, Underground Storage and Infiltration from Creek Hydraulic Study (Baker International)

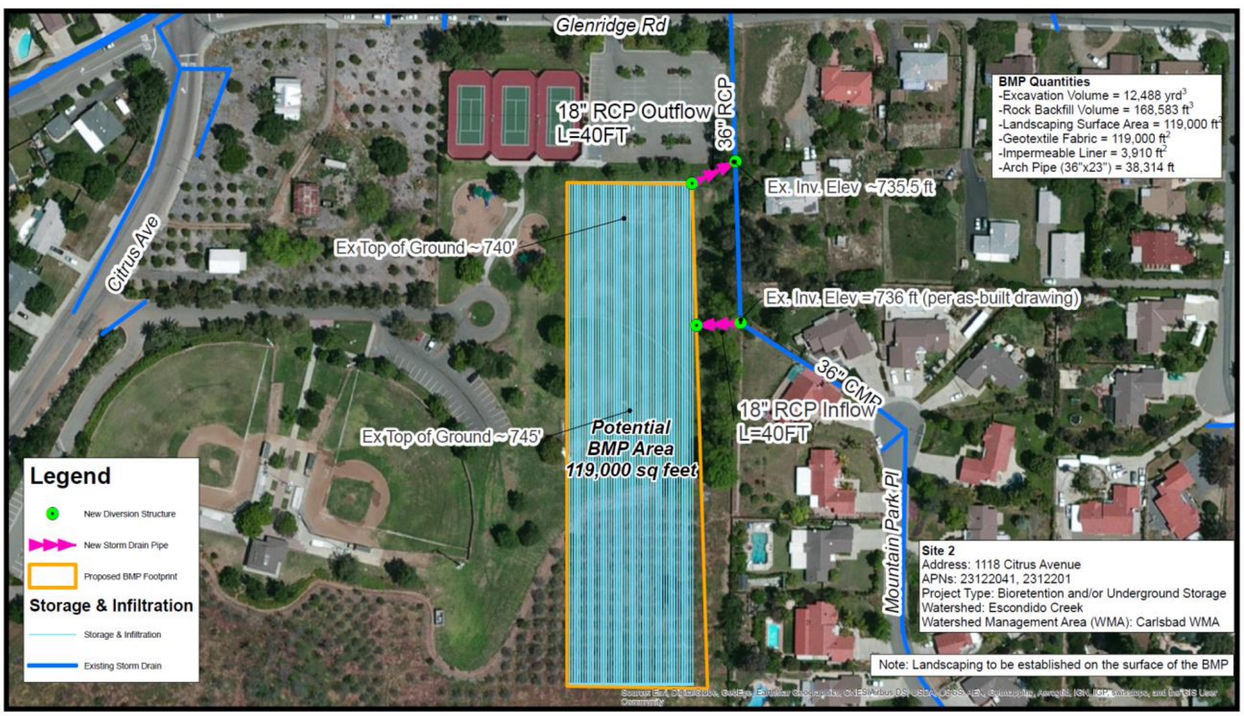
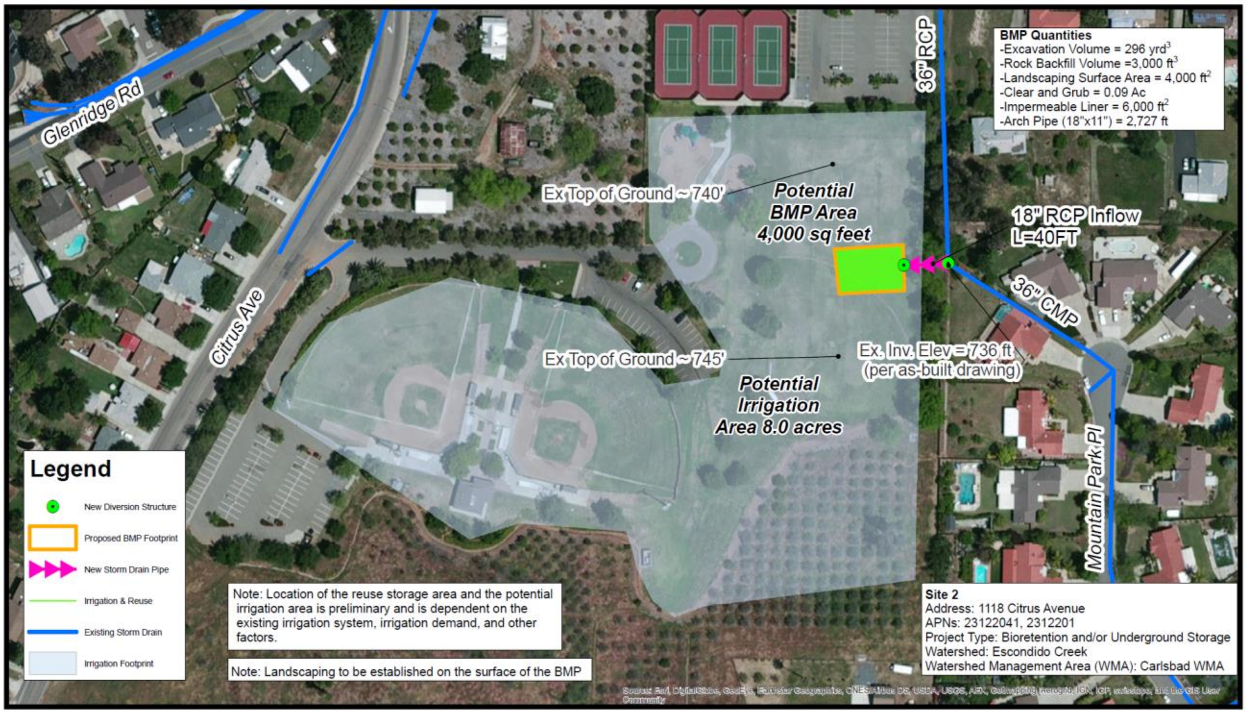
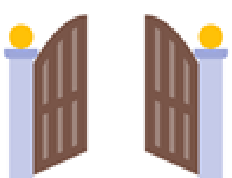


Figure 3. Mountain View Park Option 3 – Stormwater Capture, Underground Storage and Use for Irrigation of Nearby Park from Creek Hydraulic Study (Baker International)



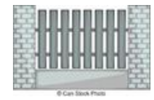
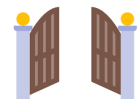
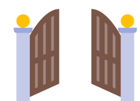
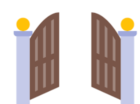
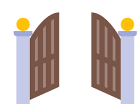
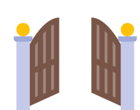
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Mountain View Park Project are summarized in Table 1. For the Mountainview Park Project there are two stormwater use alternatives, Alternative B direct infiltration to the groundwater to restore natural hydrology and Alternative C capture and use for irrigation. The two option of Alternative B include biofiltration and underground storage. The constraints and opportunities for these options are shown under Alternative B. The constraints and opportunities for Alternative C are then identified in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Alt B: Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Alt B: Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration	
Match Production with Demand/Need	Alt C: Confirm in design the captured and treated volume can be used on-site for irrigation	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Alt C: Project is scaled to meet on-site demands for the adjacent 8 acres	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Alt B: Refine bio-filtration design and design of needed infrastructure Alt C: Concept did not identify the need for treatment of stormwater for irrigation use – solids removal and disinfection likely needed New infrastructure needed for distribution of stormwater to storage or for irrigation	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Alt B: Costs included implementation of these elements Alt C: Additional treatment could be achieved with biofiltration and then diversion of portion of the flow for storage and irrigation through combining alternative uses	
Agency Agreements		***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Alt C: Project to be designed to meet requirements for on-site treatment for non-potable use in irrigation	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for irrigation use unless irrigation is below ground	***Regulator Clarity and Flexibility***	Stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application planned for funding – Stormwater Prop 1 Funding- Round 1	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	As a multiple use project, community support is likely	

QUANTIFICATION SUMMARY:

Figure 4 presents a conceptual layout of the elements of this project's stormwater capture and use process from which quantifies have been determined. The elements include stormwater basin, and irrigation area, and the neighboring MS4 line.

Figure 4. Project site and proposed locations for stormwater capture infrastructure

Table 2 presents the estimated quantities for the elements shown on Figure 2 that include the stormwater basin storage, annual infiltration to shallow groundwater[1], and estimated acre-feet per year that will be treated and used for recycled water (i.e. irrigation). These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design-level quantities, but are applicable for feasibility-level assessments.

[1] Infiltration analysis for Option 1 and Option 2 to be updated.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin
Description of Estimated Quantity	Size of Drainage Area (acres)	Basin Area, Depth and Volume (SF, ft, CF)	Design Capture Volume (DCV), 85th Percentile Rainfall Event (CF)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated or used for irrigation (AFY)
Estimated Quantities (Infiltration)	126 ac	119,000 SF 3 ft 357,000 CF	392,522 CF	0.5 in/hr	6.5 AFY
Estimated Quantities (Irrigation)	126 ac	4,000 SF 3 ft 12,000 CF	392,522 CF	---	2.7 AFY

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Tables 3 through 5 present the estimated feasibility-level costs for each project component, for the three Options reviewed at Mountain View Park. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 25-year project lifespan, the unit cost for this example project is $37,362/AFY, $161,977/AFY, or $15,498/AFY, depending on the Option selected. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. In comparing this project's unit costs to the range of costs under Alternative Use B & C (Discharge to Restore Natural Hydrology and Irrigation Use), this example project cost is within the estimated range for both Use B and Use C, though Option 2 is more expensive than most projects for Use B.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS, OPTION 1

Project Component	**Unit Costs**	**Quantities**	**Total Costs**
Excavate & Stockpile	$ 10.00	28,333	$ 283,333
Rock Backfill	$ 1.45	510,000	$ 739,500
Native Planting	$ 0.50	102,000	$ 51,000
Inflow Pipe (18" RCP)	$ 100.00	40	$ 4,000
Outflow Pipe (18" RCP)	$ 100.00	40	$ 4,000
Structures	$ 10,000.00	1	$ 10,000
Irrigation	$ 0.50	102,000	$ 51,000
Sand Import (6")	$ 10.00	1,889	$ 18,889
Contingency (20% of Total)	$ 232,344.00	1	$ 232,344
Land Cost	$ 4.00	160,000	$ 640,000
Administration (15% of Construction)	$ 209,110.00	1	$ 209,110
Design (20% of Construction)	$ 278,813.00	1	$ 278,813
Total			$ 2,521,990

TABLE 4
ESTIMATED FEASIBILITY STUDY LEVEL COSTS, OPTION 2

Project Component	**Unit Costs**	**Quantities**	**Total Costs**
Excavate & Offhaul Subgrade Area	$ 30.00	12,488	$ 374,630
Rock Backfill	$ 1.45	168,583	$ 244,446
Arch Pipe (36”x23”)	$ 150.00	38,314	$ 5,747,159
Geotextile Fabric	$ 2.00	119,000	$ 238,000
Impermeable Liner	$ 2.00	3,910	$ 7,819
Inflow Pipe (18” RCP)	$ 100.00	40	$ 4,000
Overflow Pipe (18” RCP)	$ 100.00	40	$ 4,000
Structures	$ 10,000.00	1	$ 10,000
Landscaping	$ 1.00	119,000	$ 119,000
Contingency (20% of Total)	$ 232,344.00	1	$ 1,349,811
Administration (15% of Construction)	$ 209,110.00	1	$ 1,214,830
Design (20% of Construction)	$ 278,813.00	1	$ 1,619,773
Total			$ 10,933,467

TABLE 5
ESTIMATED FEASIBILITY STUDY LEVEL COSTS, OPTION 3

Project Component	**Unit Costs**	**Quantities**	**Total Costs**
Clear & Grub	$ 20,000.00	0.09	$ 20,000
Excavate & Offhaul	$ 30.00	296	$ 8,889
Impermeable Liner	$ 2.00	6,000	$ 12,000
Rock Backfill	$ 1.45	3,000	$ 4,350
Perf. Arch pipes (18” x 11”)	$ 75.00	2,727	$ 204,545
Landscaping	$ 1.00	4,000	$ 4,000
Structures	$ 10,000.00	1	$ 10,000
Inflow Pipe (18” RCP)	$ 40.00	40	$ 4,000
Backflow Prevention Device	$ 2,500.00	1	$ 2,500
Pump & Appurtenances	50,424.18	1	50,424
Contingency (20% of Total)	$ 60,509	1	$ 60,509
Land Cost	$ 3.00	4,000	$ 12,000
Administration (15% of Construction)	$ 54,458	1	$ 54,458
Design (20% of Construction)	$ 72,611	1	$ 72,611
Total			$ 502,123

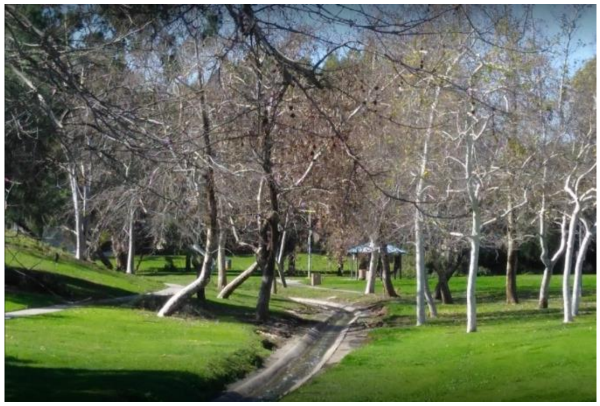
STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Telegraph Canyon Channel Improvement Project

STORMWATER USE ALTERNATIVE:
Alternative B - Discharge to groundwater to reestablish natural hydrology – to restore biological uses

PROECT TYPE: Concept[1]

PROJECT LOCATION AND SPONSOR:
Telegraph Canyon Channel, along Telegraph Canyon Drive; City of Chula Vista



Description:

This project is located in the existing Telegraph Canyon Channel along Telegraph Canyon Drive from Hilltop Drive to Country Club Road and from Sierra Way to an additional reach downstream of 3rd avenue in the City of Chula Vista.

The existing channel flows through a densely-urbanized portion of the City of Chula Vista and has undergone a number of channel improvements to alleviate flooding in recent history. The channel is primarily concrete-lined, though the location for proposed improvements is earthen, receiving all the suspend solids from the upper watershed. The existing Telegraph Canyon Channel cannot accommodate the surface and stormwater runoff resulting from development of properties within the basin, particularly because it is in an area identified as a FEMA Floodplain Special Flood Hazard Area (SFHA). The flooding that occurs on L Street and Third Avenue impacts several parcels adjacent to the channel and causes severe traffic mobility issues. Third Avenue is a high-traffic area that includes a major bus route connecting the city to adjacent communities. The flooding is worsened because the channel bottom and banks are heavily vegetated with non-native plant species downstream of L Street and Third Avenue. With the dense urbanization and high traffic volumes, the channel captures stormwater runoff with large amount debris and other suspended solids that depreciate the water quality of the watershed.

The project will simultaneously address both flooding and water quality issues by increasing the capacity of the channel and incorporating the use of bioswales in conjunction with the existing concrete channel, providing a system that can be used for stormwater detention and controlled discharge. The utilization of

[1] Project status update requested from Project Sponsor.

these bioswales will increase infiltration into the groundwater table, which will also reduce surface flows and decrease flooding potential and erosive velocities. The vegetated swales will support native plant species, which, in addition to being an aesthetic benefit, will help to restore the natural banks of the channel and remove pollutants from stormwater runoff and flow. The reduction in stormwater runoff, coupled with enhanced vegetation and increased infiltration will effectively improve water quality. Biofiltration features will pretreat stormwater runoff, screen for trash and larger debris, and separate out total suspended solids (TSS) while supporting a plant and microbe community that will capture, absorb, transform, and uptake pollutants through physical, chemical, and biological mechanisms.

The project falls within two different FEMA 100-year flood zones Types (A & AE). Flood zones designated by FEMA are areas at risk of flooding in large storm events. Additionally, these Flood zones are Special Flood Hazard Areas (SFHAs), which are areas that must enforce floodplain management regulation and minimize flooding. The proposed project will provide flood protection with improvements along Hilltop Drive, to prevent flooding downstream to residences located in a Disadvantaged Community (DAC) along the project area. A portion of the project improvements are just outside the DAC, but provide significant flood reduction to the DAC located downstream. The remaining improvements at 3rd and L Street continuing west all fall within the DAC. It is critical to have an integrated approach for the area to reduce overall flood risk to the areas within the DAC. Flood plain management is a crucial operation within communities in the flood zones as preventative and corrective measure to reduce the risk of current and future flooding.

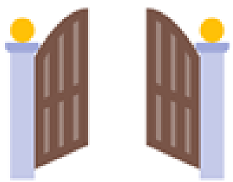
Additionally, the project will include an initiative to model the existing stream and conduct water quality sampling to determine the waterway's specific point-source pollutants. The site-specific water quality sampling and identification of point-source pollutants will be used to select and apply filtration to treat the specific water pollutants (e.g., bacteria from Hilltop Park or zinc from car breaks on adjacent roadways) that exceed the thresholds set by the R9-2015-0100 San Diego Regional MS4 Permit.

Finally, a critical element of the project will be to provide recreational uses to nearby residents and visitors. The project will include a recreational trail (i.e., bicyclists, pedestrians, etc.) near the project area to be used for outdoor activities and general aesthetic enjoyment. In addition to the recreational use, it will create a learning trail with facts about the local habitat and wildlife, as well as informative signage about water quality and the interrelation between water quality, surface water, and groundwater. The recreational trail(s) will be lined with a fence to protect the native habitat and prevent trash, debris, and other litter as well as human trampling from affecting the native habitat. The learning trail(s) will have signage with interesting facts about the species that users will see along the channel. All signage will be bilingual, with information in both English and Spanish.

Figure 1. Project location

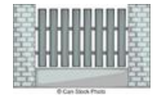
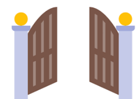
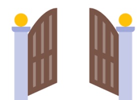
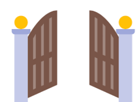
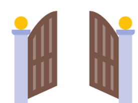
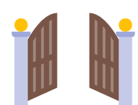
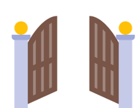
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Telegraph Canyon Channel Improvement Project are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use Reach in Hilltop Park could be provide recreational benefits.	
Match Production with Demand/Need	Confirm the captured and treated volume can be used carried by the stream	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***		
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Site is divided by several major thoroughfares Channel section affects a D.A.C.	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project scaled to use capture and divert stormwater that can be carried by the planned channel	
Agency Agreements	FEMA and DAC regulations will complicated permitting process	***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet water quality requirements for water in a natural stream	
Regulatory Ambiguity		***Regulator Clarity and Flexibility***		
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application planned for funding. Potentially available through Prop 1.	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project has community support	

QUANTIFICATION SUMMARY:

Figure 2 presents this project's stormwater capture elements, from which quantifies have been determined. The elements and quantities include stormwater capture volumes, infiltration rate from the park and creek to the shallow groundwater, and improved natural flows.

Figure 2. Stormwater capture infrastructure elements

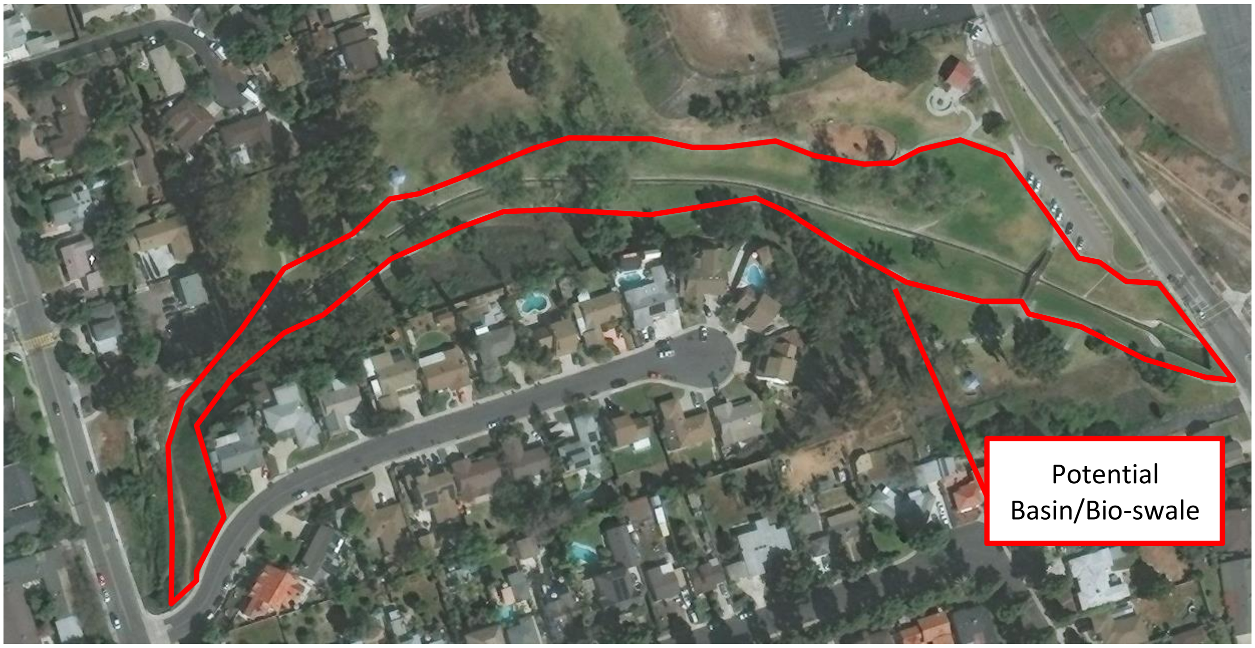


Table 2 presents the estimated quantities for the elements shown on Figure 3, including stormwater capture, annual infiltration to the shallow groundwater, and returned to natural surface flows. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet)	Annual Volume of Stormwater Captured (AFY)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated to natural systems (AFY)
Estimated Quantities	TBD	96,000 SF	TBD	D, 0.05 in/yr	TBD

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Lemon Grove Green Street Network

STORMWATER USE ALTERNATIVES:
Alternatives B - Discharge to groundwater to reestablish natural hydrology – to restore biological beneficial uses

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
City of Lemon Grove


(US EPA Municipal Handbook: Green Streets, 2008)

Description:

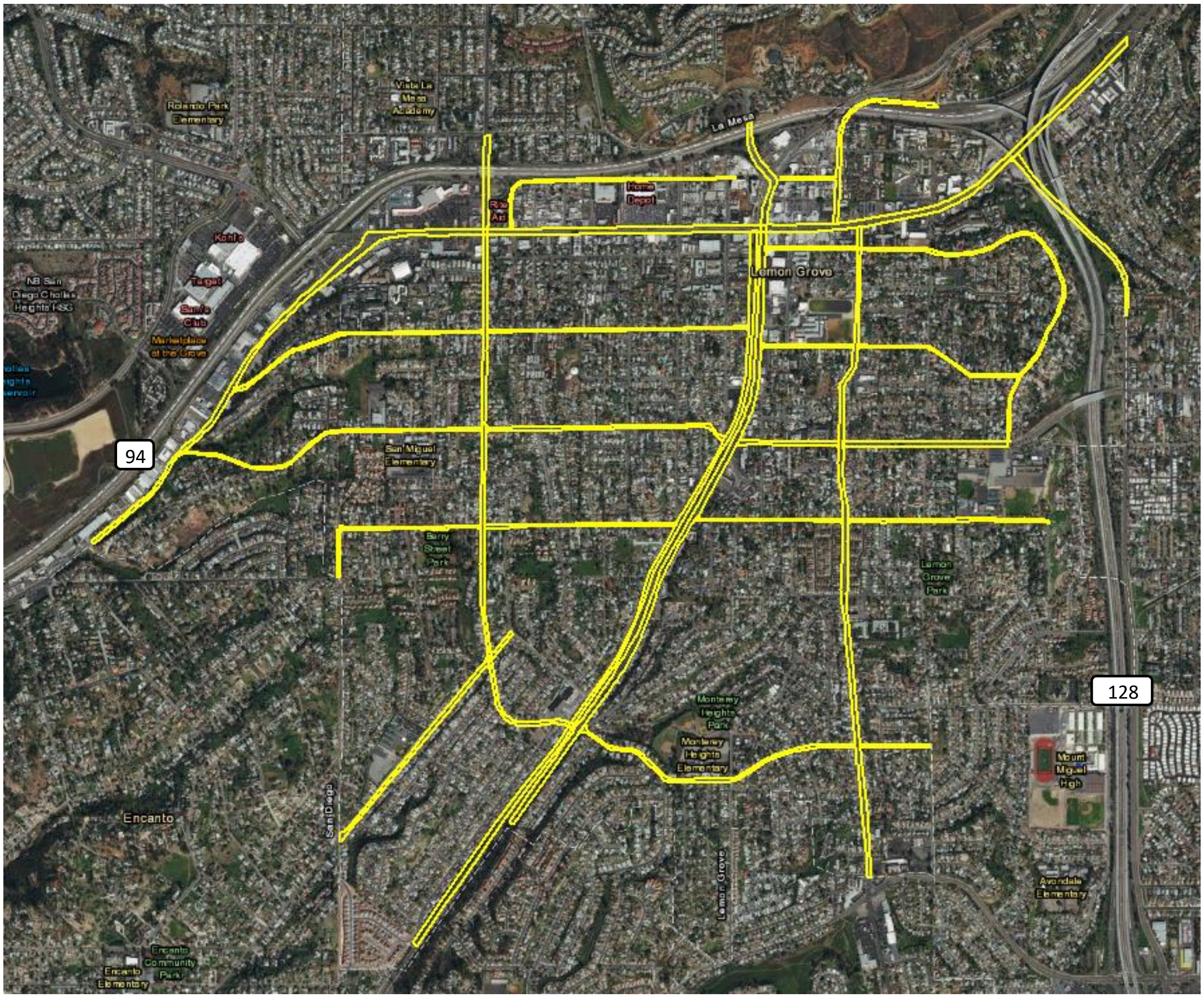
This project includes several green street renovations in the City of Lemon Grove, including Broadway and Federal Boulevard, Lemon Grove Avenue, Skyline Drive and Kempt Street, Massachusetts Boulevard, North Avenue, and Grove Street, San Miguel Street, Central Avenue, Mt. Vernon Street, Palm Street, 69th Street, Madera Street, Canton Drive, Golden Avenue, Sweetwater Rd, and Lincoln St. The streets proposed for renovation are presented in Figure 1.

At each of the streets identified for renovation, the surrounding area, like most of the city of Lemon Grove, is urbanized and has a large portion of impervious surfaces. The project will consist of reducing the amount of impervious surfaces and will include Low-Impact Development (LID) features will treat stormwater and more closely mimic natural hydrology.

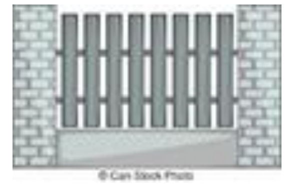
The City of Lemon Grove lies almost entirely within the Chollas Creek watershed, and the streets identified for renovation are along Chollas Creek, a region which has been identified as a high priority drainage area within the watershed. The project's focus on LID aims to improve infiltration and reduce pollutant loads entering shallow groundwater in the area, thus improving water quality and restoring natural hydrology.

Furthermore, the proposed project would increase pedestrian access which would attract a diverse audience. The entire City of Lemon Grove is considered to be an economically disadvantaged area (EDA).

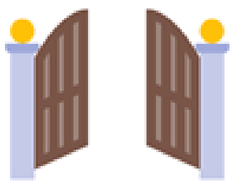
Figure 1 – Project Location



PROJECT OPPORTUNTIES AND CONTRAINTS:

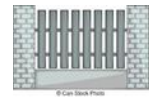
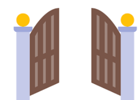
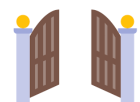
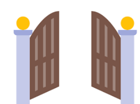
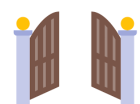
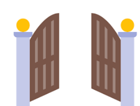
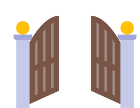


The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the Lemon Grove Green Street Network Project are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use Low-Impact Development infrastructure is complementary to current uses	
Match Production with Demand/Need	Confirm the captured and treated volume can be infiltrated	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Flexible construction extent, developing streets as available	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Site would require full remodel from traditional streets to green streets	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project elements can be repeated across the network, providing economy of scale Green streets generally have easy site access	
Agency Agreements	Streets may have right-of-ways controlled by utilities	***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet water quality requirements for infiltration	
Regulatory Ambiguity		***Regulator Clarity and Flexibility***		
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application for funding. Potentially available through Prop 1.	
Public/Agency Support	Construction will disrupt traffic (short-term)	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project generally has community support (long-term)	

QUANTIFICATION SUMMARY:

Figure 2 presents a schematic Green Street with capture and infiltration. These quantifies have been determined for this project. The elements and quantities include stormwater capture volumes, infiltration rate from the park and creek to the shallow groundwater, and water quality improvements from improved natural flows.

Figure 2. Example schematic of green street stormwater capture (from Philadelphia Green Street Design Manual)

http://www.phillywatersheds.org/img/GSDM/GSDM_FINAL_20140211.pdf

Table 2 presents the estimated quantities for the network outlined on Figure 1, assuming some of the elements shown on Figure 2, including stormwater capture and annual infiltration to shallow groundwater. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design-level quantities, but are applicable for feasibility-level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure
Description of Estimated Quantity	Size of Drainage Area (acres)	Street length renovated (mi)	Annual Volume of Stormwater Captured (AFY)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater used for infiltration and evapotranspiration (AFY)
Estimated Quantities	1,500 ac	31.2 mi	855 AFY	Varies	39 AFY

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Woodside Avenue Complete Green Street

STORMWATER USE ALTERNATIVE:
Alternative B - Discharge to groundwater to reestablish natural hydrology – to restore biological uses

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
Woodside Avenue, from Marilla Drive to Lindo Lake County Park at Chestnut Street; County of San Diego

Description:

Woodside Avenue is a major arterial road serving the community of Lakeside. This area consists of commercial, industrial land uses mixed with multi-family units that were developed before the implementation of the current storm water regulations. Storm water runoff for Woodside Avenue and adjacent properties is conveyed via curb and gutters to the adjacent receiving waters. This results in road flooding during rain events.

In addition, within the past 5 years, there have been eighteen (18) reported collisions involving pedestrians and/or bicyclists on Woodside Avenue (within the project limits). Of the eighteen collisions, two (2) were pedestrian deaths in 2015 alone. Sidewalks and bike lanes exist infrequently and sporadically along the project's 1.25 miles of Woodside Avenue which is currently an undivided 2 to 4 lane (with intermittent painted medians) 35 to 40 mph (posted) roadway.

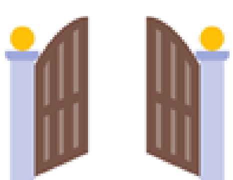
The proposed project will design and construct a complete pedestrian- and bicycle-friendly active transportation corridor from Marilla Drive and the Lakeside Middle School, through the commercial and economic village core of the Lakeside Community, to the Lakeside Community Center and Lindo Lake County Park. The project will incorporate Complete Streets and Green Streets features, improve pedestrian mobility, and provide a continuous accessible route that meets the current American with Disabilities Act (ADA) requirements. The project will enhance pedestrian (sidewalks, ADA curb ramps) and bicyclist (Green Painted Class 2 Bike Lanes) safety, provide a Safe Route to School (Lakeside Middle), and promote alternate transportation modes (Transit-Route 848).

Woodside Avenue has very limited subsurface drainage so all of the runoff is conveyed by curb and gutter where they exist, causing flooding of driveways and property frontages. This project will improve existing drainage infrastructure and provide water quality treatment. While the primary impetus for the project is safety, mobility, and accessibility, it provides an opportunity to improve drainage and stormwater beneficial use through Green Streets best practices applied when developing medians and lane separation.

Figure 1. Project location

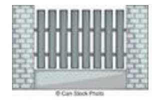
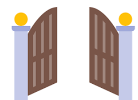
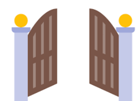
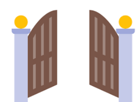
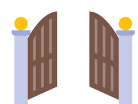
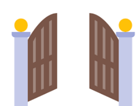
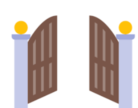
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Woodside Ave Complete Street Project are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use Low-Impact Development infrastructure is complementary to current uses	
Match Production with Demand/Need	Confirm the captured and treated volume can be infiltrated	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Flexible construction extent, developing street segments as available	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Site would require full remodel from traditional streets to green streets	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Green streets generally have easy site access	
Agency Agreements	Streets may have right-of-ways controlled by utilities	***Partnerships***	Project is on property owned by the County of San Diego	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet water quality requirements for infiltration	
Regulatory Ambiguity	NA	***Regulator Clarity and Flexibility***	NA	
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant funding potentially available through Prop 1. Project will improve ADA accessibility and a Safe Route to School, opening the project to more potential funding sources	
Public/Agency Support	Construction will disrupt traffic on this major thoroughfare (short-term)	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project has community support	

QUANTIFICATION SUMMARY:

Table 2 presents the estimated quantities for the project elements, including stormwater capture and annual infiltration to shallow groundwater. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (square feet, ft. and cubic feet)	Annual Volume of Stormwater Captured (CF/yr.)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated (AFY)
Estimated Quantities	TBD	37,500 SF[1]	TBD	C, 0.15	TBD

[1] Assumes 10% of street area will be used for LID infrastructure

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Rincon Band – Luiseno Indian Reservation Regional Stormwater Capture Project

STORMWATER USE ALTERNATIVE:

Alternative A – Direct discharge to designated groundwater aquifers to be extracted for potable use

Alternative B – Discharge to groundwater to reestablish natural hydrology and, by extension, to restore biological uses

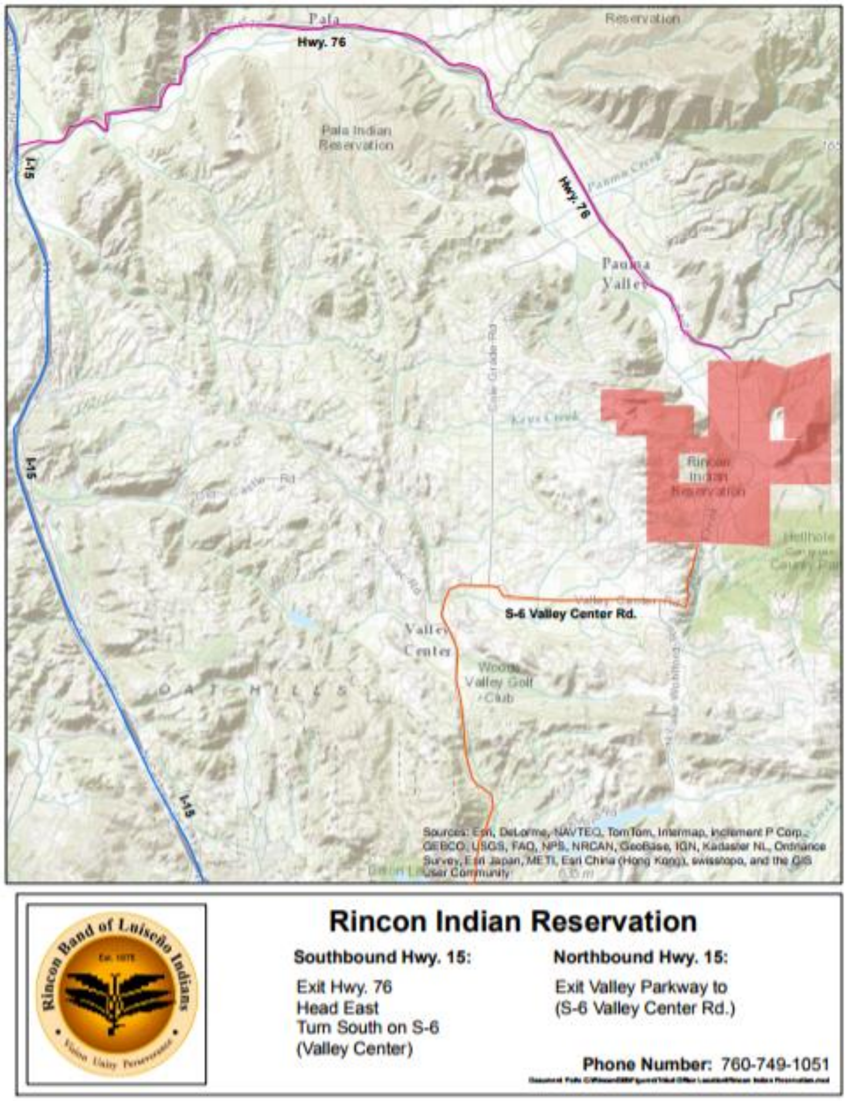
PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR: Rincon Band, Luiseno Indian Reservation, San Diego County, CA (Headquarters 33750 Valley Center Rd, Valley Center, CA 92082). Sponsor is being solicited

Description:

The tribal government of the Rincon Band of Luiseño Indians (tribe) is responsible for supplying water to over 170,000 people across the tribal reservation located in the San Luis Rey River watershed in San Diego County, California (see Figure 1). The reservation's water supply is derived entirely from groundwater in the underlying aquifer. Sustained drought conditions have resulted in declining groundwater levels and an unsustainable condition. As part of an overall strategy to secure adequate and sustainable water supply and acceptable water quality for residents and the local economy, the tribe is seeking grant funding to implement a phased stormwater capture and infiltration project. Information for this summary was derived primarily from the San Diego IWRM database, as well as information provided on the tribal website (https://www.rincontribe.org) and California Dept. of Water Resources Bulletin 118 (1975).

Figure 1. Map Showing Rincon Band of Luiseño Indians Reservation



The first phase of the project for which funding is being requested consists of evaluating appropriate locations within the reservation to capture and contain stormwater to reduce contaminant migration into the San Luis Rey River, and to increase recharge of the drinking water aquifer through stormwater infiltration projects on a local and sub-regional scale. The project would reduce the amount of metals, bacteria, and nutrients being discharged into the San Luis Rey River. The objectives of this project have been approved by the Tribal Council and have been incorporated into the existing Master Plan for the Reservation.

<u>Key Project Features</u>

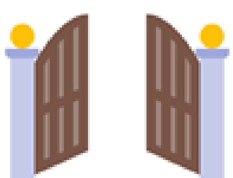
The San Luis Rey Valley contains stream channel deposits of highly permeable sand and gravel sediments that would be favorable for enhanced infiltration designs. California Dept. of Water Resources Bulletin 118 (1975) identifies the sand and gravel deposits of the San Luis Rey groundwater basin (9-007) as a prolific aquifer, with average well yields in the 500 gallon/minute range. Much of the Rincon Band's Luiseno Indian Reservation lies within the upgradient (eastern) portion of the San Luis Rey basin.

A phased approach is proposed to be undertaken, for maximizing capture of stormwater runoff and recharging the groundwater system. The first phase would consist of a feasibility study to identify favorable sites for capturing stormwater flow and infiltrating it into the groundwater system. Centralized locations may capitalize on mountain front runoff, and development of infiltration galleries or dry wells for injecting groundwater directly into the aquifer, bypassing the low permeability sediments on the valley floor. Localized small-scale projects may include green streets and parking lots that facilitate infiltration, such as at the large Harrah's casino facility that is located on reservation. Surface water and groundwater data from each watershed or sub-watershed in the reservation. Evaluation of the volume of surface runoff will be conducted in potentially favorable areas, and identification of both urban and non-urban water use volumes will be undertaken, using modeling and other techniques.

Specific areas will be ranked for being most feasible for increasing stormwater capture and infiltration. Regulatory or institutional constraints will be investigated. Public and private stakeholders will be identified, along with opportunities for integration with existing watershed initiatives to provide multiple benefits.

PROJECT OPPORTUNTIES AND CONTRAINTS:

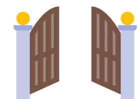
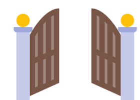
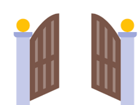
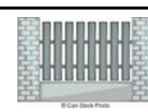
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.

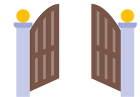
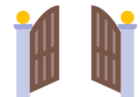


The constraints or "gates" and opportunities or "keys to open gates" associated with the Rincon Band – Luiseno Indian Reservation Regional Stormwater Capture Project are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

For the Rincon Band – Luiseno Indian Reservation Regional Stormwater Capture Project, there are a number of "gates" that include achieving pre-treatment goals for infiltration. Additional "gates" include potential incompatibility of treated runoff with ambient groundwater, lower permeability of the soil than expected, funding, and uncertainty in pre-treatment requirements. The potential "keys to opening the gate" include use of the existing infrastructure to reduce costs and the multi-benefits of this project that include pollutant load reductions from stormwater flows to the San Luis Rey River that provide a regulatory driver to inter-agency agreements, funding and discharge permit flexibility. These inter-agency cooperative opportunities can provide for additional funding.

Table 1
Project Constraints "Gates" and Opportunities "Keys"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	Groundwater basin appears to be highly permeable. Large amounts of land may be available in the river valley inside the reservation for use as an infiltration gallery or for dry wells, if needed. Green streets and parking lots (e.g., Hurrah's Casino) could be utilized.	
Match Production with Demand/Need	Groundwater demand may decrease due to conservation measures and is lower for irrigation needs during heavy wet weather periods	***Benefits of supplementing aquifer groundwater*** ***Benefits of helping reduce seawater intrusion downgradient***	Project affords opportunity to scale size and number of infiltration galleries and dry wells to capture more or less of the runoff to meet anticipated demand.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater storage and infiltration. Significant interruption of traffic during construction. Existing infrastructure may be limited.	***Existing Infrastructure (Storm drains)*** ***Community support for infrastructure construction***	Project improvements include construction of infiltration basins, galleries, and dry wells within San Luis Rey Groundwater Basin. Infrastructure construction requires cooperation due to temporary shut-down of lanes in street, parking lots, or areas already utilized for other purposes. Facilitated through community stakeholders buy-in.	
Agency Agreements	NA	***NA***	NA	
Water Type Incompatibility **Treatment Requirements**	Stormwater quality mixed with ambient groundwater may cause undesired chemical reactions in aquifer or cause contaminated groundwater plume movement	***Storage and Controlled Discharge*** ***Pre-Treatment***	Adjust pretreatment design if necessary to achieve needed quality; Infiltration through soil likely to provide significant improvement in water quality and compatibility. Evaluate presence of any known contaminants plumes and potential to affect them	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses. CEQA MND finding uncertain	***Regulator Clarity and Flexibility*** ***Identify mitigating measures***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies Identify mitigating measures to ensure CEQA finding of non-significant impacts	

Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential funding from Stormwater Prop 1 Funding. Inter-agency agreements appear secure. TMDL improvements may help with securing cooperation and funding	
Public/Agency Support	NA	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the groundwater supply to allow for area to achieve groundwater sustainability. TMDL goals more likely to be achieved, fostering support	

QUANTIFICATION SUMMARY:

This project's phased approach for stormwater capture and use will first focus on evaluating optimal locations on the reservation for collecting and infiltrating stormwater into the underlying soils and groundwater. Because this analysis is only at a concept phase at this point, only order of magnitude estimates can be made at this time, based on major assumptions and experience at other locations. The elements and quantities include stormwater capture from runoff in the reservation open space, especially near the San Luis Rey River, and stormwater runoff in city streets and/or parking lots. Captured runoff would be pre-treated to remove trash and debris, sediment, and floating petroleum product if present, and then recharge the underlying aquifer through subsurface infiltration galleries and dry wells. The project elements will result in the capture and infiltration of an estimated (TBD) acre-feet per year, recharging the local groundwater system.

Table 2 presents the estimated quantities for likely project types that may be identified during the feasibility study. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are strictly conceptual with a substantial degree of uncertainty due to lack of site-specific details. They are order-of-magnitude estimates based on experience in other areas, and are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, INFILTRATION, TREATMENT AND USE

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	TBD	TBD	TBD	TBD	TBD	TBD

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: San Marino Drive Green Street and Dry Weather Flow Management

STORMWATER USE ALTERNATIVES:
Alternative B - Discharge to groundwater to reestablish natural hydrology – to restore biological uses

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
San Marino Drive, from Calle De Arroyo to Lake San Marcos; County of San Diego

(Google Street View, 2017)

Description:

This project will improve San Marino Drive (San Marino) in the Unincorporated County of San Diego (County) within the community of Lake San Marcos. San Marino will be improved starting at Calle De Arroyo and terminating at the San Marino Cul-de-sac near Lake San Marcos

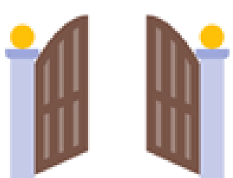
Currently there is a persistent dry weather flow entering the County's municipal separate storm sewer system (MS4) along San Marino Drive that then discharges into Lake San Marcos. San Marino Drive currently does not have any treatment of road runoff during rain events before flowing into the lake.

The proposed project will utilize the entirety of County right-of-way on San Marino Drive from Calle De Arroyo terminating at the San Marino Cul-de-sac near Lake San Marcos to construct green streets. Over this area, the project will use Green Streets best practices (i.e. low-impact development features and smaller impervious areas) to treat and/or infiltrate dry weather flows before they enter the adjacent County MS4 or infiltrate directly into shallow groundwater flows.

Figure 1. Project location

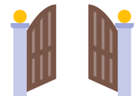
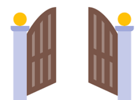
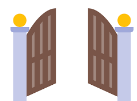
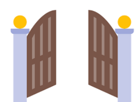
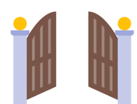
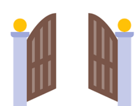
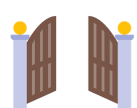
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the San Marino Green Street are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS “GATES” AND OPPORTUNITIES “KEYS”

Constraints “Gates”	Project Constraints “Gates”	Opportunities “Keys to Open Gates”	Project Opportunities “Keys”	Project “Gate Status”
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use Low-Impact Development infrastructure is complementary to current uses	
Match Production with Demand/Need	Confirm the captured and treated volume can be infiltrated	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Flexible construction extent, developing street segments in series	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Site would require remodel from traditional streets to green streets	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Green streets generally have easy site access	
Agency Agreements	Streets may have right-of-ways controlled by utilities	***Partnerships***	Project is on property owned by the city	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet water quality requirements for infiltration or discharge to MS4	
Regulatory Ambiguity		***Regulator Clarity and Flexibility***		
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Grant application for funding. Potentially available through Prop 1.	
Public/Agency Support	Construction will disrupt traffic (short-term)	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project has general community support (long-term)	

QUANTIFICATION SUMMARY:

Table 2 presents the estimated quantities for the project elements, including stormwater capture and annual infiltration to shallow groundwater. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure	Green Street LID Infrastructure
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated (AFY)
Estimated Quantities	TBD	9,500 SF[1]	TBD	D, 0.05	TBD

[1] Assumes 10% of street area will be used for LID infrastructure

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: National City "A" Avenue Green Street

STORMWATER USE ALTERNATIVES:
Alternative B - Discharge to groundwater to reestablish natural hydrology – to restore biological uses

Alternative C - Irrigation for on-site or nearby park, golf course, recreational area

PROECT TYPE: Complete

PROJECT LOCATION AND SPONSOR:
"A" Avenue, between E. 8th Street and Kimball Park; National City

Description:

This project provides an integrated stormwater capture and use system to Kimball Park, along "A" Avenue in National City. The project includes low-impact development (LID) infrastructure along "A" Avenue to improve infiltration to groundwater and storage to provide irrigation water for the park. This both reduces irrigation requirements at the park and improves water quality for water discharged to Paradise Creek.

New infiltration basins along the road are connected to the road gutters to capture stormwater flows. These basins, capped with river rock to prevent erosion, include a thick layer of rock and sediment through which water percolates on its way down into natural groundwater systems. The infiltration basins adjacent to the park also contain storm drains that feed the underground cistern system.

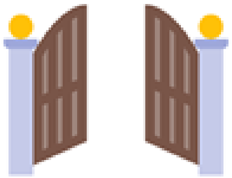
In addition to green street infrastructure along "A" Avenue, a filtration and cistern system was also installed beneath Kimball Park. Water from the street enters the system through storm drains along the edge of the park, which have grates to prevent larger debris from entering the system. The storm drain flow then proceeds into a hydrodynamic separator (a filter system using flow baffles) to remove trash, debris, and sediment, and the resulting cleaner outflows are stored in a 30,000-gallon cistern. A pump is then used to bring this water up to the park for irrigation, or direct overflow to Paradise Creek.

Figure 1. Project location

PROJECT OPPORTUNTIES AND CONTRAINTS:

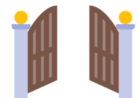
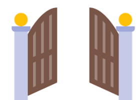
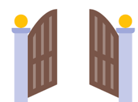
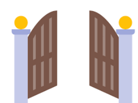
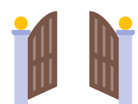
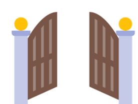
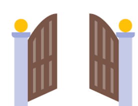
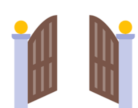
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.

The constraints or “gates” and opportunities or “keys to open gates” associated with the “A” Avenue Green Street Project are summarized in Table 1. These project opportunities and constraints should be



considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use Low-Impact Development infrastructure is complementary to current uses	
Match Production with Demand/Need	Confirm the captured and treated volume can be infiltrated	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Site irrigation and return of treated water to Paradise Creek uses all captured water	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Site would require remodel from traditional streets to green streets	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Green streets generally have easy site access	
Agency Agreements	Streets may have right-of-ways controlled by utilities	***Partnerships***	Project is on property owned by the city	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet water quality requirements for infiltration or discharge to MS4	
Regulatory Ambiguity		***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Largely grant funded (Prop 84), supplemented by city funds.	
Public/Agency Support	Construction will disrupt traffic (short-term)	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project has general community support (long-term) Project improves park access and ADA compliance	

QUANTIFICATION SUMMARY:

Figure 2 presents the subsurface elements of this project's stormwater capture and use process from which quantifies have been determined. The elements and quantities include stormwater capture volume, irrigation infiltration to shallow groundwater.

Figure 2. Stormwater capture infrastructure elements (From interpretive signs at Kimball Park)

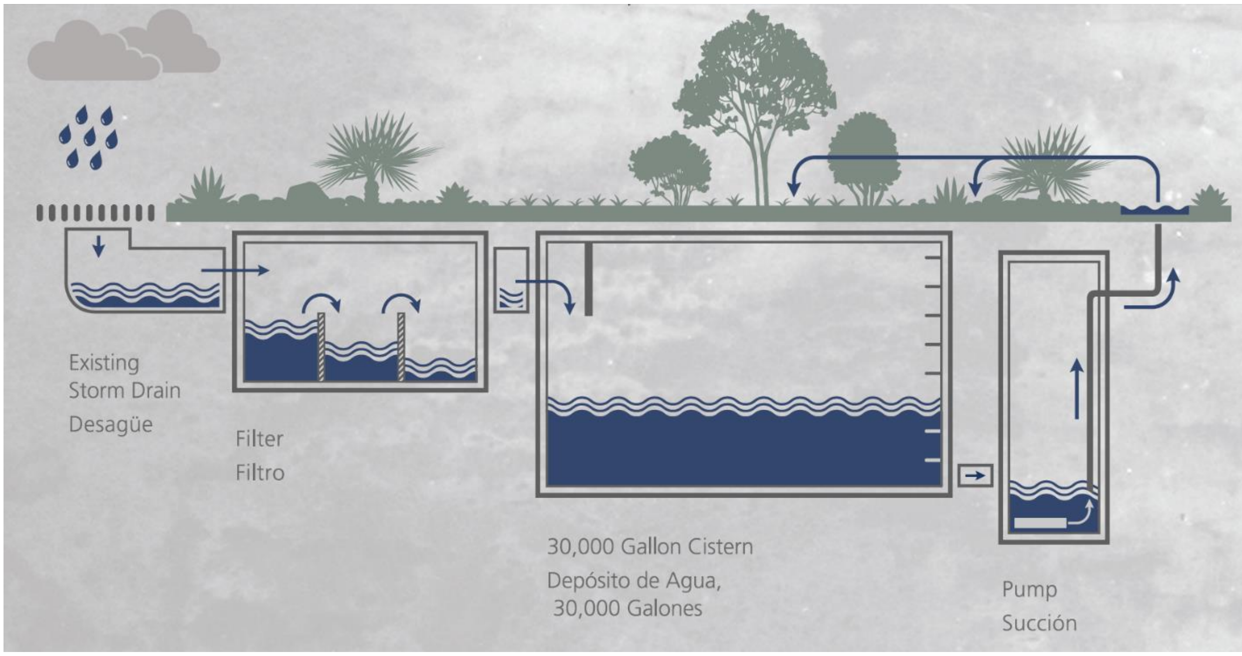


Table 2 presents the estimated quantities for the elements shown on Figure 3, including stormwater capture, annual irrigation use, and annual discharge of treated water to Paradise Creek. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Vault	Stormwater Retention Vault	Stormwater Retention Vault	Stormwater Retention Vault
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (AFY)	Annual volume of stormwater used for irrigation (AFY)	Annual volume of stormwater discharged to Paradise Creek (AFY)
Estimated Quantities	805 ac	7,000 SF Green Street[1] 4,000 CF Vault	90.5 AFY	2.5 AFY	88.0 AFY

[1] Assumes 10% of street area will be used for LID infrastructure

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 25-year project lifespan, the unit cost for this example project is $1,635/AFY. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. In comparing g this project unit costs to the range of costs under Alternative Uses B & C (Discharge to Restore Natural Hydrology and Irrigation Use), this example project cost is reasonable for Use B and notably less expensive than most Use C estimates.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	**Total Costs**
Construction Cost	$ 2,387,097
Site Preparation (5% of total)	$ 119,355
Design and Planning (permitting) (20% of total)	$ 477,419
Operations and Maintenance (10% of Total)	$ 238,710
Contingency (20% of Total)	$ 477,419
Total[1]	$ 3,700,000

[1] Only the total was reported, so standard percentages were used to estimate the cost of several components.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Stone Brewing World Bistro and Gardens

STORMWATER USE ALTERNATIVES:
Category B - Discharge to groundwater to reestablish natural hydrology – to restore biological uses

Category D - Small scale on-site use for irrigation and other private use

PROECT TYPE: Constructed

PROJECT LOCATION AND SPONSOR:
1999 Citricado Parkway; Escondido

Site Plan: Stone Brewing World Bistro & Gardens - Escondido, California

Description:

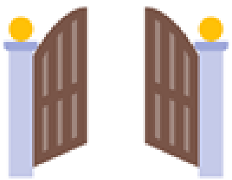
This project is located on private property at a restaurant/brewery in Escondido. The restaurant includes a one-acre landscaped area for dining and special events. In addition to aesthetic benefits, the park-like area collects and detains stormwater runoff from the surrounding industrial park.

The project converted approximately one acre of previously industrial (impervious) land into pervious landscaping and graded the area such that runoff from the surrounding industrial park gathers there. The site now acts as a stormwater detention facility within the larger network of stormwater infrastructure in the surrounding industrial park (which covers approximately 100 acres). The paths on the site are made of crushed granite to promote infiltration, and a portion of the site acts as a rain garden. In addition to bioretention and infiltration benefits, the site also uses captured stormwater to meet some of its irrigation needs.

Figure 1. Project location

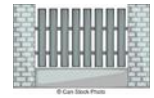
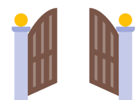
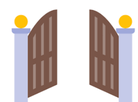
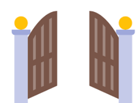
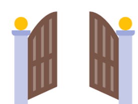
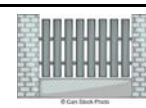
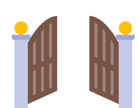
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the Stone Brewing World Bistro and Gardens Project are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Porous pavers with sub-surface storage complementary to current land use Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration and use	
Match Production with Demand/Need	Confirm captured and treated volume can be used on-site for irrigation	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Project is scaled to meet on-site demands and overflow can be captured by larger regional stormwater detention network	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Refine bio-filtration design and design of needed infrastructure for distribution of treated stormwater to storage or for irrigation	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project scaled to use planned on-site bio-filtration for treatment of captured and diverted stormwater	
Agency Agreements		***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design confirmed compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet requirements for irrigation and bio-filtration or infiltration	
Regulatory Ambiguity		***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements	
Capital and O&M Costs **Funding**	Owner responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Owner uses site as part of restaurant to cover costs	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project is on private property	

QUANTIFICATION SUMMARY:

Figure 2 presents the process diagram for each element of this project's stormwater capture and use process from which quantifies have been determined. The elements and quantities include stormwater capture volumes, infiltration rate from the park and creek to the shallow groundwater, and water quality improvements from improved natural flows.

Figure 2. Stormwater capture infrastructure components

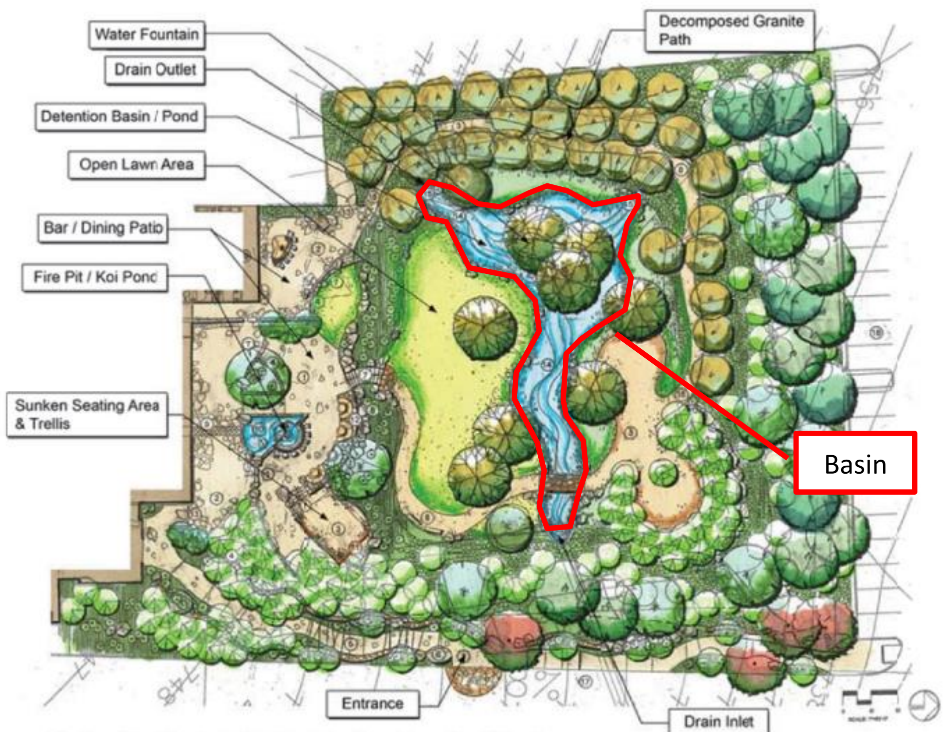


Table 2 presents the estimated quantities for the elements for stormwater capture and annual infiltration to shallow groundwater shown on Figure 2. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (AFY)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater used (AFY)
Estimated Quantities	17.5 ac	45,000 SF	9.0 AFY	B, 0.3 in/hr	5.7 AFY

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 25-year project lifespan, the unit cost for this example project is $5,260/AFY. The project only provided a total cost estimate, so some elements were assumed using common percentages. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. This project's unit costs were not compared to the range of costs under Alternative Use D (Small-Scale On-Site Use), because this study only estimated a range for rain barrels, infrastructure which is not comparable to large-scale construction like the Stone Brewing facility; however, they are within the range of unit costs estimated for Use B.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	Total Costs
Construction Cost	$ 483,871
Site Preparation (5% of total)	$ 24,194
Design and Planning (permitting) (20% of total)	$ 96,774
Operations and Maintenance (10% of Total)	$ 48,387
Contingency (20% of Total)	$ 96,774
Total[1]	$ 750,000

[1] Total is reported between $500,000 and $1,000,000, so the mean was used. Because only the total was reported, standard percentages were used to estimate the cost of several components.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Dry Weather Flow Diversion at Los Coches Creek Outfall (Alternative 1)

STORMWATER USE ALTERNATIVES:

Alternative F - Controlled discharge to waste water treatment plants for solids management during low flows

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
Los Coches Road Bridge, Lakeside CA.

Description:

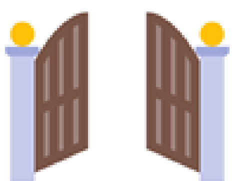
The Padre Dam Municipal Water District (Padre Dam) operates the Ray Stoyer Water Reclamation Facility (RSWRF), which currently treats about 2 MGD of wastewater for the production of recycled water for non-potable reuse. Padre Dam is planning a major expansion of the facility for subsequent indirect potable reuse, among other end-use goals. Phase 1 of this expansion involves treating about 6 MGD of wastewater, while Phases 2 and 3 will treat about 16 and 21 MGD respectively. While additional wastewater sources have been identified for Phase 1 and are currently planned for Phase 2, the identification of an additional source water stream as part of this expansion would prove beneficial to the agency for planning purposes.

This project (Alternative 1) investigates the feasibility of diverting dry weather discharge from a site adjacent to the Los Coches Road Bridge in the vicinity of Lakeside, CA. The current discharge is to Los Coches Creek. The diverted flows would be used to augment sewer flow in the Padre Dam Municipal Water District (Padre Dam) sewershed, with the goal of using this flow to augment influent to the Ray Stoyer Water Reclamation Facility (RSWRF) to help meet reuse goals. Located in the San Diego River Watershed, dry weather monitoring during 2015 and 2016 indicated that coliform and *Enterococcus* levels in this discharge were in excess of non-stormwater action levels. Therefore, in addition to augmenting Padre Dam's reuse goals, this project would also serve to reduce pathogen levels in discharge to Los Coches Creek.

An annual average discharge volume of approximately 2.6 million gallons was estimated. This amounts to roughly 10,000 gallons per day assuming constant flow during half the year. This project is assumed to be independent and mutually exclusive from Project 56, where the feasibility of storage parcels along Padre Dam's sewershed is evaluated for augmentation to the sanitary sewer. This project is also assumed to be independent and mutually exclusive from Alternative 2, which does not involve discharge to a sanitary sewer, and is evaluated separately.

PROJECT OPPORTUNTIES AND CONTRAINTS:

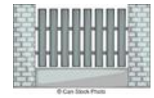
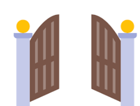
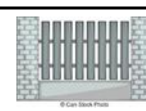
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.

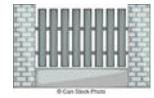
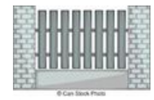


The constraints or "gates" and opportunities or "keys to open gates" associated with Dry Weather Flow Diversion at Los Coches Creek Outfall (Alternative 1) are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

For this project (Dry Weather Flow Diversion at Los Coches Creek Outfall (Alternative 1)), the major gates identified included the implementation of conveyance from the site location to Padre Dam's sanitary sewer system, or to a nearby sanitary sewer. The relatively small flow from this discharge may also make the construction of additional infrastructure less viable. Opportunities include the fact that the small flow is likely to have negligible impact on wastewater treatment process, and should therefore be easier to accommodate from a treatment perspective.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	The location of the project is approximately 2. 5 miles from the nearest 21"+ connection to Padre Dam's sanitary sewer system.	***Larger or Multiple Storage Sites offsite, with conveyance***	Built conveyance, or the augmentation of flow to sewer systems that are closer to the site, along with future agreements made between Padre Dam and east County agencies might allow for conveyance to RSWRF.	
Match Production with Demand/Need	Recycled water production will increase due to Padre Dam's planned expansions to produce up to 21 MGD (Phase 3) for multiple reuse end-goals.	***Multiple public parcel storage sites*** ***Adequate conveyance to plant***	There is adequate offsite storage capacity to meet needs, and there is expected to be adequate capacity in the sewer. However, the estimated available flow of about 0.01 MGD may not be adequate to meet Padre Dam's reuse goals.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	No storage infrastructure currently exists; neither does conveyance infrastructure to the sanitary sewer system.	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Storage infrastructure needs to be installed/built, and conveyance infrastructure needs to be built, to transfer flows from this site to the nearest sanitary sewer system. Capacity does exist in the Padre Dam sewer system to accommodate these flows.	
Agency Agreements	Additional agreements may be needed for capture and storage of stormwater on site, and for conveyance over a large distance to Padre Dam.	***Partnerships***	Local municipalities may want to partner with Padre Dam to meet water quality goals in the watershed, and to meet local recycled water demands.	
Water Type Incompatibility **Treatment Requirements**	While stormwater mixed with current upgraded treatment facility may not be compatible.	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Modeling and testing of the treatment systems is needed to adequately address any issues in product water quality, or effects on RSWRF's current treatment system; however, since the expected flows are relatively small (on the order of about 0.01 MGD), it is unlikely that there will be any major impacts to treatment process	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses or for indirect potable reuse	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	

Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential funding from Stormwater Prop 1 Funding Inter-agency agreements may allow for additional funding support to meet stormwater water quality goals and/or use of recycled water to clean sewers	
Public/Agency Support	Current facility recycled water agreements may limit added stormwater use	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the current recycled water agreements could provide flexibility to treat and store of stormwater.	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the estimate of 2.6 million gallons per year, provided earlier. This translates to about 0.01 million gallons per day, assuming the stored volume drains over half the year, after adequate storage time.

Table 2 presents the estimated quantities for the elements shown on Figure 1. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (AFY)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	185	TBD	Approx. 350,000	0.01 (limited by estimated volume produced)	TBD	TBD

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis, the unit cost for this example project is $18,255/AFY. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. In comparing g this project unit costs to the range of costs under Alternative Uses F (Controlled Discharge to Waste Water Treatment Plants for Solids Management), this example project cost is reasonable for Use F.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	Unit Costs	Quant.	Total Costs	Source/Assumptions
Mobilization/Demob	$ 7,383	1	$ 7,383	
Erosion Control & Temp Fencing	$ 25,000	1	$ 25,000	
Clearing & Grubbing/Tree Removal	$ 5,000	1	$ 5,000	assumes approximately .25 acre of clearing for diversion
Excavation	$ 7	200	$ 1,400	Assuming 200 cy excavation required to install diversion vault
Excess Soil Off-Haul	$ 15	50	$ 750	Assuming structure displacement of 50 cy requires 50 cy of soil export
Culverts from MS4 to Diversion Structure	$ 80	200	$ 16,000	Assuming 200 ft distance as in Alt G.
Underground Dry Weather Diversion Wet Well/Pump	$ 50,000	1	$ 50,000	Assuming lump sum for diversion/screening structure.
Connection to Santitary Sewer	$ 15,000	1	$ 15,000	In addition to connection, this includes building a manhole for connection.
Upgrade of Sanitary Sewer	$ -	0	$ -	Assuming current sewer capacity is maintained.
Treatment and Distribution for Recycled Water	$ 590	16	$ 9,511	Using 2.6 MGY from Los Coches Creek write-up and adding 100% to account for wet weather flow. Assuming non-potable reuse production. $590/AF comes from 2016 Pacific Institute Report on cost of alternative water supply in California by Cooley and Phurisamban. This is the median value of the range they determined.
Site Revegetation	$ 25,000	1	$ 25,000	assumes approximately .25 acre of clearing for diversion

Planning, Engineering & Permitting	$ 31,009	1	$ 31,009	
Subtotal			$ 186,053	
Contingency	$ 67,944	1	$ 67,944	Assume 20% Contingency
O&M	$ 40,267	1	$ 40,267	Assume 10% of total
Total			$ 294,264	

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: San Elijo Joint Powers Authority Stormwater Use Alternative Project

STORMWATER USE ALTERNATIVES:

Alternative A – Direct discharge to designated groundwater aquifers to be extracted for potable use

Alternative H – Controlled discharge to waste water treatment plants for potable water use

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR: 2695 Manchester Ave., Cardiff by the Sea, San Elijo Joint Power Authority

Description:

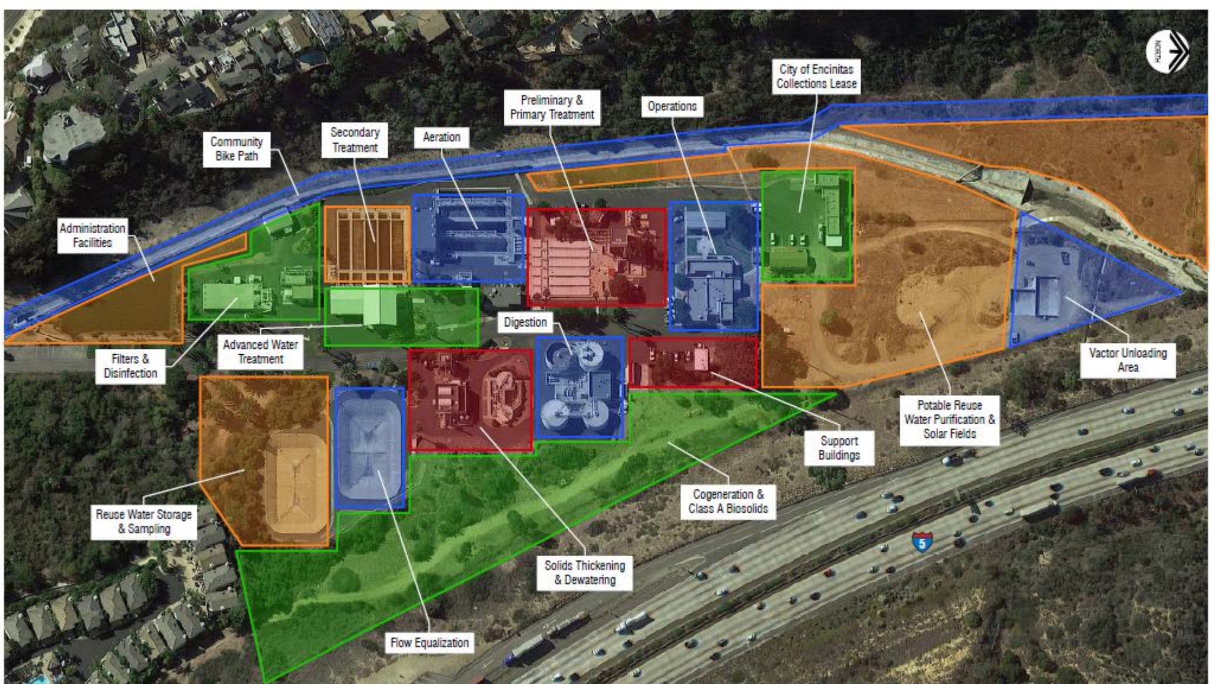
This concept project is located at the San Elijo Joint Powers Authority (SEJPA) Water Reclamation Facility. The San Elijo Water Reclamation Facility (SEWRF) is a publicly owned wastewater treatment and water recycling facility responsible for collecting, treating and safely disposing of, or recycling wastewater and its residuals for residents and businesses in the Solana Beach, Rancho Santa Fe, Olivenhain, and Cardiff communities. The plant is located in the Cardiff area, within the City of Encinitas, off Manchester Avenue.

The SEJPA owns and operates the SEWRF, including 20 miles of recycled water distribution pipelines, two recycled water reservoirs, and nine wastewater lift stations. The SEWRF handles mostly domestic waste and is permitted to distribute up to 2.48 million gallons per day (MGD) of tertiary-treated wastewater to recycled water users. It is also permitted to discharge up to 5.25 MGD of secondary-treated wastewater to the Pacific Ocean through the San Elijo Ocean Outfall, 1.5 miles offshore.

This concept project includes modifying an existing stormwater channel located in the northern portion of the SEWRF as shown on Figure 1. The modifications would include modifying the existing check dam and expanding the sediment collection area within the channel toward the open space area to the northeast to collect, store and infiltrate stormwater flows. Stormwater that is collected in this expanded retention basin would be infiltrated into the sub-surface soils to recharge the local shallow groundwater table.

The drainage area for this stormwater channel is approximately (TBD) acres and consists predominantly of open space, residential and transportation land uses. The stormwater capture area will conceptually be approximately (TBD) acres, and have a capacity of (TBD) cubic feet. The sediment capture and removal function of the channel would be moved more to the north and upstream of the retention/recharge basin. A separate check dam and maintenance access road will be constructed to continue the sediment management function of the stormwater channel system.

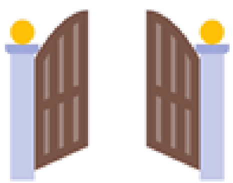
Figure 1. Conceptual Layout of the San Elijo Joint Powers Authority Stormwater Use Alternative Project



Recharged groundwater from infiltration of the captured and stored stormwater will be conceptually extracted from shallow groundwater well(s) located in the southern portion of the site. The wells will be designed to pump extracted shallow groundwater to the SEWRF where it would be treated to meet Title 22 standards for use as recycled water. No pre-treatment is anticipated, however, the rate of supply from the groundwater extraction wells will be controlled in order not to adversely affect the treatment processes in the SEWRF. As stormwater flows will vary in frequency and size, the groundwater extraction operations will be monitored for local groundwater elevation drawdown. Monitoring of groundwater levels will be used to manage groundwater extraction such that the drawdown will not adversely impact the adjacent sensitive marsh habitat.

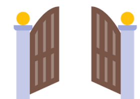
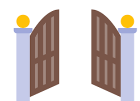
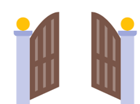
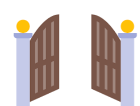
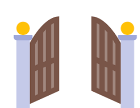
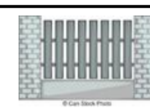
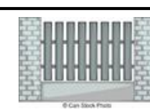
PROJECT OPPORTUNTIES AND CONTRAINTS:

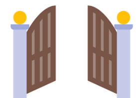
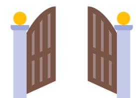
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the San Elijo Joint Powers Authority Stormwater Use Alternative Project are summarized in Table 1, The constraints and opportunities presented in columns 1 and 3 were developed by the TAC. The project specific constraints and opportunities are presented in columns 2 and 4. The final column presented in Taboe 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	Stormwater channel runs through SEJPA property, so source of stormwater is readily available	
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	Soils in the area of the basin are sandy and higher permeability.	
Match Production with Demand/Need	Groundwater demand may decrease due to conservation measures and is lower for irrigation needs during heavy wet weather periods	***Benefits of supplementing aquifer groundwater*** ***Benefits of helping reduce seawater intrusion downgradient***	Project affords opportunity to scale the extraction rate based on need to treat more or less of the runoff to meet anticipated demand.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater storage and infiltration. Significant interruption of traffic during construction.	***Existing Infrastructure (Storm drains)*** ***Community support for infrastructure construction***	Project improvements include an expanded infiltration basin and infrastructure to pump stored water to the existing SWERF for treatment.	
Agency Agreements	NA	***NA***	NA	
Water Type Incompatibility **Treatment Requirements**	Stormwater quality mixed with ambient groundwater may cause undesired chemical reactions in aquifer or cause contaminated groundwater plume movement	***Storage and Controlled Discharge*** ***Pre-Treatment***	Adjust pretreatment design if necessary to achieve needed quality; Infiltration through soil likely to provide significant improvement in water quality and compatibility. Evaluate presence of any known contaminants plumes and potential to affect them	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-	***Regulator Clarity and Flexibility*** ***Identify mitigating measures***	Treated stormwater to meet current recycled water requirements unless	

Constraints “Gates”	Project Constraints “Gates”	Opportunities “Keys to Open Gates”	Project Opportunities “Keys”	Project “Gate Status”
	potable uses. CEQA MND finding uncertain		clarifications provided by regulatory agencies Identify mitigating measures to ensure CEQA finding of non-significant impacts	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	TMDL improvements will likely help with securing cooperation and funding	
Public/Agency Support	NA	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the groundwater supply to allow for area to achieve groundwater sustainability. TMDL goals more likely to be achieved, fostering support	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantities have been determined are based on the conceptual Layout shown on Figure 1 and the highlighted project elements in Figure 2. The elements and quantities include stormwater capture from runoff in the upstream drainage and infiltration through the expanded infiltration basin. The project elements will result in the capture and infiltration of an estimated 12 acre-feet per year, recharging the local groundwater system. If injection were used, the project could add 37 acre-feet per year to the local groundwater system.

Figure 2. Stormwater Capture Elements

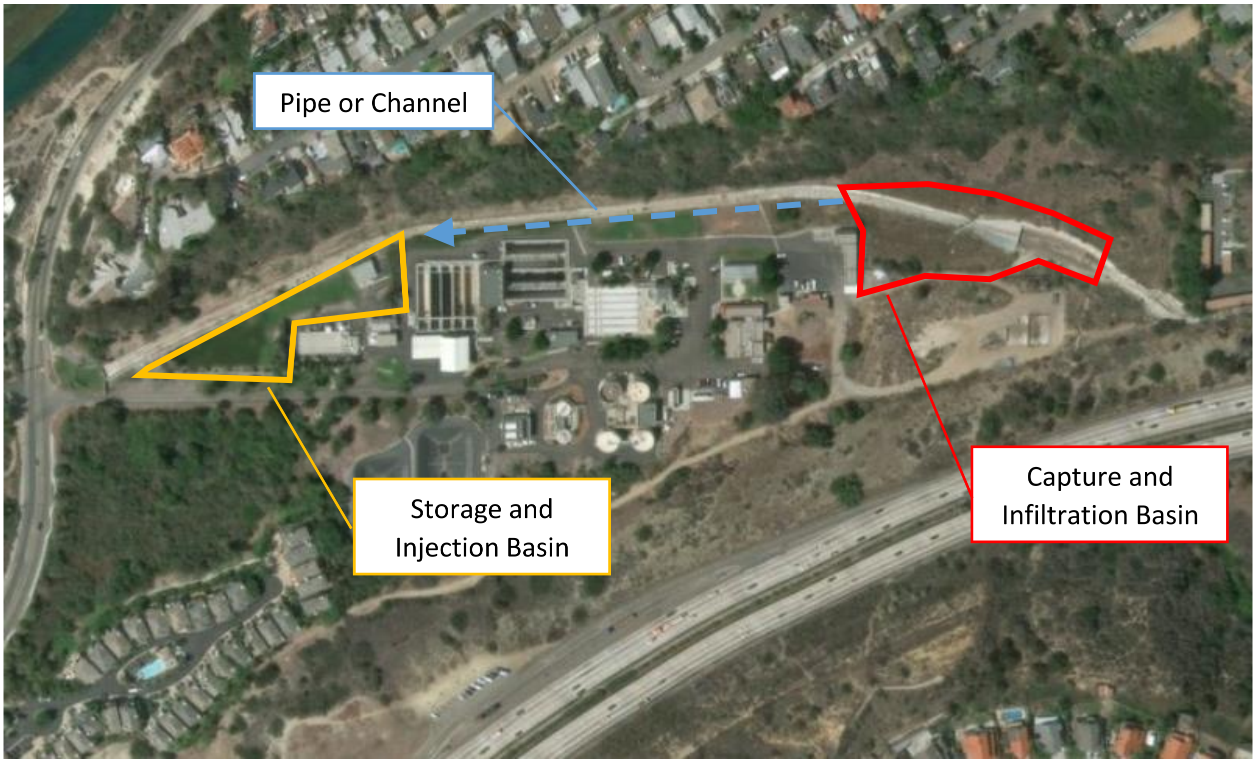


Table 2 presents the estimated quantities for the elements shown on Figure 1. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	Drainage Area	Surface Stormwater Storage Facility	Surface Stormwater Storage Facility	Surface Stormwater Storage Facility	Groundwater Injection Vault
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (SF, ft., CF)	Annual Volume of Stormwater Captured (CF/yr.)	Annual volume of stormwater infiltrated (AFY)	Annual volume of stormwater injected (AFY)
Estimated Quantities	950 ac	39,000 SF 3-6 ft 117k-234k CF	121 AFY	12 AFY	37 AFY

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Franklin D. Roosevelt Park Regional Stormwater Capture Project

STORMWATER USE ALTERNATIVES:

Alternative A – Discharge to groundwater basin that is a local source of potable water

PROECT TYPE: Completed

PROJECT LOCATION AND SPONSOR: 7600 Graham Avenue, Los Angeles, CA 90001, Los Angeles County Department of Public Works

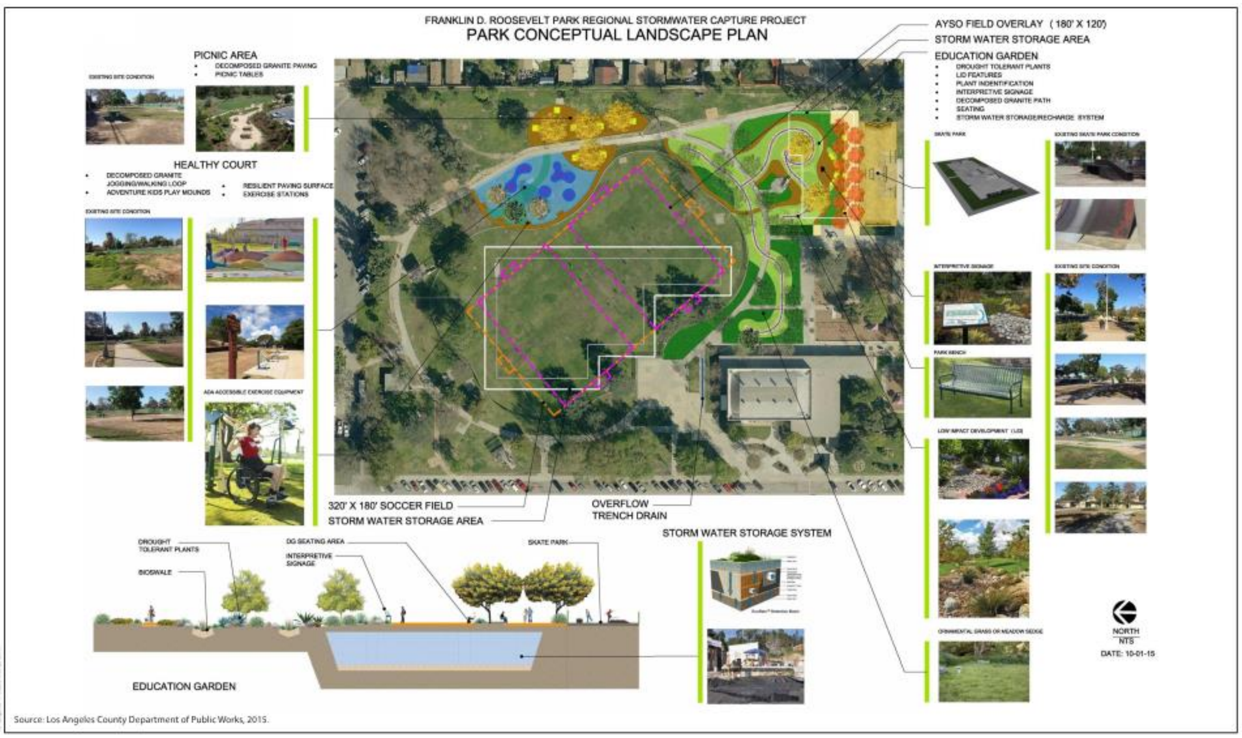
Description:

Los Angeles County's 2012 MS4 Permit gives permittees the option of implementing an innovative approach to achieving permit requirements for runoff water quality improvement. The Los Angeles County Department of Public Works (LACDPW), along with participating permittees, opted to exercise this option with an Enhanced Watershed Management Program (EWMP), which identifies best management practices (BMPs) to achieve permit compliance. The Upper Los Angeles Watershed EWMP included Franklin D. Roosevelt Park (FDR Park) as a potential location for a priority project designed to present an innovative approach to achieving permit goals for runoff water quality improvement.

The project is designed to make improvements to FDR Park to improve water quality, increase water conservation, and provide additional recreation, education, and outreach benefits to Park visitors. The project includes diverting untreated stormwater from storm drains on East 71st Street., East 76th Place, and Nadeau Street that currently drain to Compton Creek and Los Angeles River. The project would reduce the amount of metals, bacteria, nutrients, and trash being discharged into Compton Creek and Los Angeles River. This would help address the Los Angeles River metals, nutrients, and trash TMDLs, Los Angeles River Watershed bacteria TMDL, and Dominguez Channel, Greater Los Angeles, and Long Beach Harbor Water toxic pollutants TMDL. The proposed project is designed to reduce the annual load of zinc, a key metals pollutant, as well as copper, lead, and nutrients for the Los Angeles River Watershed.

The following system description is based on details provided in the Mitigated Negative Declaration document that has been developed for the project. Diversion structures and pipelines would be constructed to divert both dry weather flow and stormwater into three underground infiltration systems with pre-treatment devices, thereby providing groundwater recharge to the Central Groundwater Basin (Figure 1). Two underground infiltration systems would be located within the Park and seven drywells would be located within Whitsett Avenue, collectively termed infiltration systems. The runoff water would be pretreated to remove bulk pollutants before discharging to the infiltration systems. Infiltration systems further use the natural attenuation ability of the soil to remove remaining pollutants in stormwater runoff. The infiltration systems are designed to store runoff and gradually release it into the soil and underlying groundwater. As water migrates through porous soil and rock, pollutant attenuation mechanisms include mineral precipitation, sorption, chemical transformation, physical filtration, and bacterial transformation.

Figure 1. Conceptual Layout of Franklin D. Roosevelt Park Regional Stormwater Capture Project



The proposed project is intended to capture runoff from up to the 85th percentile storm event from a 195-acre drainage area and provide infiltration to the underlying soil and groundwater through two underground infiltration systems installed below ground in the Park and seven underground drywells located below Whitsett Avenue (see Figure 1). The 85th percentile storm event is approximately 0.75 inches over 24 hours. The proposed project would provide approximately 105 acre-feet of stormwater per year (equal to the water use of 210 households) based on the average annual rainfall from the nearest rain gauge. The amount of runoff flow diverted to the underground infiltration systems would be monitored with flow meters to determine the potential groundwater recharge rate.

The three diversion structures and pipelines would divert flow from existing storm drains on East 71st Street, East 76th Place, and Nadeau Street. The combined design capacity of the underground infiltration systems would be 8.47 acre-feet (approximately 368,000 gallons). Table 1 presents the proposed design parameters for the underground infiltration systems and pipelines. The proposed infiltration systems within the Park would be approximately 7 feet deep, with 6 feet of cover soil and 2 feet of underlying gravel. The depth of each of the underground infiltration systems within the Park is restricted to a maximum of 15 feet with a footprint of up to 0.6 acres to maximize vertical infiltration to the water table.

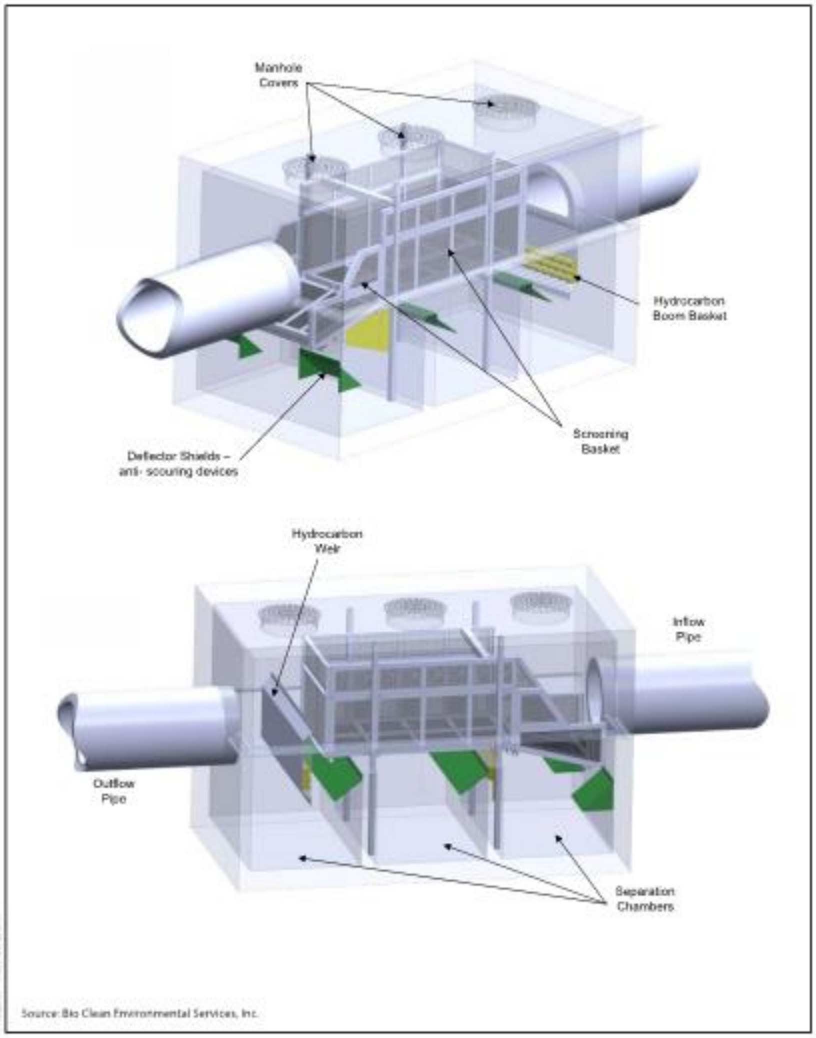
The seven drywells would be constructed with 60-inch diameter reinforced concrete pipe (RCP) and would be approximately 76 feet deep. The bottom 25 feet of each drywell would have perforations in the sidewall so that water can flow out and infiltrate into the surrounding soil. The drywells would be connected via a 45 foot long, 18 inch wide RCP.

TABLE 1
PROPOSED INFILTRATION SYSTEMS DESIGN PARAMETERS

Location	Tributary Area (acres)	Size (square feet)	85th Percentile Runoff Volume (acre-feet)	85th Percentile Peak Flow Rate (cfs)	24-inch Diversion Pipe (feet)	24-inch Diversion Pipe (location)
Soccer Field	118	22,000	5.651	12.92	1,442	Holmes Avenue
Adjacent Skate Park	23.6	2,250	0.914	2.86	259	76th Place
Whitsett Avenue	53.7	170	1.179	3.39	116	Whitsett Avenue
Total	195.3	24,420	7.744		1,817	

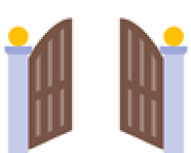
The proposed project includes pre-treatment of the stormwater flows prior to infiltration. Each infiltration system would include a baffle filtration unit, a multi-stage, self-contained treatment train composed of multiple sediment removal chambers, a screening system designed to capture and store solid debris such as foliage and litter in a dry state, and a skimmer system to remove hydrocarbons, as shown on Figure 2. Each stage protects subsequent stages from clogging and includes screening, separation, and absorption. Screening is provided by a rectangular basket that is suspended above the standing water level of the sedimentation chambers and captures gross solids including litter and sediments. Separation is provided by three settling chambers that target smaller sediments, larger total settable solids, particulate metals, and nutrients. Primary absorption is provided by hydrocarbon boom filters, which remove free-floating and emulsified hydrocarbons from water. Automatic samplers for in-flow and out-flow will be located in a manhole in the system and will monitor chemical parameters to assess the efficiency of the pretreatment system.

Figure 2. Proposed Pre-treatment Device



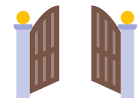
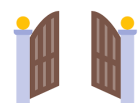
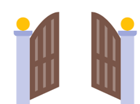
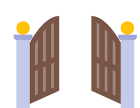
PROJECT OPPORTUNTIES AND CONTRAINTS:

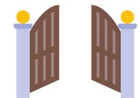
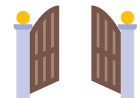
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Franklin D. Roosevelt Regional Stormwater Capture Project are summarized in Table 2. Table 2 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 2 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or “gates” have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 2*:* PROJECT CONSTRAINTS “GATES” AND OPPORTUNITIES “KEYS”

Constraints “Gates”	Project Constraints “Gates”	Opportunities “Keys to Open Gates”	Project Opportunities “Keys”	Project “Gate Status”
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	Much more land is available in the Park for use as an infiltration gallery if needed. Additional lengths of dry wells could be installed beneath the streets if infiltration rate becomes limiting.	
Match Production with Demand/Need	Groundwater demand may decrease due to conservation measures	***Benefits of supplementing aquifer groundwater*** ***Benefits of helping reduce seawater intrusion downgradient***	Project affords opportunity to scale size and number of infiltration galleries and dry wells to capture more or less of the runoff to meet anticipated demand.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater storage and infiltration.	***Existing Infrastructure (Storm drains)*** ***Community support for infrastructure construction***	Project improvements include construction of infiltrations galleries beneath park, and dry wells beneath street. Easily incorporated inside Park, but requires cooperation due to temporary shut-down of soccer field, lanes in street. Facilitated through community stakeholders buy-in.	
Agency Agreements	NA	***Partnerships***	NA	
Water Type Incompatibility **Treatment Requirements**	Stormwater quality requires some level of pre-treatment prior to infiltration for groundwater use	***Storage and Controlled Discharge*** ***Pre-Treatment***	Pretreatment is included in the to achieve needed quality; Infiltration through soil likely to provide significant improvement in water quality and compatibility.	
Regulatory Ambiguity		***Regulator Clarity and Flexibility*** ***Identify mitigating measures***		

Constraints “Gates”	Project Constraints “Gates”	Opportunities “Keys to Open Gates”	Project Opportunities “Keys”	Project “Gate Status”
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential funding from Stormwater Prop 1 Funding Inter-agency agreements appears secure. TMDL improvements will likely help with securing cooperation and funding	
Public/Agency Support	NA	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the groundwater supply to allow for area to achieve groundwater sustainability. TMDL goals more likely to be achieved, fostering support	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the conceptual layout shown on Figure 1 and Figure 2. The elements and quantities include stormwater capture from runoff in the Park open space and stormwater runoff in several city streets, and infiltration through subsurface infiltration galleries and dry wells. The project elements will result in the capture and infiltration of an estimated 105 acre-feet per year, recharging the local groundwater system.

Table 3 presents the estimated quantities for the elements shown on Figure 1 and Figure 2. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 3
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE, AND TREATMENT

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Quantity of Stormwater Used to Recharge Ground Aquifer
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Annual Volume of Stormwater Infiltrated to Recharge Groundwater Aquifer used for Potable Use (acre-ft/yr.)
Estimated Quantities	195.3	0.56 acres, 15 ft,	4,573,800	120 acre-ft/yr

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Santa Monica Sustainable Water Infrastructure Project

STORMWATER USE ALTERNATIVES:

Alternative A – Direct discharge to designated groundwater aquifers to be extracted for potable use
Alternative G - Controlled discharge to waste water treatment plants for recycled water use

PROECT TYPE: Planning

PROJECT LOCATION AND SPONSOR:
1401 Olympic Park Blvd., Santa Monica, CA
1855 Main St., Santa Monica, CA
1625 Appian Way, Santa Monica, CA

City of Santa Monica
Department of Public Works

Description:

In 2013, the City of Santa Monica City Council adopted the City's Sustainable Water Master Plan, which among other key elements, included a provision for the City to be water self-sufficient by 2020. To work towards achieving this goal, the City will rely upon a mix of water conservation; rehabilitation of several existing water supply wells to improve water production; the pilot testing of an advanced groundwater treatment technology for the City's Olympic sub-basin; the planned installation of new supply wells over the next four to five years; and the planned construction of a large new drinking water treatment facility. Together these measures will bring the City close to achieving its goal of independence from imported water. However, to ensure sustainability, and the long-term yield of its groundwater resources, the City has recognized that further steps are necessary, including the harvesting, treatment and reuse of municipal wastewater, stormwater runoff, and impaired brackish/saline groundwater.

The City's Sustainable Water Infrastructure Project (SWIP) is an integral part of achieving that goal. The following project description comes from an Initial Study/Mitigated Negative Declaration (IS/MND) for the SWIP project (August 2016), which can be found at the following web address:
https://www.smgov.net/uploadedFiles/Departments/Public_Works/Water/SantaMonicaSWIP_IS-MND_PublicReviewDraft-with%20Appendices.pdf

The SWIP consists of three integral project elements:

- Element 1: Brackish/Saline Impaired Groundwater Treatment and Reuse, which will be achieved by an upgrade to the existing Santa Monica Urban Runoff Reclamation Facility (SMURRF)
- Element 2: Recycled Municipal Wastewater Treatment and Conjunctive Reuse at the yet to be constructed SWIP Recycled Water Treatment Facility (SRWTF)
- Element 3: Stormwater Harvesting, Treatment, and Reuse at stormwater harvest tanks that will be constructed at two locations in the City

Together these elements will provide for advanced treatment and reuse of brackish/saline impaired groundwater, recycled municipal wastewater, and stormwater runoff. The remainder of this discussion will focus on the stormwater runoff aspects of the project, which includes Elements 2 and 3 as described in the IS/MND. A map showing the locations of the project elements are shown on Figure 1.

Figure 1. Map of the Three Project Elements

Source: Presentation by Jim Borchardt of Stantec, June 2017

Element 2: Recycled Water Production and Conjunctive Reuse. When completed, construction and implementation of the recycled water treatment facility (Element 2) will provide water compliant with CCR Title 22 and Title 17 standards and the following beneficial outcomes:

- Advance treat and recycle approximately 1.0 million gallons per day (MGD) of municipal wastewater for immediate non-potable reuse,
- Allow for conjunctive reuse, when permitted, via aquifer recharge for indirect potable reuse,

- Capacity to advance treat and reuse harvested stormwater diverted to the facility from the SWIP Element 3 stormwater harvest tanks,
- Provide for sustainable groundwater management and increased drought resiliency
- Result in annual groundwater or imported water reductions of approximately 1,120 acre-feet (AF) (i.e., 33,600 AF, or 10 billion gallons over 30 years), and
- Achieve the goals of water resources reliability, restoration, and resilience set forth in the Governor's California Water Action Plan and the City's Sustainable Water Master Plan.

As part of Element 2, the City will construct an underground, recycled water treatment facility at a location beneath the existing Civic Center parking lot (Figure 1). When completed, the recycled water facility will be capable of advanced treatment of up to 1.0 MGD of municipal wastewater. The treatment plant will be sourced primarily by nearby City sanitary sewers and will utilize, among other things, membrane bio-reactor (MBR)-type technology and RO filtration. A seasonal secondary source of water for treatment and reuse will be stormwater harvested by the runoff storage tanks described in SWIP Element 3 (below). The advanced treated water produced by the recycled facility will be of a quality acceptable for immediate non-potable reuse, and eventually (when permitted) for injection towards the purposes of sustainable groundwater management and most importantly for indirect potable reuse. Treated water will be distributed via the City's existing purple pipe system for all planned uses.

Element 3: Stormwater Harvesting and Reuse. When completed, the stormwater harvesting element of the SWIP will:

- Harvest and divert for advanced treatment and use approximately 4.5 milion gallons (MG) of stormwater from any single storm event that will ordinarily be discharged to the ocean at the Pico-Kenter Outfall;
- Improve beach and Santa Monica Bay water quality by reducing the volume of stormwater discharged to ocean at the Pico-Kenter outfall;
- Provide for required municipal separate stormwater sewer system (MS4) and Enhanced Watershed Management Plan (EWMP) stormwater nonpoint source pollution control measure compliance; and
- Contribute towards groundwater conservation and sustainability by providing an alternative source of water for advance treatment and permitted use.

In order to achieve the Element 3 outcomes listed above, the City will construct two stormwater control and harvest tanks, described below (see locations on Figure 1). These tanks will reduce the amount of stormwater that currently discharges to the Pico-Kenter outfall. Element 3 will utilize the existing MS4 to divert harvested stormwater runoff from the subject tanks to the Element 2 recycled water advanced treatment facility.

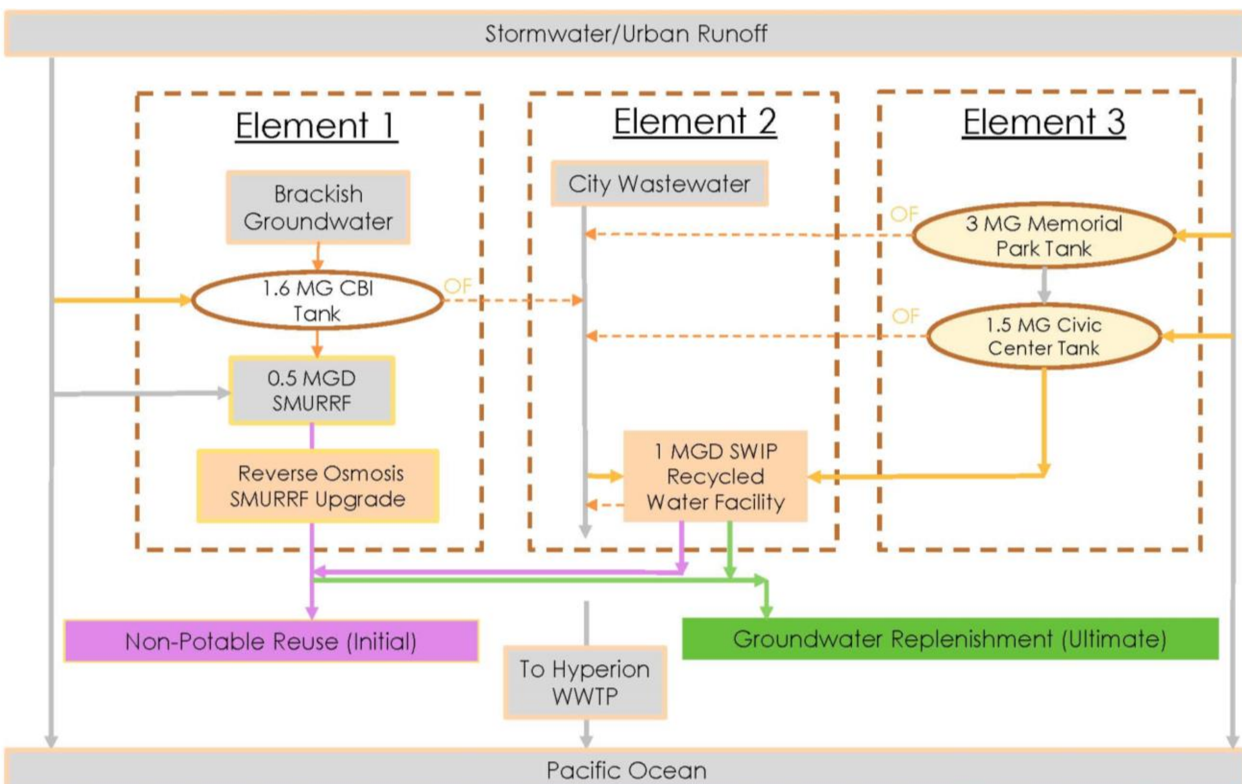
- **Memorial Park Tank.** The underground Memorial Park Tank is a recognized stormwater best management practice (BMP) that will be capable of harvesting up to 3.0 MG of stormwater from any single precipitation event from the Pico-Kenter sub-watershed tributary area within the City. Memorial Park is located at the intersection of 14th Street and Olympic Boulevard. The Memorial Park tank will be constructed beneath the existing play field adjacent to the City' Colorado Maintenance Yard and will harvest stormwater from two City storm drains: one beneath Santa Monica Boulevard with a diversion structure that goes from 15th Street to the Park; and one beneath Broadway, also with a diversion at the intersection with 15th Street. After a storm event, the Memorial Park tank will slowly release its contents to the downgradient Civic Center Tank (described below) via the City's existing storm drain system. The Civic Center Tank will gradually release its contents into the source water feed to the proposed recycled water advanced treatment plant (SWIP Element 2).

- **Civic Center Tank.** The second stormwater control measure BMP included under Element 3 is an underground 1.5-MG stormwater harvest tank adjacent to the SWIP Element 2 recycled water treatment facility. The Civic Center Tank is designed to accomplish the following:
  - Reduce stormwater discharges at the Pico-Kenter outfall, improve beach water quality, and comply with MS4 and EWMP nonpoint source pollution control requirements; and
  - Function as a settling tank for stormwater collected at the Memorial Park Tank which, after a storm event, will be diverted down the City's existing sewer system (MS4) to the recycled water facility for eventual treatment.

  As described above for the Memorial Park Tank, the Civic Center Tank will receive flows from the Memorial Park Tank via the City's existing storm drain system, and will then release flows to the recycled water treatment plant included under SWIP Element 2.

A schematic of the three project elements are shown on Figure 2.

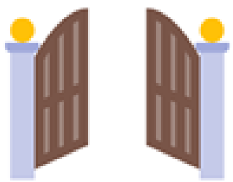
Figure 2. Schematic Showing Connections Between the Three Project Elements



Source: Presentation by Jim Borchardt of Stantec, June 2017

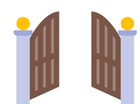
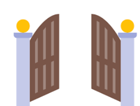
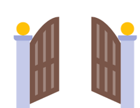
PROJECT OPPORTUNTIES AND CONTRAINTS:

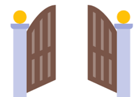
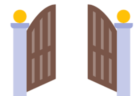
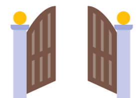
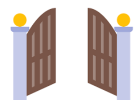
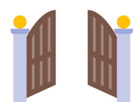
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Santa Monica Sustainable Water Infrastructure Project are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1. PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	Stormwater will not be infiltrated as part of the SWIP, but will be harvest I holding tanks, treated at the SRWTF, and directed to the recycled water supply. Direct aquifer injection of the treated water is anticipated in the future for groundwater replenishment.	
Match Production with Demand/Need	Groundwater demand may decrease due to conservation measures and is lower for irrigation needs during heavy wet weather periods	***Benefits of supplementing aquifer groundwater*** ***Benefits of helping reduce seawater intrusion downgradient***	The project would capture and treat a maximum of 4.5 MG from a single storm event for distribution to the recycled water supply. Combined treatment of wastewater at the SRWTF provide additional flexibility.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater storage and infiltration. Significant interruption of traffic during construction.	***Existing Infrastructure (Storm drains)*** ***Community support for infrastructure construction***	Project improvements include construction of harvest tanks (on City property) and the SRWTF. Existing stormdrain infrastructure will provide conveyance between the project elements.	

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Agency Agreements	Inter-agency agreements needed for capture and storage of stormwater on nearby public lands	***Partnerships*** ***Multiple-agency cooperation***	Project will address MS4, EWMP, and TMDL requirements, which could enhance funding opportunities.	
Water Type Incompatibility **Treatment Requirements**	Stormwater quality mixed with ambient groundwater may cause undesired chemical reactions in aquifer or cause contaminated groundwater plume movement	***Storage and Controlled Discharge*** ***Pre-Treatment***	Captured stormwater will be treated at the SRWTF to meet recycled water standards. Additional considerations may be needed for future aquifer injection.	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses. CEQA MND finding uncertain	***Regulator Clarity and Flexibility*** ***Identify mitigating measures***	Stormwater treated at the SRWTF will meet the same standards as those for the existing SMURRF and will be co-mingled.	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Funding from Stormwater Prop 1 for multiple-benefit project. Funding. Water quality improvements related to TMDLs will likely help with securing cooperation and funding.	
Public/Agency Support	NA	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the groundwater supply to allow for area to achieve groundwater sustainability. TMDL goals more likely to be achieved, fostering support	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the conceptual layout shown on Figure 1 and Figure 2. Based on the size of the harvest tanks (Element 3), the project can harvest and treat a maximum of 4.5 MG of stormwater from a single storm event.

The quantities in Table 2 will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

Table 2 – Estimated Quantities for Stormwater Collection, Storage and Treatment

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (MGY)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	224 acres	4.5 MG/event	TBD	TBD	1.0 MGD[a]	1.0 MGD[a]

[a] The maximum volume of water treated by the SRWTF is listed as 1.0 MGD, as described in the IS/MND. This value includes both wastewater (WW) and stormwater (SW) combined. Separate values for SW alone were not available.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

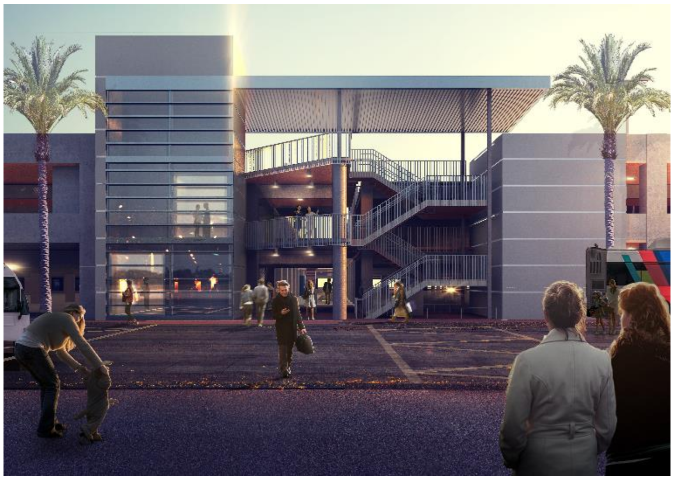
Project Title: Lindbergh Field Terminal 2 Parking Plaza

STORMWATER USE ALTERNATIVES:

Alternative D - Small scale on-site use for irrigation and other private use

PROECT TYPE: Planning

PROJECT LOCATION AND SPONSOR:
Lindbergh Field; San Diego County Regional Airport Authority



Description:

This project is located at San Diego International Airport. As part of expanding and remodeling Terminal 2 at Lindbergh Field, the airport is building a three-story parking plaza in place of the existing open lot. The project includes a sub-grade stormwater storage system to capture and use water from the site.

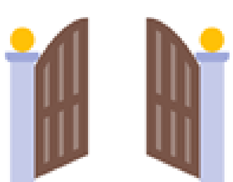
The sub-grade storage system consists of a set of 36-inch-diameter pipes beneath the garage. Inlets on the top level of the structure will direct stormwater to these pipes, which are large enough to hold the 85th-percentile runoff volume (the Design Capture Volume (DCV) from the San Diego MS4 permit). This captured water will be treated with a series of pre-treatment devices, then supplemented with water purchased from the City of San Diego to operate the cooling towers at the airport's Central Utilities Plant.

The new parking structure will cover a portion of the existing lot, keeping the east side of the existing lot at grade for continued parking use. Stormwater runoff from the at-grade lot will be directed through a new Bio Clean Modular Wetland Unit to treat the DCV from the lot. This will bring the at-grade lot into compliance with local and regional permit requirements for post-construction stormwater treatment.

Figure 1. Project location

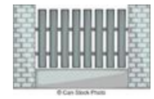
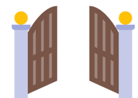
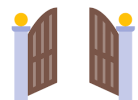
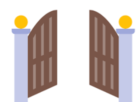
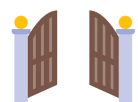
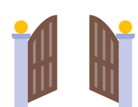
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the Lindbergh Field Terminal 2 Parking Plaza are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

Table 1: Project Constraints "gates" and opportunities "keys"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Porous pavers with sub-surface storage complementary to current land use	
Match Production with Demand/Need	Confirm captured and treated volume can be used on-site for infiltration or facility cooling	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Project is scaled to capture 85th percentile event; on-site demand exceeds this	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Refine bio-filtration design and design of needed infrastructure for distribution of treated stormwater for facility use	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project scaled to use all captured water and supplement with purchased water, implying additional use capacity	
Agency Agreements		***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility Proximity to San Diego Bay leads to pollution concerns in discharge	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Project designed to meet requirements for facility use or for bio-filtration or infiltration	
Regulatory Ambiguity	Regulations for on-site facility use are unclear	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements	
Capital and O&M Costs **Funding**	Owner responsible for implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Owner uses captured water to offset facility maintenance costs Project is part of on-going expansion and renovation	
Public/Agency Support	Project is in urbanized area with noise concerns and construction time constraints	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Project is on private property	

QUANTIFICATION SUMMARY:

Figure 1 presents the process diagram for each element of this project's stormwater capture and use process from which quantities have been determined. The elements and quantities include stormwater capture volumes, infiltration rate from the park and creek to the shallow groundwater, and water quality improvements from improved natural flows.

Table 2 presents the estimated quantities for the project elements that include stormwater capture, annual on-site facility use, and annual infiltration to shallow groundwater. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Storage System	Stormwater Storage System	Facility Water Use
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (AFY)	Annual volume of stormwater used for facility functions (AFY)
Estimated Quantities (facility use)	460 ac	479,000 SF 14,000 CF	6.1 AFY	6.1 AFY

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility-level costs for each project component. Stormwater capture and use is a relatively small element of this project, so it was assumed that it contributed only 5% the final budget. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 50-year project lifespan, the unit cost for this example project is $20,950/AFY. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. This project's unit costs were not compared to the range of costs under Alternative Use D (Small-Scale On-Site Use), because this study only estimated a range for rain barrels, infrastructure which is not comparable to large-scale construction like the Terminal 2 Parking Plaza.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	**Total Costs**
Construction Cost	$4,122,581
Site Preparation (5% of total)	$206,129
Design and Planning (permitting) (20% of total)	$824,516
Operations and Maintenance (10% of Total)	$412,258
Contingency (20% of Total)	$824,516
Total[1]	$6,390,000

[1] Only the total was reported, so standard percentages were used to estimate the cost of several components.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Mission Valley Stormwater Capture Project

STORMWATER USE ALTERNATIVES:

Alternative A – Direct discharge to designated groundwater aquifers to be extracted for potable use

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR:
See Figure 1 for project location,
City of San Diego

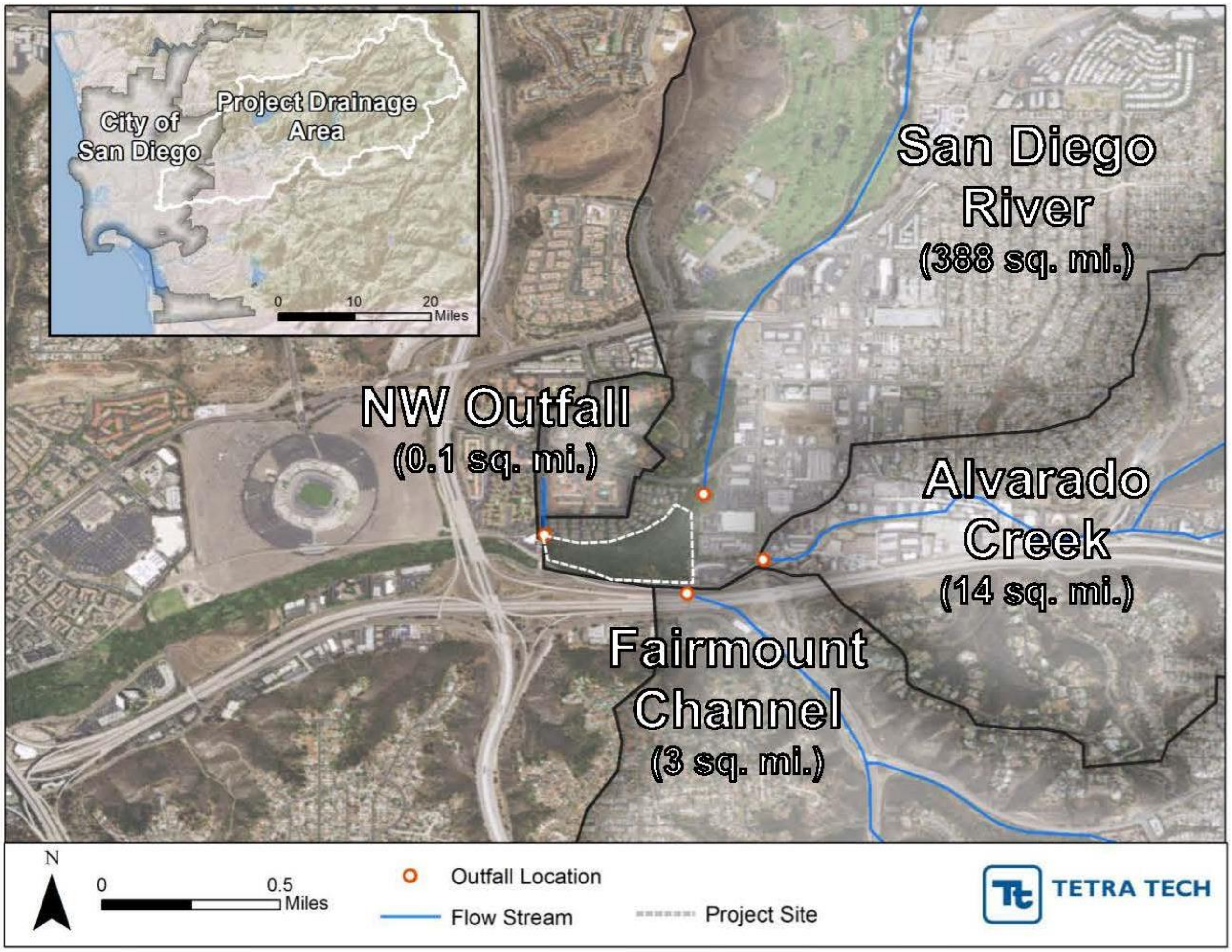
Description:

The City of San Diego (City), like other municipalities in Southern California faces a number of drivers for stormwater management, including (1) maintaining a reliable and local water supply, (2) improving water quality in impaired receiving waterbodies, and (3) flood risk reduction. The following project description comes from a report produced for the City of San Diego on San Diego River Valley Stormwater Capture Concepts (TetraTech 2017). The report recognizes the City's desire to focus on a strategic storm water capture framework that can positively impact these drivers by integrating their overlapping components and synergizing elements of their implementation to reduce overall program costs. The objective of the Mission Valley Stormwater Capture Project (project) was to augment recharge of the Mission Valley Groundwater Basin for future extraction, treatment, and use by using design elements that help maintain a local water supply, improve water quality, and reduce flood risk.

The candidate parcel for the project is located just upstream of SDCCU Stadium, northeast of the Interstate 8 and Interstate 15 interchange (Table 1) at the confluence of a 260,000-acre upstream drainage area. The site is owned by the California Department of Fish and Wildlife (CDFW) and receives surface runoff from four inputs: San Diego River, Alvarado Creek, Fairmount Channel, and a storm drain outfall discharging to the northwest (NW) portion of the parcel. Because the site is located at the confluence of the above-listed streams, the site is generally flowing with surface runoff during wet months, and when flows decrease in drier months, the site remains saturated. For this reason, a high-density riparian woodland has been established at the project site. Unlike most of the City, the project site is geographically unique, underlain by alluvial deposits that are conducive to infiltration. Additionally, the

Mission Valley Groundwater Basin lies beneath the site, providing ideal conditions for stormwater storage and extraction to augment the local water supply.

Figure 1. Map of the Project Site, Stream Inputs, and Their Corresponding Drainage Areas



Source: TetraTech, 2017

To determine the lowest cost storm water capture strategy for capitalizing on the geologic and hydrologic conditions at the site, a pair of conceptual capture facilities were proposed for the project. The proposed infrastructure would take advantage of the geology of the site by using two infiltration-oriented facilities:

- a detention facility paired with an injection well, and
- an infiltration gallery

The dimensions of the facilities are presented in Table 1.

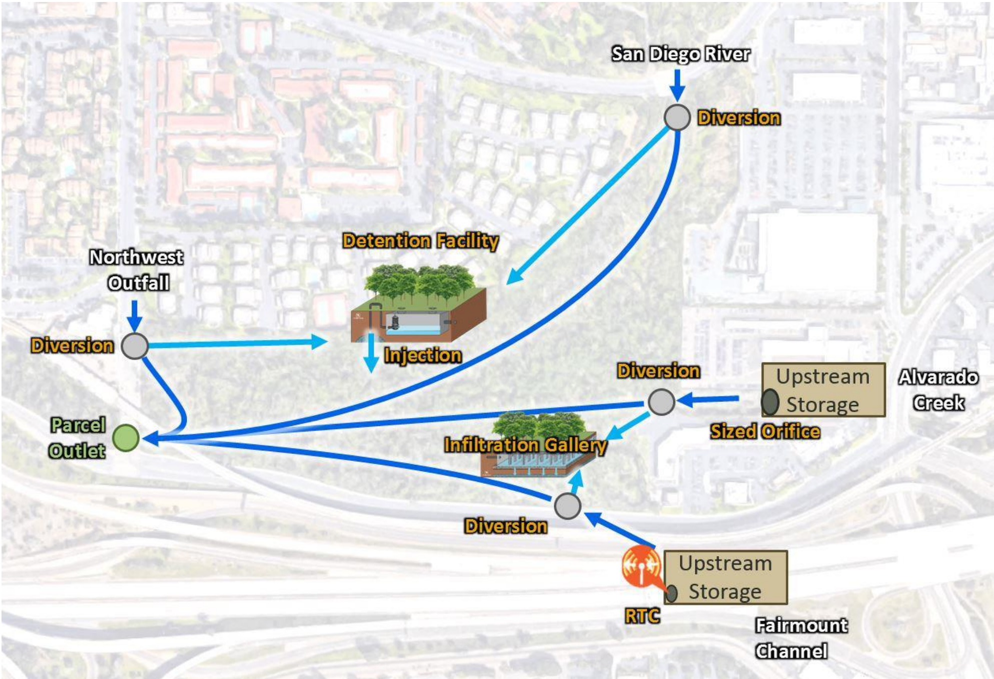
TABLE 1
KEY FACILITY PARAMETERS USED FOR MODELING ASSUMPTIONS

Parameter	Infiltration Gallery	Detention and Injection
Maximum Storage Depth (feet)	8	8
Maximum Footpring (acres)	0.76	7.71
Maximum Volume (ac-ft)	6.1	61.4
Subgrade Infiltration Rate (inch/hour)	0.7	Varies with injection rate
Configuration	Offline	Offline

Source: TetraTech, 2017:
[a] Remaining regional facility modeling assumptions were consistent with parameters used for the City's Upper Chollas Creek Watershed Master Plan (Tetra Tech 2016).
[b] Offline facilities receive runoff that is diverted out of the main channel; the diversion is disabled when the facility is full. Online facilities receive all runoff from a conveyance channel (i.e., they are flow-through facilities that accommodate the full range of flows regardless of how full they are).

The conceptual facilities could potentially be supplied with surface runoff by a total of four diversion structures: three for each of the three major tributaries and one for the NW outfall to direct flows away from their respective streams to the proposed facilities. Additional parameters included upstream storage opportunities identified in the Fairmount Channel and Alvarado Creek drainages to further enhance performance at the project site. The conceptual layout for the project is depicted on Figure 2.

Figure 2. Conceptual Layout of the Mission Valley Stormwater Capture Project



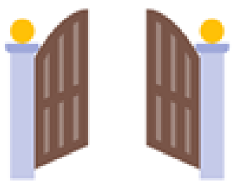
Source: TetraTech, 2017

A decision support framework and modelling exercises were implemented for the project to determine the optimal configuration and value for each of nine project parameters to maximize the benefits of the three project drivers (water supply, water quality, and flood control). Results from the water supply optimization indicated that the most cost-effective configuration for groundwater recharge is a diversion structure directing water from the San Diego River to the detention facility and injection well. This optimization minimized all of the other parameters that were varied (infiltration gallery size and diversion structures from other streams) because they were all relatively less cost-effective than taking advantage of the consistent baseflows from the San Diego River. The optimal solution for water supply (based on the model) was able to divert approximately 1,900 acre-feet per year (AFY) from the San Diego River to the injection well. These results exceed the City's goal to extract 1,680 AFY at a downstream extraction well; however, environmental considerations may limit the flow rate that can be diverted from the San Diego River to the facility. The report recognized that it might be necessary to maintain a minimum flow rate in the San Diego River to support the existing ecosystem. For this reason, a second optimization was executed to discern how an assumed minimum flow rate of 5 cubic feet per second (cfs) in the San Diego River would impact performance. The minimum baseflow rate was presumed by identifying the 75th percentile long-term modeled flow, which represented typical low-flow conditions during the 10-year modeling period.

In this limited scenario, whenever the flow rate in the San Diego River was above 5 cfs, water was able to be diverted; when the flow rate was 5 cfs or less, water would not be diverted. Under these conditions, the model suggested that the difference in performance was substantial, with less than half the annual volume under optimal conditions. The report emphasized that further study is required to determine the minimum flow rate necessary to be maintained in the San Diego River to more accurately assess the volume of water able to be captured and diverted for water supply.

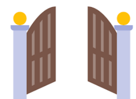
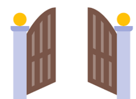
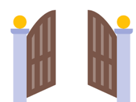
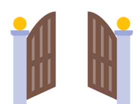
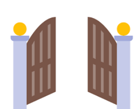
PROJECT OPPORTUNTIES AND CONTRAINTS:

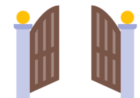
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the Mission Valley Stormwater Capture Project are summarized in Table 2. Table 2 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 2 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 2
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Rate of infiltration is highly site-specific and depends heavily on the hydraulic conductivity of the soil. Storage of recycled water before infiltration may be limited during heavy wet weather periods.	***Larger or Multiple Storage Sites*** ***Use of more infiltration galleries and/or dry wells*** ***Complementary land uses***	The site represents nearly ideal conditions with multiple potential water sources, favorable soils for infiltration, and proximity to a large ground water basin.	
Match Production with Demand/Need	Groundwater demand may decrease due to conservation measures and is lower for irrigation needs during heavy wet weather periods	***Benefits of supplementing aquifer groundwater*** ***Benefits of helping reduce seawater intrusion downgradient***	Project affords opportunity to scale size and number infiltration galleries and detention facility for direct injection to capture more or less of the runoff to meet anticipated demand.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater storage and infiltration. Significant interruption of traffic during construction.	***Existing Infrastructure (Storm drains)*** ***Community support for infrastructure construction***	Project improvements include construction of the detention facility for direct injection and infiltration galleries for multiple water sources with existing infrastructure.	
Agency Agreements	Land is owned by CDFW and supports existing wildlife habitat.	***Restoration of existing site*** ***Multiple-agency cooperation***	Incorporating a restoration component in the project along with inter-agency cooperation could enhance funding opportunities.	
Water Type Incompatibility **Treatment Requirements**	Stormwater quality mixed with ambient groundwater may cause undesired chemical reactions in aquifer or cause contaminated groundwater plume movement	***Storage and Controlled Discharge*** ***Pre-Treatment***	Adjust pretreatment design if necessary to achieve needed quality; Infiltration through soil likely to provide significant improvement in water quality and compatibility, but direct injection may not. Evaluate presence of any known contaminants plumes and potential to affect them	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses. CEQA MND finding uncertain	***Regulator Clarity and Flexibility*** ***Identify mitigating measures***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies Identify mitigating measures to ensure CEQA finding of non-significant impacts	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit***	Potential funding from Stormwater Prop 1 for multiple-benefit project. Funding. Water quality improvements related to TMDLs will likely help with securing cooperation and	

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
		Grant Funding	funding. Good potential for inter-agency cooperation.	
Public/Agency Support	NA	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the groundwater supply to allow for area to achieve groundwater sustainability. TMDL goals more likely to be achieved, fostering support	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the conceptual layout shown on Figure 1 and Figure 2. Values in Table 3 represent the optimal scenario for the San Diego River, as summarize in the text above (TetraTech, 2017) and would result in capture and storage of a maximum of 1,900 AFY. Further evaluation is necessary to determine if the optimal scenario is feasible.

The quantities in Table 3 will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 3
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (MGY)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	248,320 acres	7.71 acres, 8 ft, 2,674,580 CF	619 MGY (1,900 AFY)	TBD	TBD	TBD

Values in the table represent the optimal scenario for the San Diego River, as summarize in the text above (TetraTech, 2017). Further evaluation is necessary to determine if the optimal scenario is feasible.

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Capture, Conveyance and Flow Augmentation to the South Bay Water Reclamation Plant

STORMWATER BENEFICIAL USE:

Alternative H - Controlled discharge to waste water treatment plants for recycled water use

PROECT TYPE: Conceptual Evaluation

PROJECT LOCATION AND SPONSOR: South Bay Water Reclamation Plant, City of San Diego (sewershed located in other jurisdictions in the South San Diego Bay region).

Description:

The South Bay Water Reclamation Plant (SBWRP), which is owned and operated by the City of San Diego, is expected to produce up to 10 MGD of recycled water for non-potable reuse per agreement with Otay, Caltrans and other jurisdictions. The plant currently does not receive enough flow to meet this target, and 2-4 MGD in additional flow is needed. Therefore, the potential for stormwater capture in the SBWRP sewershed was identified, such that stormwater can be used to augment wastewater flow to SBWRP via storage and controlled discharge to sanitary sewers that flow to SBWRP. Since SBWRP is a constant-flow, or scalping plant, its sewershed is relatively variable, and any excess flows are customarily sent northward to the Point Loma Wastewater Treatment Plant.

The evaluation performed as part of this project description is a high-level analysis that determined the volumes of stormwater storage potentially available in the vicinity of SBWRP's sewershed, which includes several jurisdictions in the South San Diego Bay area. It also investigated the sewer system's capacity to handle flows from controlled discharge, in addition to base wastewater flows that the system already accommodates.

For this evaluation, sewer lines in the sewershed that were at or greater than 24 inches in diameter were identified, to ensure adequate capacity. Potential storage parcels were then identified within a 200-foot buffer zone of these sewers. The system was then divided into several "branches", in which cumulative flow from parcels was calculated, moving downstream in the sewershed. In general, the major gravity sewers feed the Grove Avenue Pump Station, from where wastewater flows are pumped south to SBWRP. Figure 1 shows the major sewer lines evaluated, along with the branches used for capacity evaluation in SBWRP's sewershed. Note that not all the branches identified in the figure were found to consistently send flow to SBWRP, and some flow from this sewershed likely goes toward the Point Loma Wastewater Treatment Plant instead. For this reason, Branches G, H and I, as shown in Figure 1, were excluded from this evaluation, but may be candidates for consideration in the future, if integration into SBWRP's customary sewershed is a possibility.

After several model iterations, it was seen that maintaining a common flow of about 0.5 cubic feet per second (cfs) from each parcel would maximize discharge to the sewers while still maintaining capacity through the majority of sewer lines. Among the major assumptions made to determine sewer capacity was a base domestic wastewater flow in each gravity sewer segment, at a d/D value of 0.5 (50% full) and a conservative velocity of 8 ft/s. Parcel flow at relevant sewer segments, along with the cumulative flow from upstream parcels, was added to the base wastewater flow, and the value of d/D was recalculated to ensure that it was below an assumed upper limit of 75% percent full. Another major conservative assumption made was that all parcels in the sewershed discharge at the same time (at their respective flows), and conveyance time in the sewer system is not accounted for. With force main lines, all upstream flows were added in, with no additional base wastewater flow assumed. The force main velocity was calculated with upstream additional parcel flows, and capacity was assumed to have been met if the calculated velocity was at or under 8 ft/s.

This evaluation resulted in two major determinations: (1) the maximum flow available to augment SBWRP via discharge from parcels, and (2) whether any capacity limitations exist in the sewer system as a result of additional parcel flows. The maximum flow available to SBWRP was calculated to be about 2.3 million gallons per day (mgd). Actual flow from parcels is likely to be lower, since this evaluation assumed all parcels discharging together over an extended time period.

While the additional parcel flows were found to be manageable by the majority of the sewershed, some capacity limitations were found. The major issues arose in locations where a sudden reduction in gravity sewer pipe size occurred along a given branch, or where force main flows were large enough to produce flow velocities greater than 8 ft/s. These issues were the result of a conservative analysis of sewer capacity, but may warrant more detailed sewer system modeling before further consideration of this project.

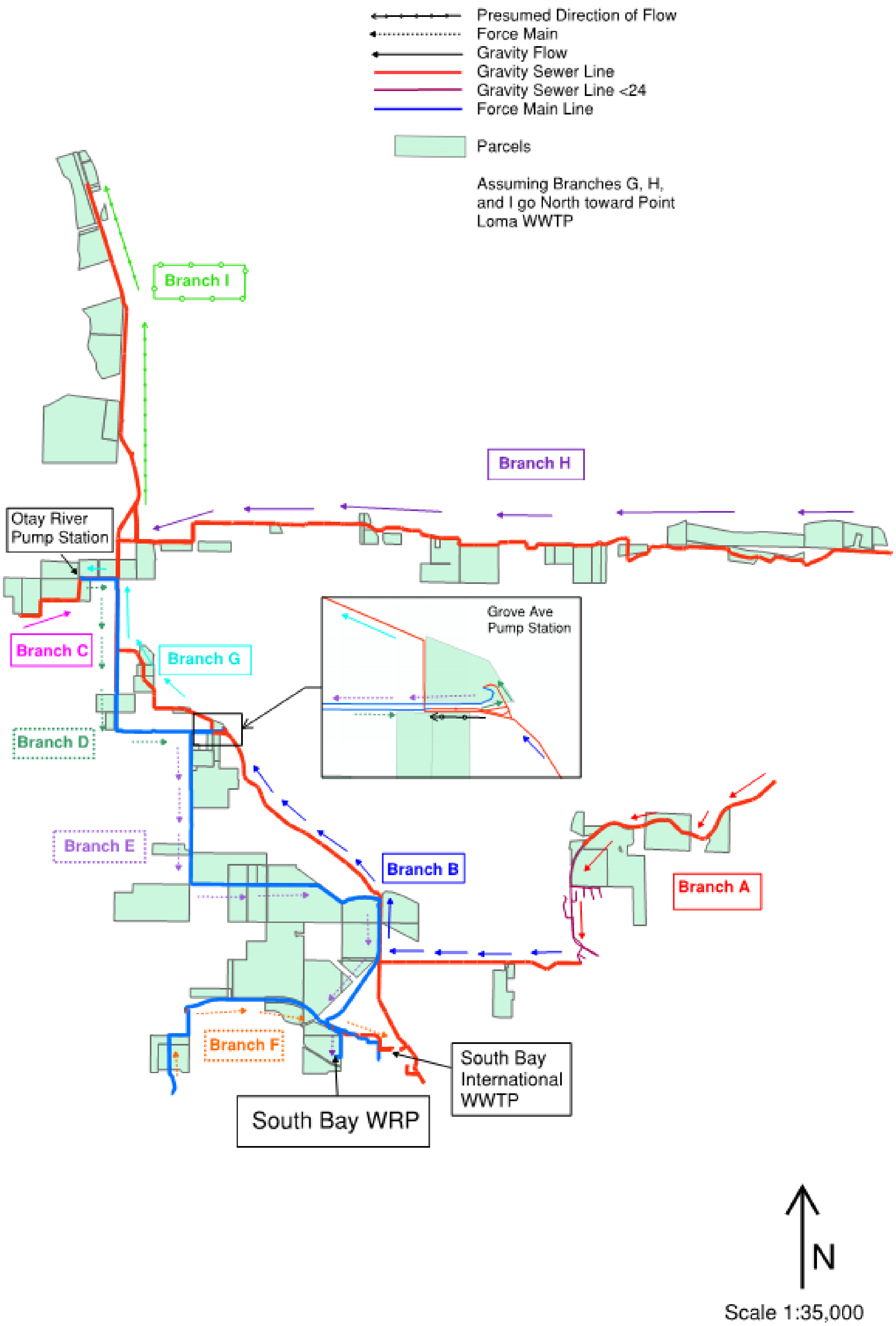
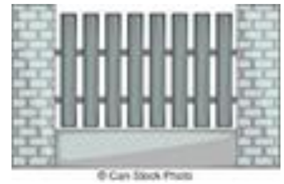
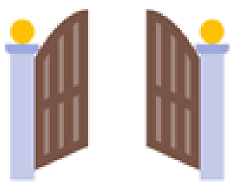


FIGURE 1 – SBWRP Sewershed, showing major sewer lines, force mains, and stormwater parcels used for volume and capacity evaluations.

PROJECT OPPORTUNTIES AND CONTRAINTS:



The results of the second Technical Advisory Committee (TAC) meeting included the identification of constraints and opportunities that can be applied to stormwater capture and use projects. These are discussed in more detail in Section 2. Project constraints can be used to assess the potential "gates" in which a project needs to pass through to be implemented. Through the identification of these "gates," project sponsors can assess the feasibility of the projects and what constraints may be overcome in the future through opportunities or "keys to open gates." Project constraints or "gates" may be identified early in the project planning phase that cannot be "opened" resulting in an infeasible project.

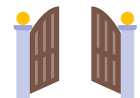
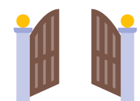
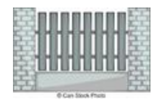
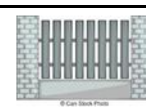
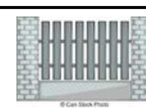


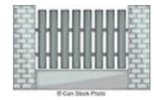
The example projects and identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by current or future opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint such as new technology or greater demand for recycled water. This management tool also provides a basis for the prioritization of projects in to short, mid- and long-term timelines for implementation.

The constraints or "gates" and opportunities or "keys to open gates" associated with Capture, Conveyance and Flow Augmentation to the South Bay Water Reclamation Plant are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

For this project (Capture, Conveyance and Flow Augmentation to the South Bay Water Reclamation Plant), the major gate identified was the demand for additional flows to augment the plant's already established recycled water program for non-potable reuse. The existence of several viable parcels within reach of the plant's sewershed, and a sewer system with the ability to convey these flows to the plant provide the major existing keys to open this gate. Other major gates identified are the lack of infrastructure and agreements to store stormwater on public parcels in the sewershed, and the need to build conveyance and pumping systems from parcels to nearby sanitary sewers. Additionally, the potential incompatibility of water quality between stormwater and wastewater that may affect the treatment process may need to be evaluated.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	SBWRP has the need for additional flows for recycled water production, but does not have enough onsite storage to facilitate onsite stormwater capture	***Larger or Multiple Storage Sites offsite, with conveyance***	Public parcels within the SBWRP sewershed can be used for stormwater capture and storage	
Match Production with Demand/Need	Recycled water demand has increased due to agreements with multiple agencies for non-potable water needs	***Multiple public parcel storage sites*** ***Adequate conveyance to plant***	There is adequate offsite storage capacity to meet needs, and near adequate capacity in the sewer system to convey stormwater to SBWRP.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	No storage infrastructure currently exists for storage at parcels along the sewershed. However, conveyance insfrastructure exists, and with some exceptions, can convey most of the stored water to SBWRP.	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Storage infrastructure needs to be installed/built, and conveyance infrastructure needs to be modeled in detail to determine actual capacity constraints. Any additional pipes, pumping systems or other assets that need to be built to accommodate parcel flows need to be accounted for before the project can be implemented.	
Agency Agreements	Inter-agency agreements already exist for recycled water production. Additional agreements needed for capture and storage of stormwater on nearby public lands	***Partnerships***	Local municipalities may want to partner with the City of San Diego to meet water quality goals in the watershed, and to meet local recycled water demands.	
Water Type Incompatibility **Treatment Requirements**	Stormwater mixed with current upgraded treatment facility may not be compatible, and adding relatively large flows of stormwater blended with wastewater may affect current biological treatment at SBWRP	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Extensive modeling and testing of the treatment systems is needed to adequately address any issues in product water quality, or effects on SBWRP's current treatment system. The neighboring South Bay International Wastewater Treatment Plant may provide additional treatment capacity.	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits***	Potential funding from Stormwater Prop 1 Funding Inter-agency agreements may allow for additional funding support to meet	

		Supportable trade-off between cost and benefit ***Grant Funding***	stormwater water quality goals and/or use of recycled water to clean sewers	
Public/Agency Support	Current facility recycled water agreements may limit added stormwater use	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the current recycled water agreements could provide flexibility to treat and store of stormwater.	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the analysis described above using the parcel and sewer system layouts in Figure 1. The elements and quantities include stormwater capture, storage and controlled discharge to SBWRP. The analysis conservatively assumed that all parcels along the sewershed discharge at the same time, and did not account for transit time within the sewer system. This resulted in the calculation of up to 2.3 MGD of additional flow available to augment the influent at SBWRP. However, actual flow available from captured stormwater is likely less than this value.

Table 2 presents the estimated quantities for the elements shown on Figure 1. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	**Drainage Area**	**Underground Stormwater Storage Facility**	**Underground Stormwater Storage Facility**	**Advanced Treatment**	**Recycled Water Generation**	**Recycled Water Distribution**
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	Approx. 36	6 ft deep storage vaults, covering the equivalent of the drainage area; approx. 20 million cubic feet	~1.9 million CF/yr	2-4 MGD (based on Plant Capacity only)	Up to 2.3 MGD (not accounting for any losses in the plant)	Up to 2.3 MGD (2,555 acre-ft./yr.) (maximum identified from capacity analysis)

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis, the unit cost for this example project is $1,427,383/AFY. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. This project's unit costs were compared to the range of costs under Alternative Uses H (Controlled Discharge to Waste Water Treatment Plants for Recycled Water Use), and the estimated unit cost is higher than the calculated range.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	Unit Costs	Quant.	Total Costs	Source/Assumptions
Mobilization/Demob	$6,896,416	1	$6,896,416	
Erosion Control & Temp Fencing	$50,000	61	$3,050,000	
Clearing & Grubbing/Tree Removal	$20,000	73	$1,464,000	Applying 201,700 cf (below) to 6 ft vault depth gives ~34,000 sf. Adding 20 percent as noted below for additional grading. This comes to roughly 1.2 acres.
Excavation (storage vault)	$ 7	701,500	$4,910,500	Vault dimensions and overexcation - 4:1 slopes. See attached calcs.
Placement of Site Material	$ 6	237,900	$1,427,400	Low end assume full excavation and high end 0
Excess Soil Off-Haul	$15	463,600	$6,954,000	Low end assume 0, high end full excavation
Culverts from MS4 to Underground Vault	$80	12,200	$ 976,000	Low end 0, high end 250 ft - base on actual distance
Concrete Vault	$ 9	12,303,700	$ 110,733,300	Using median of nonzero parcel volumes from both evaluated sewersheds.
Solids/Trash Removal prior to Vault	$50,000	61	$3,050,000	Assuming lump sum per median parcel.
Final Grading	$4,500	73	$ 329,400	Area of basin x 1.20 for additional grading
Plantings (shrubs-perimeter)	$15,000	73	$1,098,000	
Hydroseeding	$10,000	73	$ 732,000	Area of basin x 1.20 for additional grading
Temp Irrigation	$15,000	73	$1,098,000	
Mulch	$15	59,048	$ 885,720	Area of basin x 0.5 ft

Maintenance to Establish Veg	$5,000	244	$1,220,000	
Underground Wet Well/Pump from Vault to Sanitary Sewer	$50,000	61	$3,050,000	Using lump sum per median parcel
Connection to Santitary Sewer	$5,000	61	$ 305,000	In addition to connection, this includes building a manhole for connection.
Upgrade of Sanitary Sewer	$ -	0	$-	Assuming current sewer capacity is maintained.
Treatment and Distribution for Recycled Water	$1,300	202	$ 261,950	Using ESA's 40-year hydrologic models, the stormwater component of flow to a plant during the wettest year was estimated at 105 MGY for RSWRF. The unit cost of $1,300/AF comes from 2016 Pacific Institute Report on cost of alternative water supply in California by Cooley and Phurisamban. This is the median value of the range they determined.
Planning, Engineering & Permitting	$ 28,964,947	1	$ 28,964,947	
Contingency	$ 68,973,370	1	$ 68,973,370	Assume 20% Contingency
O&M	$ 41,237,622	1	$ 41,237,622	Assume 10% of total
Total			$ 287,617,625	

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Flow Augmentation to the Ray Stoyer Water Reclamation Facility for Non-Potable and Indirect Potable Reuse

STORMWATER BENEFICIAL USE:

Alternative H - Controlled discharge to waste water treatment plants for recycled water use

PROECT TYPE: Conceptual Evaluation

PROJECT LOCATION AND SPONSOR: Ray Stoyer Water Reclamation Facility and associated sewershed; Padre Dam Municipal Water District

Description:

The Padre Dam Municipal Water District (Padre Dam) operates the Ray Stoyer Water Reclamation Facility (RSWRF), which currently treats about 2 MGD of wastewater for the production of recycled water for non-potable reuse. Padre Dam is planning a major expansion of the facility for subsequent indirect potable reuse, among other end-use goals. Phase 1 of this expansion involves treating about 6 MGD of wastewater, while Phases 2 and 3 will treat about 16 and 21 MGD respectively. While additional wastewater sources have been identified for Phase 1 and are currently planned for Phase 2, the identification of an additional source water stream as part of this expansion would prove beneficial to the agency for planning purposes. To this end, the potential for stormwater storage and capture in parcels within Padre Dam's sewershed, accompanied by controlled discharge to sanitary sewers for flow augmentation to RSWRF, was evaluated as part of this project. Since RSWRF is a constant-flow, or scalping plant, its effective sewershed is variable, but currently includes the majority of wastewater flows from Padre Dam's own sewershed, as well as some wastewater flows from San Diego County and other sources. Flows in excess of the plant's treatment capacity are customarily conveyed to San Diego Metro.

The evaluation performed as part of this project description is a high-level analysis that determined the volumes of stormwater storage potentially available in the vicinity of RSWRF's sewershed. It also investigated the sewer system's capacity to handle flows from controlled discharge, in addition to base wastewater flows that the system already accommodates. Furthermore, the evaluation also investigated the potential for stormwater capture and storage in the vicinity of the Santee Lakes, along with additional flow augmentation to the sewer line between the influent pump station and RSWRF.

For this evaluation, sewer lines in the sewershed that were at or greater than 21 inches in diameter were identified, to ensure adequate capacity. Potential storage parcels were then identified within a 200-foot buffer zone of these sewers. The system was then divided into several “branches”, in which cumulative flow from parcels was calculated, moving downstream in the sewershed. In general, the major gravity sewers feed the Influent Pump Station, from where wastewater flows are pumped north to RSWRF, along the Santee Lakes. Figure 1 shows the major sewer lines evaluated, along with the branches used for capacity evaluation in Padre Dam’s sewershed. Phases 2 and 3 of the expansion for IPR involve the conveyance of wastewater from several sources external to PDMWD’s sewershed and the potential construction of a second influent pump station. Additionally, new treatment facilities will be built, adjacent to the current 2 MGD facility, to incorporate Phase 2 and 3 flows. These future assets were not considered in this evaluation because of current uncertainties in their capacities and locations.

After several model iterations, it was seen that maintaining a common flow of about 0.5 cubic feet per second (cfs) from each parcel would maximize discharge to the sewers while still maintaining capacity through the majority of sewer lines. In evaluating parcel capacity, subjective assessments were made for each parcel on what percent of the area of each parcel can be considered usable for storage, in a 6-ft deep below-ground vault. Among the major assumptions made to determine sewer capacity was a base domestic wastewater flow in each gravity sewer segment, at a d/D value of 0.5 (50% full) and a conservative velocity of 8 ft/s. Parcel flow at relevant sewer segments, along with the cumulative flow from upstream parcels, was added to the base wastewater flow, and the value of d/D was recalculated. If the additional parcel flow resulted in gravity sewers being over 75% full, parcel flow rates were reduced. Another major conservative assumption made was that all parcels in the sewershed discharge at the same time (at their respective flows), and conveyance time in the sewer system is not accounted for. With force main lines, all upstream flows were added in, with no additional base wastewater flow assumed. The force main velocity was calculated with additional upstream parcel flows, and capacity was assumed to have been met if the calculated velocity was at or under 8 ft/s.

This evaluation resulted in two major determinations: (1) the maximum flow available to augment RSWRF via discharge from parcels, and (2) whether any capacity limitations exist in the sewer system as a result of additional parcel flows. The maximum flow available to RSWRF was calculated to be about 3.9 MGD. Actual flow from parcels is likely to be lower, since this evaluation assumed all parcels with storage volume at full capacity, discharging together over an extended time period, without accounting for transit time in the sewer system.

While the additional parcel flows were found to be manageable by the majority of the sewershed, some capacity limitations were observed. The major issues arose in locations where a sudden reduction in gravity sewer pipe size occurred along a given branch, and just upstream of the influent pump station, where flows from several branches were brought together, specifically, just upstream of RSWRF’s influent pump station. While the former issue may be resolved with the replacement of undersized pipes in the event this project is implemented, the latter determined final d/D values close to 90%, which are likely the result of a conservative analysis of sewer capacity. Nevertheless, these findings may warrant more detailed sewer system modeling before further consideration of this project.

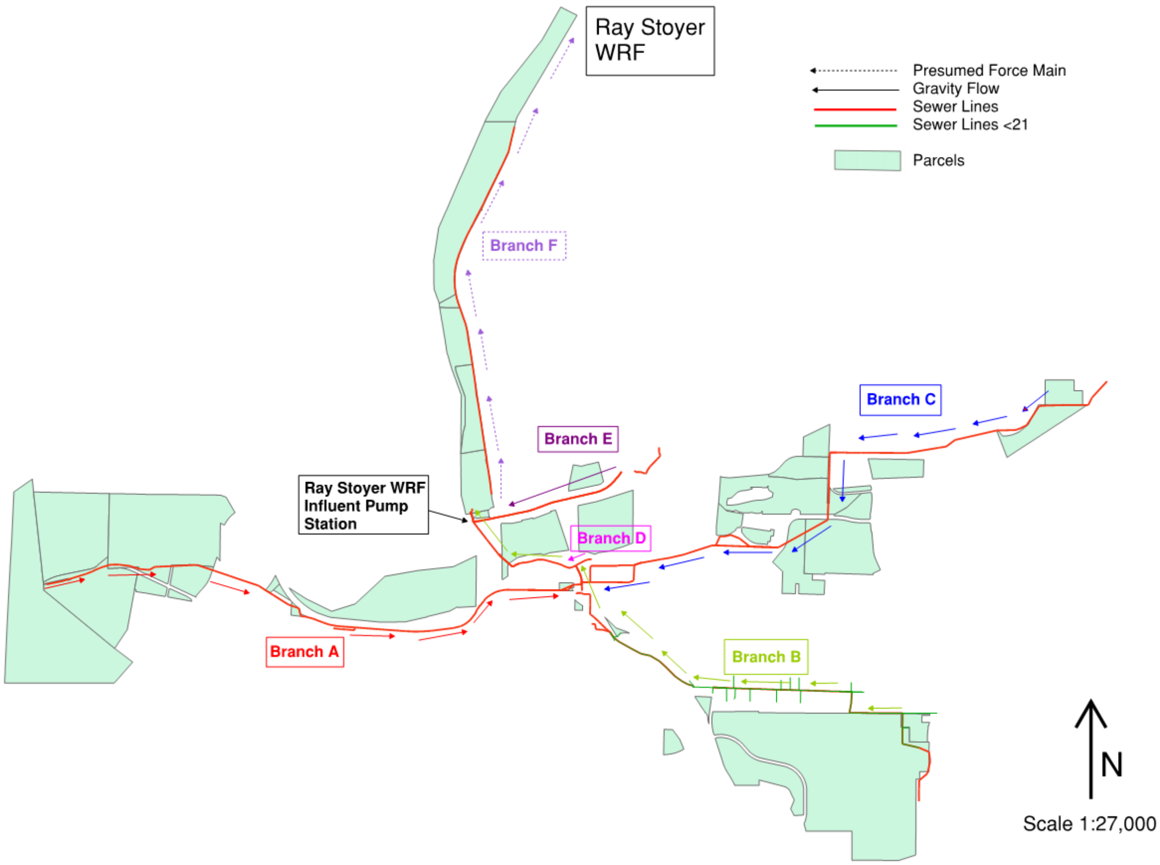
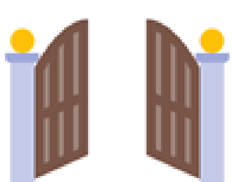


FIGURE 1 – PDMWD Sewershed, showing major sewer lines, force mains, and stormwater parcels used for volume and capacity evaluations.

PROJECT OPPORTUNTIES AND CONTRAINTS:



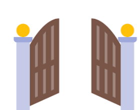
The results of the second Technical Advisory Committee (TAC) meeting included the identification of constraints and opportunities that can be applied to stormwater capture and use projects. These are discussed in more detail in Section 2. Project constraints can be used to assess the potential "gates" in which a project needs to pass through to be implemented. Through the identification of these "gates," project sponsors can assess the feasibility of the projects and what constraints may be overcome in the future through opportunities or "keys to open gates." Project constraints or "gates" may be identified early in the project planning phase that cannot be "opened" resulting in an infeasible project.

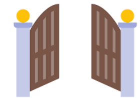
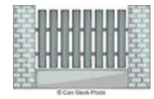
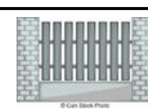
The example projects and identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by current or future opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint such as new technology or greater demand for recycled water. This management tool also provides a basis for the prioritization of projects in to short, mid- and long-term timelines for implementation.

The constraints or "gates" and opportunities or "keys to open gates" associated with Flow Augmentation to the Ray Stoyer Water Reclamation Facility for non-potable and indirect potable reuse are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other storwmater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

For this project (Flow Augmentation to the Ray Stoyer Water Reclamation Facility for non-potable and indirect potable reuse), the major gate identified was the demand for additional flows to facilitate the plant's planned expansions for non-potable and indirect potable reuse. The existence of several viable parcels within reach of the plant's sewershed, and a sewer system with the ability to convey these flows to the plant provide the major existing keys to open this gate. Other major gates identified are the lack of infrastructure and agreements to store stormwater on public parcels in the sewershed, and the need to build conveyance and pumping systems from parcels to nearby sanitary sewers. Additionally, the potential incompatibility of water quality between stormwater and wastewater that may affect the treatment process may need to be evaluated.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	PDMWD has identified the need for additional flows for recycled water production in its future expansions, but does not have enough onsite storage to facilitate onsite stormwater capture	***Larger or Multiple Storage Sites offsite, with conveyance***	Public parcels within the Padre Dam sewershed can be used for stormwater capture and storage	

Match Production with Demand/Need	Recycled water production will increase due to Padre Dam's planned expansions to produce up to 21 MGD (Phase 3) for multiple reuse end-goals	***Multiple public parcel storage sites*** ***Adequate conveyance to plant***	There is adequate offsite storage capacity to meet needs, and near adequate capacity in the sewer system to convey stormwater to RSWRF.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	No storage infrastructure currently exists for storage at parcels along the sewershed. However, conveyance insfrastructure exists, and with some exceptions, can convey most of the stored water to RSWRF.	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Storage infrastructure needs to be installed/built, and conveyance infrastructure needs to be modeled in detail to determine actual capacity constraints. Any additional pipes, pumping systems or other assets that need to be built to accommodate parcel flows need to be accounted for before the project can be implemented.	
Agency Agreements	Additional agreements may be needed for capture and storage of stormwater on nearby public lands	***Partnerships***	Local municipalities may want to partner with Padre Dam to meet water quality goals in the watershed, and to meet local recycled water demands.	
Water Type Incompatibility **Treatment Requirements**	Stormwater mixed with current upgraded treatment facility may not be compatible, and adding relatively large flows of stormwater blended with wastewater may affect biological treatment at RSWRF	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Extensive modeling and testing of the treatment systems is needed to adequately address any issues in product water quality, or effects on RSWRF's current treatment system. The expansion of RSWRF for Phase 2 and Phase 3 targets involves the construction of neighboring plants. These new facilities may be designed to target the treatment of wastewater-stormwater blends, making for a relatively unique treatment system.	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses or for indirect potable reuse	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential funding from Stormwater Prop 1 Funding Inter-agency agreements may allow for additional funding support to meet stormwater water quality goals and/or use of recycled water to clean sewers	
Public/Agency Support	Current facility recycled water agreements may limit added stormwater use	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the current recycled water agreements could provide flexibility to treat and store of stormwater.	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the analysis described above using the parcel and sewer system layouts in Figure 1. The elements and quantities include stormwater capture, storage and controlled discharge to RSWRF. The analysis conservatively assumed that all parcels along the sewershed discharge at the same time, and did not account for transit time within the sewer system. This resulted in the calculation of up to 3.9 MGD of additional flow available to augment the influent at SBWRP. However, actual flow available from captured stormwater is likely less than this value.

Table 2 presents the estimated quantities for the elements shown on Figure 1. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	Approx. 8	6 ft deep storage vaults, covering the equivalent of the drainage area; approx.. 13.4 million cubic feet	~3.1 million CF/yr	Up to 3.6 MGD (based on sewer system capacity)	Up to 3.9 MGD (based on system capacity)	Up to 3.9 MGD (4,380 acre-ft./yr.)(maximum identified from sewer system capacity analysis)

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Table 3 presents the estimated feasibility level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis, the unit cost for this example project is $305,874/AFY. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provides the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives. This project's unit costs were compared to the range of costs under Alternative Uses H (Controlled Discharge to Waste Water Treatment Plants for Recycled Water Use), and the estimated unit cost is within the calculated range.

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	Unit Costs	Quant.	Total Costs	Source/Assumptions
Mobilization/Demob	$ 2,374,176	1	$ 2,374,176	
Erosion Control & Temp Fencing	$ 50,000	21	$ 1,050,000	
Clearing & Grubbing/Tree Removal	$ 20,000	25	$ 504,000	Applying 201,700 cf (below) to 6 ft vault depth gives ~34,000 sf. Adding 20 percent as noted below for additional grading. This comes to roughly 1.2 acres.
Excavation (storage vault)	$ 7	241,500	$ 1,690,500	Vault dimensions and overexcation - 4:1 slopes. See attached calcs.
Placement of Site Material	$ 6	81,900	$ 491,400	Low end assume full excavation and high end 0
Excess Soil Off-Haul	$ 15	159,600	$ 2,394,000	Low end assume 0, high end full excavation
Culverts from MS4 to Underground Vault	$ 80	4,200	$ 336,000	Low end 0, high end 250 ft - base on actual distance
Concrete Vault	$ 9	4,235,700	$ 38,121,300	Using median of nonzero parcel volumes from both evaluated sewersheds.
Solids/Trash Removal prior to Vault	$ 50,000	21	$ 1,050,000	Assuming lump sum per median parcel.
Final Grading	$ 4,500	25	$ 113,400	Area of basin x 1.20 for additional grading
Plantings (shrubs-perimeter)	$ 15,000	25	$ 378,000	
Hydroseeding	$ 10,000	25	$ 252,000	Area of basin x 1.20 for additional grading
Temp Irrigation	$ 15,000	25	$ 378,000	
Mulch	$ 15	20,328	$ 304,920	Area of basin x 0.5 ft

Maintenance to Establish Veg	$ 5,000	84	$ 420,000	
Underground Wet Well/Pump from Vault to Sanitary Sewer	$ 50,000	21	$ 1,050,000	Using lump sum per median parcel
Connection to Sanitary Sewer	$ 5,000	21	$ 105,000	In addition to connection, this includes building a manhole for connection.
Upgrade of Sanitary Sewer	$ -	0	$ -	Assuming current sewer capacity is maintained.
Treatment and Distribution for Recycled Water	$ 1,300	326	$ 423,150	Using ESA's 40-year hydrologic models, the stormwater component of flow to a plant during the wettest year was estimated at 105 MGY for RSWRF. The unit cost of $1,300/AF comes from 2016 Pacific Institute Report on cost of alternative water supply in California by Cooley and Phurisamban. This is the median value of the range they determined.
Planning, Engineering & Permitting	$ 9,971,539	1	$ 9,971,539	
Contingency	$ 23,878,119	1	$ 23,878,119	Assume 20% Contingency
O&M	$ 14,276,471	1	$ 14,276,471	Assume 10% of total
Total			$ 99,561,975	

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Olivenhain Municipal Water District 4S Ranch Pilot Stormwater Treatment for Recycled Water

STORMWATER USE ALTERNATIVES:

Alternative H - Controlled discharge to waste water treatment plants for recycled water use

PROECT TYPE: Concept

PROJECT LOCATION AND SPONSOR: 16595 Dove Canyon Rd, San Diego, CA 92127, Olivenhain Municipal Water District

Description:

During the economic boom of the late 1980s, San Diego County experienced tremendous growth. During this time, the first portion of 4S Ranch was developed. In order to serve the sanitation needs of this development, the County of San Diego built a small 0.2 million gallons per day (MGD) wastewater treatment plant to serve the area. In 1998, Olivenhain Municipal Water District (OMWD) annexed the sanitation district from the County. Since that time, OMWD has provided wastewater collection and treatment services for the 4S Ranch and Rancho Cielo communities. In considering the future water supply needs of its customers, OMWD decided to reduce dependence on imported water (100% of its potable (drinking) water supply), and turned to alternative sources of water, including recycling water locally. However, the capacity of the wastewater treatment plant limited the feasibility to generated increased recycled water for irrigation to off-set use of treate3d imported water. OMWD took this opportunity to expand the plant to a 2 MGD facility, creating the 4S Ranch Water Reclamation Facility that incorporates “tertiary” treatment and disinfection processes, substantially increasing the treated water quality and produce of recycled water for irrigation. (https://www.youtube.com/watch?v=2d834g7a-bA&version=3&hl=en%5FUS)

The 4S Ranch Water Reclamation Facility produces over one million gallons of recycled water per day which is delivered to irrigation customers in the southeastern portion of OMWD’s service area for use at HOA common areas, schools, parks, streetscapes, and golf courses. OMWD supplements the recycled water it produces with recycled water purchased from Rancho Santa Fe Community Services District and the City of San Diego.

The conceptual project is to potentially expand the production of recycled water to serve the local communities using captured and stored stormwater that is treated using the older 0.2 MGD treatment facility that has been replaced with the 2.0 MGD upgraded and enhanced treatment system. Stormwater will be collected from the community municipal separate storm sewer system and stored in a basin or underground vault on public lands. The stormwater will be stored to address the lower demand period during storm events and higher wastewater inflows to the facility due to infiltration[1]. Stored stormwater will then be diverted at a controlled flow to the 4S Ranch Water Reclamation Facility as a separate inflow from the wastewater to the older portion of the facility.

The older portion of the plant was the original waste water treatment system that has since been replaced with upgraded systems to more efficiently meet recycling water standards in accordance with the 4S facility permit. The original treatment infrastructure is in working condition and is occasionally used to provide flexibility under higher flow conditions. This original treatment infrastructure can potentially be used for a pilot project that will treat the captured and stored stormwater to meet recycled water standards and augment current supplies for the community irrigation. The pilot project would have an initial treatment capacity of 0.2 MGD. The pilot project could be expanded based on the operational results and determination of the cost effectiveness of the system compared to other local and regional sources of recycled water.

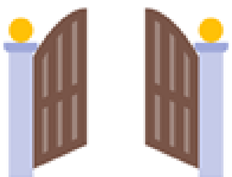
Because the facility does not currently have the flexibility to discharge recycled water to receiving waters under its current permit, there is a high risk from potential upsets to the treatment process should stormwater be introduced to the waste inflows. The concept is therefore to treat stormwater flows separately from the wastewater. Should greater flexibility be approved in the facility's NPDES discharge permit, alternatives could be explored. The new more efficient facultative process implemented in the upgraded plant is sensitive to changes in inflow characteristics and is a further reason the proposed pilot will use the older systems to treat the stormwater separately.

The 4S Ranch Water Reclamation Facility also has an 80-day reservoir that is used for temporary storage of recycled water produced by the plant. The reservoir may be used to temporary store treated stormwater until it is distributed through a system of purple pipes for use as irrigation to the surrounding community. This reservoir may have limited storage capacity during wetter years when irrigation demand is lower and wastewater inflow remains consistent. Increased recycled water demand and greater flexibility in discharge requirements would improve the feasibility of greater use of stormwater.

[1] Potential storage sites to be identified with Project Sponsor.

PROJECT OPPORTUNTIES AND CONTRAINTS:

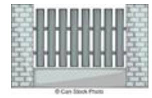
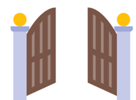
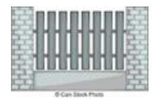
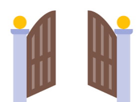
The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current "gates" that may be addressed by opportunities or "keys" that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify "gates" that remain closed until a "key" can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or "gates" and opportunities or "keys to open gates" associated with the OMWD 4S Ranch Pilot Stormwater Treatment for Recycled Water are summarized in Table 1. Table 1 presents the constraints and opportunities developed by the TAC, followed by the project specific "gates" and "keys to open the gates". The final column presented in Table 1 provides the current status of the project with regard to the remaining constraints or "gates" to the implementation of the projects and which constraints or "gates" have been opened with project opportunities. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

For the OMWD 4S Ranch Pilot Stormwater for Recycled Water Project, there are a number of "gates" that include obtaining greater flexibility in the current NPDES discharge permit that would allow for discharge of excess recycled water during heavy wet weather periods to allow for treatment and storage of stormwater using existing infrastructure under this pilot program. Additional "gates" include handling of solid waste from treatment processes, inter-agency agreements on the capture and storage of stormwater on public lands, cost competitiveness and funding. Common to stormwater capture and use projects in this development period is the competitive cost of using storwmater compared to other sources, in this case recycled water produced from other wastewater treatment facilities. The potential "keys to opening the gate" include use of the existing infrastructure to reduce costs and the multi-benefits of this project that include pollutant load reductions from stormwater flows that provide a regulatory driver to inter-agency agreements, funding and discharge permit flexibility. An additional benefit includes use of recycled water to clean wastewater lines to address solids management issues. These inter-agency cooperative opportunities can provide for additional funding.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	No on-site storage is for stormwater requiring off-site collection and storage Off-site storage of recycled water may be limited during heavy wet weather periods	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Public parcels within the 4S Ranch waste-shed can be used for stormwater capture and storage Greater flexibility in NPDES discharge permit could provide for needed temporary for treated stormwater during very wet low demand periods	
Match Production with Demand/Need	Recycled water demand has decreased due to conservation measures and is lower during heavy wet weather periods	***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Project is a smaller scale pilot to determine if the costs of stormwater treatment provides a viable competitive source that meets anticipated demand.	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Infrastructure needed for stormwater capture, storage and conveyance to the treatment facility	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Project scaled to use on-site older 0.2 MGD facility, recycled water 80-day reservoir and recycled water distribution system.	
Agency Agreements	Inter-agency agreements needed for capture and storage of stormwater on nearby public lands	***Partnerships***	Local municipalities under the Stormwater NPDES permit may want to partner with OMWD on pilot project to meet water quality goals in the watershed	
Water Type Incompatibility **Treatment Requirements**	Stormwater mixed with current upgraded treatment facility may not be compatible and is a high risk due to restrictions of current discharge permit	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***	Pilot Project uses older treatment facility and keeps waste streams separate.	
Regulatory Ambiguity	Regulations not clear on the treatment standards for stormwater for non-potable uses	***Regulator Clarity and Flexibility***	Treated stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	Funding needed for project implementation and O&M costs Cost of recycled water from stormwater may not be competitive	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential funding from Stormwater Prop 1 Funding Inter-agency agreements may allow for additional funding support to meet stormwater water quality goals and/or use of recycled water to clean sewers	
Public/Agency Support	Current facility NPDES discharge permit is restrictive and limits added stormwater use	***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	Greater flexibility in the current permit to allow for discharge of recycled water under certain conditions could provide flexibility to treat and store of stormwater.	

QUANTIFICATION SUMMARY:

The elements of this project's stormwater capture and use process from which quantifies have been determined are based on the conceptual layout. The elements and quantities include stormwater capture, storage and controlled discharge to the 4S Ranch treatment facility. The temporary stormwater storage facility will capture stormwater from the MS4 store it for up to three days and then discharge it to the treatment facility at a rate of 0.2 MGD for a period of five days. Additional elements include treatment of the stormwater at the existing 0.2 MGD treatment facility to add to the recycled water production of the 4S Ranch facility. Recycled water is then storage at the existing 80-sday storage reservoir for distribution through the existing purple pipe system to customers in the 4S Ranch for use in irrigation of landscape areas of residential and commercial properties, parks and golf courses.

Table 2 presents the estimated quantities for the project elements. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design level quantities, but are applicable for feasibility level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND TREATMENT

Project Component	Drainage Area	Underground Stormwater Storage Facility	Underground Stormwater Storage Facility	Advanced Treatment	Recycled Water Generation	Recycled Water Distribution
Description of Estimated Quantity	Size of Drainage Area (acres)	Area, Depth and Volume (acres, ft. and cubic feet (CF)	Annual Volume of Stormwater Captured (CF/yr.)	Rate treatment facility can accept stormwater (MGD and MGY)	Daily and annual rate of recycled water that would be generated from treated stormwater (MGD and MGY)	Daily and annual rate of distribution of treated stormwater (MGD and MGY)
Estimated Quantities	TBD	TBD	TBD	0.2MGD	0.2 MGD	0.2MGD

STORMWATER CAPTURE AND USE FEASIBILITY STUDY EXAMPLE PROJECTS

Project Title: Integrated Stream Restoration and Water Quality Project on the San Luis Rey River

STORMWATER USE ALTERNATIVE:
Alternative B - Discharge to groundwater to reestablish natural hydrology and, by extension, to restore biological beneficial uses

PROECT TYPE: Design

PROJECT LOCATION AND SPONSOR:
Old River Road near Camino del Rey, Bonsall County of San Diego

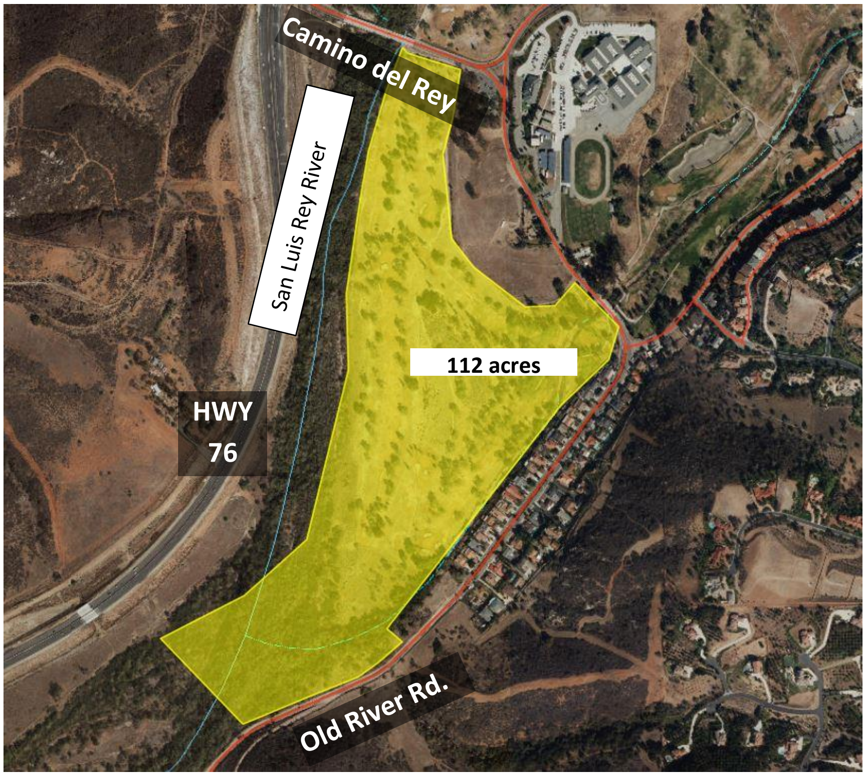
Description:

This concept project is located east of Oceanside, in Bonsall, CA. It is located within the historical floodplain between the San Luis Rey River and Moosa Creek, south of Camino Del Rey and bordered to the west by the San Luis Rey River and State Route 76, and to the east by the Moosa Creek and Old River Road. The area is outlined in Figure 1.

The aim of the project is to maximize water quality and alternative use benefits in the 112-acre parcel by restoring the natural channel and flood plain for Moosa Creek and the San Luis Rey River, incorporating an off-line BMP for water quality treatment, and accommodating passive recreation for equestrians, bicyclist, and pedestrians by providing trail connectivity across the property. The project will accomplish this through the construction of a combination of offline wetlands and a biofiltration basin, covering approximately 5.2 acres of the site. These measures will improve the quality of water returning Moosa Creek and the San Luis Rey River in accordance with the Water Quality Improvement Plan (WQIP).

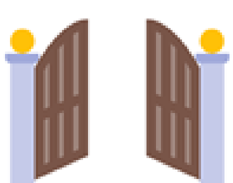
The proposed alternatives include 1.4 miles of trail to increase connectivity and accessibility in the area, designed in accordance with the County’s guidelines for trails in preserved lands; an offset of Moosa Creek, decreasing encroachment issues associated with the neighboring properties; and grading of the area between the creek and the river to improve natural floodplain functionality. These are expected to result in several benefits, including public access, flood management, and water quality.

Figure 1. Project Location



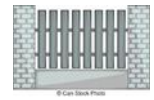
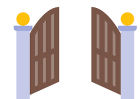
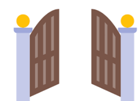
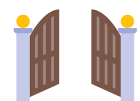
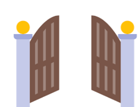
PROJECT OPPORTUNTIES AND CONTRAINTS:

The identification of constraints and opportunities below provide a management tool for the assessment of the feasibility of similar stormwater capture and use projects. This tool provides for the consideration of current “gates” that may be addressed by opportunities or “keys” that may include potential future grant funding or interagency agreement to share existing infrastructure and costs. The tool may also identify “gates” that remain closed until a “key” can change or address the constraint. This management tool also provides a basis for the prioritization of projects.



The constraints or “gates” and opportunities or “keys to open gates” associated with the Integrated Stream Restoration and Water Quality Project on the San Luis Rey River are summarized in Table 1. These project opportunities and constraints should be considered in the further development and planning of this project and other stormwater capture and use projects with similar elements. Each site/project will have its own set of opportunities and constraints, but there are common elements and site conditions that can be used to assess and plan similar projects.

TABLE 1
PROJECT CONSTRAINTS "GATES" AND OPPORTUNITIES "KEYS"

Constraints "Gates"	Project Constraints "Gates"	Opportunities "Keys to Open Gates"	Project Opportunities "Keys"	Project "Gate Status"
Site Characteristics – Favorable Geology, Complimentary Land Use	Geotechnical Data needed to confirm infiltration potential	***Larger or Multiple Storage Sites*** ***Complementary land uses***	Low infiltration rates in subsoils may be addressed with increased storage and greater volumes going to bio-filtration	
Match Production with Demand/Need		***Small Scale Implementation*** ***Multiple Public Parcel Storage Sites*** ***Market Demand Identified***	Project designed to use known flows in the river/creek system, passing excess via existing channels	
Absence of Existing Infrastructure (Storage, Conveyance, Treatment, Distribution)	Refine bio-filtration design and design of needed infrastructure	***Existing Infrastructure (Storage, Conveyance, Treatment Capacity, Distribution)*** ***Large Scale project – Economies of Scale***	Costs include implementation of these elements	
Agency Agreements		***Partnerships***	Project is on property owned by the sponsor	
Water Type Incompatibility **Treatment Requirements**	Design to confirm compatibility	***Storage and Controlled Discharge*** ***Separate or Pre-Treatment***		
Regulatory Ambiguity		***Regulator Clarity and Flexibility***	Stormwater to meet current recycled water requirements unless clarifications provided by regulatory agencies	
Capital and O&M Costs **Funding**	City responsible for implementation and O&M costs Funding sources have not yet been settled	***Regulatory Drivers*** ***Multi-Benefits*** ***Supportable trade-off between cost and benefit*** ***Grant Funding***	Potential grant application for funding – Stormwater Prop 1 Funding	
Public/Agency Support		***Public/Agency Support*** ***Regulatory Driver*** ***Public/Private Partnerships***	As a low-impact project on city land, community support is not likely to be an issue	

QUANTIFICATION SUMMARY:

Table 2 presents the estimated quantities for the project elements, and estimated acre-feet per year that will be treated and returned to the storm drain system. These quantities will be used for project prioritization and to apply to applicable feasible public parcels. These quantities are conceptual and do not represent design-level quantities, but are applicable for feasibility-level assessments.

TABLE 2
ESTIMATED QUANTITIES FOR STORMWATER COLLECTION, STORAGE AND INFILTRATION

Project Component	Drainage Area	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin	Stormwater Retention Basin
Description of Estimated Quantity	Size of Drainage Area (acres)	Basin Area, Depth and Volume (SF, ft, CF)[2]	Design Capture Volume (DCV) (CF)	Soil Type and Estimated Infiltration Rate (in./hr.)	Annual volume of stormwater infiltrated or used for irrigation (AFY)
Estimated Quantities (Infiltration)	186,000 ac[1]	225,000 SF 3 ft 675,000 CF	TBD[3]	0.5 in/hr	TBD[3]

[1] Drainage area is large because the project draws from San Luis Rey River

[2] Depth and Volume estimated from similar projects

[3] Annual capture volume to be estimated

FEASIBILITY STUDY LEVEL COST ESTIMATES:

Tables 3 presents the estimated feasibility-level costs for each project component. Based on the estimated total project costs and volume of stormwater that is used beneficially on an annual basis and assuming a 25-year project lifespan, the unit cost for this example project is $---/AFY[1]. This cost per volume provides a project-level estimate for planning purposes for similar projects. This cost estimate will vary by project. The cost ranges developed for the Alternative Uses provide the basis for a regional comparison of these alternatives, whereas these project example cost estimates provide a specific example from each of the alternatives This project's unit costs were compared to the range of costs under Alternative Use B (Discharge to Restore Natural Hydrology), and the estimated unit cost is within the calculated range[2].

TABLE 3
ESTIMATED FEASIBILITY STUDY LEVEL COSTS

Project Component	**Total Costs**
Demolition	$ 380,000
Earthwork	$ 6,000,000
Water Quality	$ 5,320,000
Landscaping	$ 4,600,000
Site Improvements	$ 260,000
Mobilization (10%)	$ 1,660,000
Engineering and Permitting (20%)	$ 3,310,000
Contingency (20%)	$ 3,310,000
Total	$ 25,840,000

[1] TBD, based on input from Project Sponsor
[2] Review indicates this is true, but the assessment will be revised based on cost input from the Project Sponsor.

ATTACHMENT B

Example Cost Tables with Assumptions

Table B-1

Example Costs and Assumptions for Alternative A, Infiltration Basin

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative A, Infiltration Basin. For this example, the parcel has an area of 1.5 acres and volume of 7,270 cubic yards. Erosion control and temporary fencing, inlet and outlet structures, plantings, and maintenance to establish vegetation are all lump sum costs. Costs associated with excavation, final grading, hydroseeding, temporary irrigation and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul, culverts, and the distribution network have different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project cost using the low-end assumptions is $459,300 and using the high-end assumption is $1,296,500.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$14,800 - $41,800	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	1.5	$30,000	
Excavation	CY	$7	7270	$50,900	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	7270	$43,611 - $109,027	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Basin	LF	$80	0 - 250	$0 - $20,000	Low end 0, high end 250 ft- based on actual distance
Culverts from Basin to Groundwater Basin	LF	$80	0 - 5,280	$0 - $422,400	Low end 0, high end 5280 ft- based on parcel analysis
Distribution Network at Groundwater Basin	LF	$160	0 - 200	$0 - $32,000	Low end 0, high end 200 ft
Inlet & Outlet Structures	LS	$20,000	1	$20,000	
Final Grading	AC	$4,500	1.8	$8,100	Area of basin x 1.20 for additional grading
Plantings (shrubs)	LS	$15,000	1	$15,000	
Hydroseeding	AC	$10,000	1.65	$18,000	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$25,000	1.5	$22,500	
Mulch	CY	$15	1,210	$18,200	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$59,300- $167,200	Assume 20%
Subtotal				$296,400 - $836,200	
Contingency	LS		1	$59,300 - $167,300	Assume 20%
O&M	LS		1	$29,600 - $83,600	Assume 10%
Total				$459,300 -$1,296,500	
Total Volume Used over 25-year Project Lifespan	AC-FT		650		
Total Cost per Volume	$/AC-FT			$710 - $2,000	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

TABLE B- 2

EXAMPLE COSTS AND ASSUMPTIONS FOR ALTERNATIVE A, INJECTION WELLS

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative A, Injection Wells. For this example, the parcel has an area of 1.9 acres and volume of 9,060 cubic yards. Erosion control and temporary fencing, the injection well, inlet and outlet structures, plantings, and maintenance to establish vegetation are all lump sum costs. Costs associated with excavation, final grading, hydroseeding, temporary irrigation and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul, culverts, and the distribution network have different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project cost using the low-end assumptions is $757,900 and using the high-end assumption is $1,922,800.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$24,400 - $62,000	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	1.9	$37,500	
Excavation	CY	$7	9,060	$63,500	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	9,060	$54,400 - $136,000	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Basin	LF	$80	0 - 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Inlet & Outlet Structures	LS	$20,000	1	$20,000	
Additional Treatment Prior to Injection	EA	$650,000	1	$0 - $650,000	
Injection Well	EA	$147,000	1	$147,000	
Final Grading	AC	$4,500	2.2	$8,400	Area of basin x 1.20 for additional grading
Plantings (shrubs)	LS	$15,000	1	$15,000	
Hydroseeding	AC	$10,000	2.1	$22,500	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$25,000	1.9	$28,100	
Mulch	CY	$15	1,510	$22,700	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$97,800 - $248,100	Assume 20%
Subtotal				$489,000 - $1,240,500	
Contingency	LS		1	$97,800 - $248,100	Assume 20%
O&M	LS		1	$48,900 - $124,100	Assume 10%
Total				$757,900 - $1,922,800	
Total Volume Used over 25-year Project Lifespan	AC-FT		3,510		
Total Cost per Volume	$/AC-FT			$220 - $550	
Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)					

TABLE B-3

EXAMPLE COSTS AND ASSUMPTIONS FOR ALTERNATIVE B, INFILTRATION BASIN

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative B, Infiltration Basin. In this example, the parcel had an area of 1.5 acres and volume of 7,270 cubic yards. Erosion control and temporary fencing, inlet and outlet structures, plantings, and maintenance to establish vegetation are all lump sum costs. Costs associated with excavation, final grading, plantings, hydroseeding, temporary irrigation and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul and culverts have different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project cost using the low-end assumptions is $459,300 and using the high-end assumption is $591,800.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$14,800 - $19,100	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	1.5	$30,000	
Excavation	CY	$7	7270	$50,900	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	7270	$43,600 - $109,000	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Basin	LF	$80	0 - 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Inlet & Outlet Structures	LS	$20,000	1	$20,000	
Final Grading	AC	$4,500	1.8	$8,100	Area of basin x 1.20 for additional grading
Plantings (shrubs)	LS	$25,000	1	$15,000	
Hydroseeding	AC	$10,000	1.65	$18,000	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$25,000	1.5	$22,500	
Mulch	CY	$15	1210	$18,120	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$59,300 - $76,300	Assume 20%
Subtotal				$296,400- $381,800	
Contingency	LS		1	$59,300 - $76,400	Assume 20%
O&M	LS		1	$29,600 - $38,200	Assume 10%
Total				$459,300 - $591,800	
Total Volume Used over 25-year Project Lifespan	AC-FT		650		
Total Cost per Volume	$/AC-FT			$710 - $920	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

Table B-4

Example Costs and Assumptions for Alternative B, Biofiltration Basin

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative B, Biofiltration Basin. In this example, the parcel had an area of 1.5 acres and volume of 7,270 cubic yards. Erosion control and temporary fencing, inlet and outlet structures, plantings, and maintenance to establish vegetation are all lump sum costs. Costs associated with excavation, aggregate for underdrain, media for aggregate, final grading, plantings, hydroseeding, temporary irrigation and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size and volume. Placement of site material or excess soil off-haul, underdrain, and culverts have different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project cost using the low-end assumptions was $800,500 and using the high-end assumption was $1,120,700

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$25,888 - $34,000	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	1.5	$30,000	
Excavation	CY	$7	7270	$50,900	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	7270	$43,600 - $109,000	Low end assume full excavation and high end assumes full off-haul
Aggregate for Underdrain/Storage	CY	$34	2420	$82,400	Area of basin and 12 inches of underdrain storage
Media for Aggregate	CY	$30	3630	$109,027	Area of basin and 18 inches of media filter
Underdrain	LF	$40	500-2400	$20,000 - $96,000	Low end, average basin size; high end, 1.5 times the maximum square basin size
Culverts from MS4 to Basin	LF	$80	0 - 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Inlet & Outlet Structures	LS	$10,000	1	$10,000	
Final Grading	AC	$4,500	1.8	$8,100	Area of basin x 1.20 for additional grading
Plantings (shrubs)	LS	$20,000	1	$20,000	
Hydroseeding	AC	$10,000	1.65	$18,000	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$25,000	1.5	$37,500	
Mulch	CY	$15	1,210	$18,200	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$103,600 - $15,800	Assume 20%
Subtotal				$517,800 - $679,200	
Contingency	LS		1	$103,600 - $135,800	Assume 20%
O&M	LS		1	$51,800 - $679,200	Assume 10%
Total				$800,500 - $1,120,700	
Total Volume Used over 25-year Project Lifespan	AC-FT		650		
Total Cost per Volume	$/AC-FT			$1,240 - $1,630	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

TABLE B-5

EXAMPLE COSTS AND ASSUMPTIONS FOR ALTERNATIVE C, IRRIGATION

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative C, Irrigation. In this example, the parcel has an area of 1.0 acres and volume of 9,962 cubic yards. Erosion control and temporary fencing, inlet and outlet structures, plantings, maintenance to establish vegetation, solids/trash removal system, and pump and structure for distribution are all lump sum costs. Costs associated with excavation, final grading, plantings, hydroseeding, temporary irrigation, concrete vault, distribution to irrigation, irrigation system and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul, pre-treatment, and culverts had different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project using the low-end assumption is $6,310,300 and using the high-end assumption is $7,487,800.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$203,600- $241,500	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	1	$20,600	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	9,962	$59,800 - $149,400	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Basin	LF	$80	0 - 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Concrete Vault (Including Excavation)	CF	$9	268,9780	$2,420,800	
Solids/Trash Removal	EA	$36,531	1	$36,500	Assumed Stormceptor STC 2400
Additional Treatment Prior to Irrigation	EA	$650,000	1	$0 - $650,000	Package UV Treatment System; based on Poche Beach System
Pump and Structure For Distribution	EA	$12,000	1	$12,000	Match pump with UV treatment system output; assum 400 gallon per minute output
Distribution to Irrigation	LF	$120	1,150	$138,000	
Irrigation System	AC	$25,000	170	$126,300	
Final Grading	AC	$4,500	1.2	$5,600	Area of basin x 1.20 for additional grading
Plantings (shrubs)	LS	$5,000	1	$5,000	
Hydroseeding	AC	$10,000	1.2	$12,400	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$15,000	1	$15,400	
Mulch	CY	$15	1,210	$12,500	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$814,200 - $966,200	Assume 20%
Subtotal				$4,071,200 - $4,830,300	
Contingency	LS		1	$814,200- $966,200	Assume 20%
O&M	LS		1	$407,100 - $483,000	Assume 10%
Total				$6,310,300 - $7,487,800	
Total Volume Used over 25-year Project Lifespan	AC-FT		36		
Total Cost per Volume	$/AC-FT			$173,000 - $205,300	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

TABLE B-6

EXAMPLE COSTS AND ASSUMPTIONS FOR BENEFIT E, WETLAND TREATMENT

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative D, Wetland Treatment. In this example, the parcel has an area of 4.7 acres and volume of 45,800 cubic yards. Erosion control and temporary fencing, inlet and outlet structures, and maintenance to establish vegetation, are all lump sum costs. Costs associated with excavation, final grading, plantings, hydroseeding, temporary irrigation, and mulch do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul and culverts had different costs for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project using the low-end assumption is $1,820,200 and using the high-end assumption is $2,489,700

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$58,700 - $80,300	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	1	$50,000	
Clearing & Grubbing/Tree Removal	AC	$20,000	4.7	$94,600	
Excavation	CY	$7	45,800	$320,379	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	45,800	$274,600 - $686,500	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Basin	LF	$80	0 – 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Inlet/Outlet Structure	LS	$20,000	1	$20,000	
Final Grading	AC	$4,500	5.7	$25,500	Area of basin x 1.20 for additional grading
Plantings (shrubs)	AC	$36,000	4.7	$170,200	
Hydroseeding	AC	$10,000	5.1	$56,700	Area of basin x 1.10 for additional grading
Temp Irrigation	AC	$15,000	4.7	$85,100	
Mulch	CY	$15		$57,200	Area of basin x 0.5 ft
Maintenance to Establish Veg	Month	$5,000	4	$20,000	
Planning, Engineering, & Permitting	LS		1	$234,900 - $321,300	Assume 20%
Subtotal				$1,174,400 - $1,606,300	
Contingency	LS		1	$234,00 - $321,300	Assume 20%
O&M	LS		1	$117,400- $160,600	Assume 10%
Total				$1,820,200 - $2,489,700	
Total Volume Used over 25-year Project Lifespan	AC-FT		680		
Total Cost per Volume	$/AC-FT			$2,700 - $3,600	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

TABLE B-7

EXAMPLE COSTS AND ASSUMPTIONS FOR ALTERNATIVE F, DRY WEATHER WASTEWATER DIVERSION

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative F, Dry Weather Wastewater Diversion. In this example, the parcel has an excavation volume of 3,300 cubic yards. Erosion control and temporary fencing, clearing and grubbing/tree removal, underground diversion wet well pump, connection to sanitary sewer, treatment and distribution, and site revegetation are all lump sum costs. Costs associated with excavation do not vary between the low and high cost assumptions; they are influenced by parcel size. Placement of site material or excess soil off-haul costs vary for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project using the low-end assumption is $2,501,300 and using the high-end assumption is $2,581,200

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$78,200 - $80,700	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$25,000	1	$25,000	
Clearing & Grubbing/Tree Removal	LS	$5,000	1	$5,000	
Excavation	CY	$7	3,330	$23,300	
Placement of Site Material OR Excess Soil Off-Haul	CY CY	$6 $15	3,330	$20,000 - $50,000	Low end assume full excavation and high end assumes full off-haul
Culverts from MS4 to Diversion Structure	LF	$80	0 – 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Underground Dry Weather Diversion Wet Well/Pump	LS	$50,000	1	$50,000	Assumes an allowance based on a gravity fed equalization structure cost of approximately $30,000 and installation costs of $20,000
Connection to Sanitary System	LS	$15,000	1	$15,000	Assumes connection requires a 5-ft diameter, 8-10-ft deep precast manhole structure. Approximate material costs will be $7,500, with installation and traffic control costs of $7,500.
One-Time Connection Fee	EA	$150,000	1	$150,000	Based on volume
Annual Sewer Fee	YR	$50,000	25	$1,250,000	Based on volume
Site Revegetation	LS	$25,000	1	$25,000	Assumes approximately 0.25 acre of clearing for diversion
Planning, Engineering, & Permitting	LS		1	$312,700 - $322,700	Assume 20%
Subtotal				$1,563,300- $1,613,300	
Contingency	LS		1	$312,700 - $322,700	Assume 20%
O&M	LS		1	$234,500 - $242,000	Assume 15%
Total				$2,501,300 - $2,581,200	
Total Volume Used over 25-year Project Lifespan	AC-FT		339		
Total Cost per Volume	$/AC-FT			$7,400 -$7,600	
Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)					

TABLE B-8

EXAMPLE COSTS AND ASSUMPTIONS FOR ALTERNATIVE G, WASTEWATER DIVERSION FOR RECYCLED WATER

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative G, Wastewater Diversion for Recycled Water. In this example, the vault as an area of 0.34 acres and a volume of 89,913 cubic yards. Erosion control and temporary fencing, clearing and grubbing/tree removal, solids trash removal, maintenance to establish vegetation, underground wet well/pump, connection to sanitary sewer, and treatment and distribution are all lump sum costs. Costs associated with the concrete vault, final grading, plantings, hydroseeding, temporary irrigation, and mulch do not vary between the low and high cost assumptions; they are influenced by project area and acreage. Placement of site material or excess soil off-haul costs vary for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project using the low-end assumption is $1,914,300 and using the high-end assumption is $3,241,000.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$59,800 – $62,300	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	0.34	$50,000	
Clearing & Grubbing/Tree Removal	LS	$20,000	0.34	$6,880	
Placement of Site Material	CY	$6			
OR			3,330	$20,000 - $50,000	Low end assume full excavation and high end assumes full off-haul
Excess Soil Off-Haul	CY	$15			
Culverts from MS4 to Diversion Structure	LF	$80	0 – 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Concrete Vault (Includes Excavation)	CF	$9	89,900	$809,200	Material cost from $6 - $10/CF of storage volume + 5% installation
Solids Trash Removal Prior to Vault	EA	$50,000	1	$50,000	Assumes structure cost of $30,000 and installation costs of $20,000
Final Grading	ACRE	$4,500	0.4	$1,900	
Plantings (shrubs-perimeter)	ACRE	$15,000	0.4	$5,200	
Hydroseeding	ACRE	$10,000	0.4	$4,100	
Temp Irrigation	ACRE	$15,000	0.4	$5,200	
Mulch	CY	$15	7,500	$4,200	Area of basin x 1.20 for additional grading
Maintenance to Establish Vegetation	MONTH	$2,000	4	$20,000	
Underground Wet Well/Pump from Vault	EA	$50,000		$50,000	
Connection to Sanitary Sewer	EA	$15,000	1	$15,000	Material of $7,500, with installation and traffic control of $7,500
One-Time Connection Fee	EA	$15,000	1	$15,000	Based on volume
Annual Sewer Fee	YR	$5,000	25	$125,000	Based on volume
Planning, Engineering, & Permitting	LS		1	$239,300 – $249,300	Assume 20%
Subtotal				$1,196,500 – $1,246,500	
Contingency	LS		1	$239,300 - $249,300	Assume 20%
O&M	LS		1	$179,500 - $187,000	Assume 15%
Total				$1,914,300 - $3,241,000	
Total Volume Used over 25-year Project Lifespan	AC-FT		66		
Total Cost per Volume	$/AC-FT			$28,900 - $48,900	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)

Table B-9

Example Costs and Assumptions for Alternative H, Wastewater Diversion for Potable Water

The table below shows an example of a cost calculation using both the high and low end assumptions for one project in Alternative H, Wastewater Diversion for Potable Water. In this example, the vault as an area of 0.34 acres and a volume of 89,913 cubic yards. Erosion control and temporary fencing, clearing and grubbing/tree removal, solids trash removal, maintenance to establish vegetation, underground wet well/pump, connection to sanitary sewer, and treatment and distribution are all lump sum costs. Costs associated with the concrete vault, final grading, plantings, hydroseeding, temporary irrigation, and mulch do not vary between the low and high cost assumptions; they are influenced by project area and acreage. Placement of site material or excess soil off-haul costs vary for the low and high end assumption; the range shown in both the quantity and cost per item columns represent the low and high end costs and quantities. The sources/assumptions provide the basis for these low and high end costs. For this example, the total project using the low-end assumption is $1,846,800 and using the high-end assumption is $3,165,900.

Item	Unit	Cost per Unit	Quantity	Cost per Item	Source/Assumptions
Mobilization/Demobilization	LS		1	$59,800 – $62,300	Assume 5% of total cost
Erosion Control & Temp Fencing	LS	$50,000	0.34	$50,000	
Clearing & Grubbing/Tree Removal	LS	$20,000	0.34	$6,880	
Placement of Site Material	CY	$6	3,330	$20,000 - $50,000	Low end assume full excavation and high end assumes full off-haul
OR Excess Soil Off-Haul	CY	$15			
Culverts from MS4 to Diversion Structure	LF	$80	0 – 250	$0 - $20,000	Low end 0, high end 250 ft - base on actual distance
Concrete Vault (Includes Excavation)	CF	$9	89,900	$809,200	Material cost from $6 - $10/CF of storage volume + 5% installation
Solids Trash Removal Prior to Vault	EA	$50,000	1	$50,000	Assumes structure cost of $30,000 and installation costs of $20,000
Final Grading	ACRE	$4,500	0.4	$1,900	
Plantings (shrubs-perimeter)	ACRE	$15,000	0.4	$5,200	
Hydroseeding	ACRE	$10,000	0.4	$4,100	
Temp Irrigation	ACRE	$15,000	0.4	$5,200	
Mulch	CY	$15	7,500	$4,200	Area of basin x 1.20 for additional grading
Maintenance to Establish Vegetation	MONTH	$2,000	4	$20,000	
Underground Wet Well/Pump from Vault	EA	$50,000		$50,000	
Connection to Sanitary Sewer	EA	$15,000	1	$15,000	Material of $7,500, with installation and traffic control of $7,500
One-Time Connection Fee	EA	$15,000	1	$15,000	Based on volume
Annual Sewer Fee	YR	$5,000	25	$125,000	Based on volume
Planning, Engineering, & Permitting	LS		1	$239,300 – $249,300	Assume 20%
Subtotal				$1,196,500 – $1,246,500	
Contingency	LS		1	$239,300 - $249,300	Assume 20%
O&M	LS		1	$179,500 - $187,000	Assume 15%
Total				$1,914,300 - $3,241,000	
Total Volume Used over 25-year Project Lifespan	AC-FT		66		
Total Cost per Volume	$/AC-FT			$28,900 - $48,900	

Note: Unit abbreviations are as follows: Lump Sum (LS), Cubic Yard (CY), Linear Foot (LF), Each (EA), Acre (AC), Acre-foot (AC-FT)