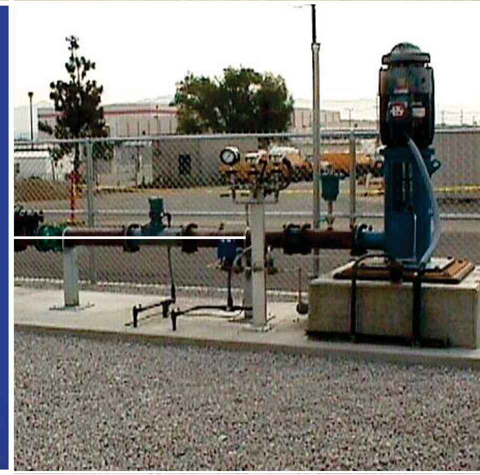
ATTACHMENT #1

Thousand Oaks Groundwater and Reclaimed Water Study

Prepared for the City of Thousand Oaks Public Works Department

February 2016



CDM Smith

Executive Summary

ES. 1 Introduction

The City of Thousand Oaks (City) is located in eastern Ventura County encompassing 56 square miles with a current population of approximately 130,000. Currently all of the City's domestic water demands are met from imported water from the Metropolitan Water District of Southern California (MWD). The source of the imported water is from the California State Water Project (SWP), which have recently been curtailed due to the exceptional statewide drought. Groundwater from the Conejo Valley Groundwater Basin (CVGB) was the sole source of water prior to the 1960's and presents a valuable resource that has been largely untapped in the last half-century after imported water became available. The groundwater basin was over drafted in the early 1960s, but has since rebounded—presenting a viable and sustainable supplemental local water supply for the City.

To evaluate the viability of groundwater as well as expanded use of reclaimed water for the City, the City's Department of Public Works launched the Groundwater and Reclaimed Water Study (Study). The purpose of the Study was to evaluate the safe yield for groundwater production from the CVGB, determine potential uses for expanded reclaimed water supply, and develop and evaluate alternatives of local supply projects.

ES.2 Conejo Valley Groundwater Basin

The CVGB is a 45.2 square mile area that underlies the City, located in the southwest portion of Ventura County. After WWII, the population of Thousand Oaks began to rise, which increased stress on the groundwater basin as agricultural, private, and municipal groundwater pumping increased. By the early 1960s, water level drawdown was as much as 300 feet in some areas of the eastern portion of the basin. When imported water became available in 1963, pumping nearly ceased and groundwater levels quickly returned to predevelopment levels.

A total of 488 wells were identified in and around the CVGB of which 467 have addresses or location descriptions. The majority of wells are identified as domestic wells, drilled and completed from the late 1940s through the early 1960s. Other than location data, the amount and quantity of data were sparse: 95 percent of the wells can be mapped, 31 percent of the wells have lithologic records, 17 percent of the wells have recorded pumping tests to help determine well capacity, 10 percent of the wells had at least one water quality sampling event, 8 percent of the wells have recorded water levels during the period from 1948 through 2014, and 5 percent of the wells have monthly pumping production data between 1960 and 1963.

ES.2.1 Geology and Hydrogeology

The City and the CVGB are located at the base of the north slopes of the Santa Monica Mountains. The Simi Hills and the Conejo Hills surround the basin to the east and west. The Conejo Valley watershed drainage area has its headwaters in these hills and mountains. Arroyo Conejo, an intermittent stream, is the main surface drainage for the Conejo Valley. The Arroyo Conejo flows north and joins the Arroyo Santa Rosa – in the Santa Rosa Valley, to the north of the Conejo Valley – to become Conejo Creek. The components of recharge to the CVGB include mountain front recharge, streambed recharge in Arroyo Conejo and its tributaries, and deep percolation of applied water (irrigation water for outdoor use).

The groundwater basin is an unconfined aquifer and groundwater flows generally follow surface topography from areas of high elevation to low elevation. Groundwater elevations in the basin range from 600 to 900 feet above means sea level (MSL) with elevations in the western portion of the basin ranging between 600 and 700 feet MSL and elevations in the eastern portion of the basin between 700 and 900 feet. Although there is not enough data to reproduce current groundwater elevation contours, the few current water level trends suggest that water levels are similar to predevelopment levels. Pumping production in the Conejo Valley Basin peaked between 1960 and 1963 before imported water became available.

ES.2.2 Well Capacity

The Conejo Volcanics are the most productive formation in the CVGB, but well yield can vary significantly, from a very poor production zone to a good production zone (greater than 200 gallons per minute [gpm]), depending on the fracture network and connectivity to other water bearing formations. French (1980) reported that the well capacity for 55 wells ranged from 17 to 1,080 gpm, with an average well capacity of 250 gpm.

ES.2.3 Operating Yield

One of the objectives of this Study is to develop, to the extent possible, an estimate of the operating or sustainable yield of the basin. Groundwater extractions in excess of natural recharge can result in overdraft of a groundwater basin, with attendant economic, environmental, and social impacts. Overdraft causes groundwater elevations to decrease and may require well owners and operators to lower pump bowls and, if the overdraft is severe, to drill and equip deeper wells, which tap into different aquifer zones. Safe yield is an average term and applies to the entire groundwater basin. Safe yield is typically estimated by examining the storage changes in a groundwater basin due to groundwater extractions. Significant pumping of the CVGB ended soon after imported water from the SWP became available to the valley in 1963; therefore the production and water level response data typically used to estimate operating yield are not available. Estimates of operating yield were made using four methods as outlined in Table ES-1 below.

Table ES-1 Summary of Operational Yield Estimates for the Conejo Valley Groundwater Basin

Method	Operational Yield (Acre-Feet/Year)	
	Low Range	High Range
Prior estimate (USGS) based on Conejo Creek Discharge	2,000	
Current estimate based on Conejo Creek Discharge	3,300	3,500
Replenishment of overdraft post 1963	2,000	3,000
Water budget analysis	8,000*	

* The water budget method for estimating the operating yield is based on a number of assumptions. Rates (evaporation, precipitation, etc.) are multiplied by relatively large areas, hence, a small change in a given rate, can result in a large differences in the operating yield.

Because of the uncertainty associated with the water budget method, the water budget operational yield estimate is not recommended to be used when determining the operational yield of the basin. For the purposes of this study, the operational safe yield of the CVGB is assumed to be 3,500 acre-feet per year (AFY).

ES.2.4 Regional Groundwater Quality

The primary water quality issue of concern in the CVGB is high total dissolved solid (TDS), which may make groundwater – in certain parts of the basin – unsuitable for potable use. In some cases where

TDS is exceptionally high, the water may be unsuitable for irrigation. High concentrations of dissolved iron, which can cause staining at concentrations above 0.3 mg/L and other trace elements may also be problematic. The east side of the basin is generally of poor quality, high in both TDS and dissolved iron. The west side of the basin is generally of higher water quality with lower concentrations of TDS and dissolved iron.

ES.2.5 Point Sources of Potential Groundwater Contamination

As part of this Study areas of potential groundwater contamination were investigated. If the CVGB is pumped for beneficial uses in the future, it is important that existing or new production wells not be sited in areas with potential groundwater contamination from point sources. Sites potentially impacting groundwater in the CVGB fall into the following categories: Leaking Underground Tank (LUST) Cleanup Sites, Permitted Underground Storage Tanks (UST) Sites, Waste Discharge Requirement (WDR) Cleanup Sites, and Other Cleanup Sites. One site – TFX Aviation (formerly Talley Corporation and later Telair International) – has impacted groundwater and there is a trichloroethene (TCE) plume emanating from this site on the west side of the CVGB. Active groundwater remediation is presently ongoing at this site and groundwater monitoring progress reports are submitted annually to the California Environmental Protection Agency.

ES.3 Groundwater and Reuse Supply Options

The CVGB is a valuable resource to expand and diversify the City's water supply options. Another resource is reclaimed or recycled water; the City's Hill Canyon Treatment Plant (HCTP) discharges an annual average of 8.5 million gallons per day (mgd) of recycled water into Conejo Creek, where a majority of the water is sold to Camrosa Water District (Camrosa) for reuse. To the east, the Tapia Water Reclamation Facility (WRF), operated by the partnership of LVMWD and Triunfo Sanitation District as a Joint Powers Authority (JPA), produces an annual average of 6.0 mgd of recycled water. Recycled water from the HCTP or purchased from JPA are potential sources of recycled water for reuse options.

Table ES-2 provides a summary of the planning horizons for potential groundwater and recycled water reuse options.

Table ES-2 Planning Horizons for Reuse and Groundwater Options

Options	Implementation Period	Applications
Near-Term	Within 5 years	Non-potable and potable groundwater
Mid-Term	Within 10 years	Non-potable and potable groundwater and non-potable reuse
Long-Term	Within 15 to 20 years	Potable groundwater and indirect/direct potable reuse

ES.3.1 Groundwater Options (Near-Term and Mid-Term)

Groundwater options would consist of installing wells and pumping higher-quality groundwater.

- **Groundwater Phase 1**. Phase 1 wells are proposed to be located near parks and schools and used initially for non-potable uses (e.g., landscape irrigation). Los Robles Golf Course well would be restarted with partial RO treatment. Well production and water quality would be monitored for 12 months.

- **Groundwater Phase 2.** Once the water quality from Groundwater Phase 1 is monitored, if it is found to be of consistently good quality meeting all drinking water standards, then the well can continue to be used to meet non-potable demands and also be used to augment the local potable distribution system with the addition of disinfection.
- **Groundwater Phase 3.** Additional extraction wells would be installed in the similar higher-quality portions of the basin with combined capacities to extract up to the safe yield. At this time, however, it is unknown if the safe yield (3,500 AFY) can be extracted only from the higher water quality portions of the basin. Phase 3 groundwater options are considered part of the mid-term options as an alternative to developing a brackish groundwater extraction and treatment system.

Table ES-3 provides a summary of the potential yields for Groundwater Phases 1, 2, and 3 for the service areas noted.

Table ES-3 Summary of Groundwater Demands for Near-Term (Phases 1 and 2) and Mid-Term (Phase 3)

	Near-Term			Mid-Term	
Area/Well	Groundwater Phase 1 (non-potable) (AFY)	Groundwater Phase 2 (potable) (AFY)	Groundwater Phase 1 & 2 (non-potable and potable) (AFY)	Groundwater Phase 3 (potable) (AFY)	Groundwater Total (AFY)
Northern City Service Area					
TO Community	100	110	210	0	210
Spring Meadow	140	70	210	0	210
Northwood	0	210	210	0	210
CLU	0	210	210	0	210
Two additional potable wells	0	0	0	420	420
Subtotal	240	600	840	420	1,260
Central City Service Area					
Newbury Gateway	0	210	210	0	210
Additional potable well	0	210	210	0	210
Two additional potable wells	0	0	0	420	420
Subtotal	0	420	420	420	840
Cal Am Service Area					
Borchard Park	60	150	210	0	210
Pepper Tree Park	0	210	210	0	210
DV Community	0	210	210	0	210
Del Prado Playfield	0	210	210	0	210
Two additional potable wells	0	0	0	420	420
Subtotal	60	780	840	420	1,260
Los Robles Golf Course	180	0	210	0	210

ES.3.2 Mid-Term Options

Mid-term options would both maximize the safe yield of the CVGB for potable use as well as increase non-potable reuse of recycled water in the City.

- **Brackish Groundwater Desalination Facility**. As an alternative to the Groundwater Phase 3 option, where additional wells would be installed in higher water quality portions of the basin, the brackish groundwater treatment option would extract and treat groundwater from parts of the basin with poorer water quality up to the safe yield of the CVGB.

- **Additional Non-Potable Reuse**. Purchase of tertiary recycled water from LVMWD is a potential option for the mid-term.

ES.3.3 Long-Term Options

Long-term options focus on indirect or direct potable reuse, assuming that the CVGB safe yield has been maximized with the projects described for the near-term and mid-term and that additional non-potable reuse demands have been met with additional recycled water supply from LVMWD.

- **Option 1 –** Dual Brackish Groundwater/Indirect Potable Reuse Treatment Facility. This option would involve the expansion of the mid-term brackish groundwater treatment facility to treat both brackish groundwater for potable use and tertiary recycled water for indirect potable reuse via injection wells in the CVGB. After further evaluation, it is recommended that Option 1 not be pursued.

- **Option 2 –** Direct Potable Reuse/Reservoir Augmentation. Because the potential for a successful IPR project is uncertain, DPR or Reservoir Augmentation (RA) is considered as a long-term option for potable water supply. Repurposing HCTP for DPR would have a significant impact on the amount that Camrosa can divert from the creek. Two scenarios were evaluated for the low (Option 2a) and high (Option 2b) quantity of recycled water that may be available from HCTP for DPR/RA.

- **Option 3 –** Camrosa GWR. This option would involve participating with Camrosa in their potential GWR project in the Santa Rosa Basin.

ES.3.4 Conceptual Cost Estimates

Detailed capital and O&M cost estimates are provided in Appendix C. Table ES-4 provides a summary of the conceptual capital and O&M costs for the groundwater options. Note that while Groundwater Phase 3 costs are included below it is technically a mid-term option.

Table ES-5 provides a summary of the conceptual capital and O&M costs for the mid-term and long-term options. Note that Long Term Option 1 was not carried forward based on evaluation in this Study.

Table ES-4 Near-Term and Mid-Term Groundwater Conceptual Cost Estimates

Service Areas and Proposed Wells	Near-Term				Mid-Term	
	Groundwater Phase 1		Groundwater Phase 2		Groundwater Phase 3	
	Capital Costs ($M)	O&M Costs ($)	Capital Costs ($M)	O&M Costs ($)	Capital Costs ($M)	O&M Costs ($)
Northern City Service Area						
TO Community	$2.22M	$18,000	$0.71M	$32,000	-	-
Spring Meadow	-	-	$2.58M	$41,000	-	-
Northwood	$2.17M	$21,000	$0.51M	$38,000	-	-
CLU	-	-	$2.51M	$52,000	-	-
Two additional potable wells	-	-	-	-	$4.98M	$79,000
Central City Service Area						
Newbury Gateway	-	-	$2.51M	$41,000	-	-
Additional potable well	-	-	$2.82M	$47,000	-	-
Two additional potable wells	-	-	-	-	$4.98M	$79,000
Cal Am Service Area						
Borchard Park	$2.22M	$15,000	$1.01M	$44,000	-	-
Pepper Tree Park	-	-	$2.48M	$52,000	-	-
DV Community	-	-	$2.48M	$52,000	-	-
Del Prado Playfield	-	-	$2.48M	$52,000	-	-
Two additional potable wells	-	-	-	-	$4.98M	$79,500
Los Robles Golf Course	$1.9M	$143,000	-	-	-	-
Total	**$7.95M**	**$197,000**	**$20.08M**	**$451,000**	**$14.94M**	**$237,500**

Table ES-5 Mid-Term Conceptual Cost Estimates

	Capital Costs ($M)	O&M Costs ($M)
Mid-Term Options		
Groundwater Phase 3[1]	$14.94M	$0.24M
Brackish Groundwater Desalination	$14.4M	$0.39M
Additional NPR	Thousand Oaks Blvd Extension: $5.14M[2] Lake Sherwood Pipeline Future Customers/Westlake Conversions: $1.89M[2] Conejo Creek Park Extension: $5.5M[2]	Purchase cost of LVMWD recycled water is estimated at $1,300/AF.
Long-Term Options		
Option 2a	$57.7M	$3.18M
Option 2b	$116.1M	$7.71M
Option 3	$7.5M	Minimal

1) From Table ES-4.
2) RWMP 2014 Update for JPA and Calluegas

ES.4 Alternative Analysis

A total of nine alternatives were defined for this Study (see Table ES-6). The alternatives were assembled from the near-, mid- and long-term project options. The alternatives fall into five categories as follows:

- **No Action Alternative –** Represents the status quo of relying exclusively on imported water.
- **Exploratory Alternative –** Only includes irrigation wells in the near-term to gauge the water yield and water quality in the lower TDS areas of the groundwater basin.
- **Low Unit Cost Alternatives –** Maximizes groundwater production for potable use with disinfection, in the lower total dissolved solids (TDS) areas of the groundwater basin. Expanding non-potable reuse in the eastern part of Thousand Oaks is an option.
- **Higher Reliability Alternatives –** Maximizes reliability and certainty of groundwater production by spreading wells throughout the basin through brackish groundwater desalination. Expanding non-potable reuse in the eastern part of Thousand Oaks is an option.
- **Full Resource Utilization Alternatives –** Builds on the Higher Reliability Alternatives and also includes potable reuse in the long-term to further reduce the City's reliance on imported water. Potable reuse for these alternatives ranges from groundwater replenishment in Camrosa with no additional wastewater treatment to DPR/RA options with advanced treatment.

Each of the nine alternatives was scored using the metrics for each sub-objective defined in Table ES-7. The scores for each alternative for each sub-objective are summarized in Table ES-8. These metrics, along with the relative weights of importance were input into the decision software CDP. All of the metrics were then standardized in order to facilitate ranking of alternatives.

Table ES-6 Summary of Project Alternatives

No.	Name	Description	Groundwater and Reclaimed Water Options: Near-Term (1-5 years)	Groundwater and Reclaimed Water Options: Mid-Term (5-10 years)	Groundwater and Reclaimed Water Options: Long-Term (10-20 years)	Total Local Supply (AFY)
1	No Action	No new local supplies, 100% dependent on imported water.	None	None	None	0
2	Exploratory	Initial irrigation wells, no treatment except for Golf Course well.	Phase 1 GW (480 AFY)	None	None	480
3	Low Unit Cost	Irrigation and potable wells with only minimum treatment (chloramination).	Phases 1 and 2 GW (2,280 AFY)	Phase 3 GW (1,260 AFY)	None	3,540
4	Low Unit Cost Plus	Irrigation and potable wells with only minimum treatment (chlorination), plus non-potable reuse expansion.	Phases 1 and 2 GW (2,280 AFY)	Phase 3 GW (1,260 AFY) + NPR (615 AFY)	None	4,155
5	Higher Reliability	Irrigation and potable wells with minimum treatment and brackish desalination.	Phases 1 and 2 GW (2,280 AFY)	Brackish GW (650 AFY)	None	2,930
6	Higher Reliability Plus	Irrigation and potable wells with minimum treatment and brackish desalination, plus non-potable reuse expansion.	Phases 1 and 2 GW (2,280 AFY)	Brackish GW (650 AFY) + NPR (615 AFY)	None	3,545
7	Full Resource Utilization-A	Irrigation and potable wells with minimum treatment and brackish desalination, plus non-potable reuse expansion and groundwater recharge in Camrosa.	Phases 1 and 2 GW (2,280 AFY)	Brackish GW (650 AFY) + NPR (615 AFY)	GW Recharge (200 AFY)	3,745
8	Full Resource Utilization-B	Irrigation and potable wells with minimum treatment and brackish desalination, plus non-potable reuse expansion and smaller-sized direct potable reuse.	Phases 1 and 2 GW (2,280 AFY)	Brackish GW (650 AFY) + NPR (615 AFY)	DPR/RA small (2,600 AFY)	6,145
9	Full Resource Utilization-C	Irrigation and potable wells with minimum treatment and brackish desalination, plus non-potable reuse expansion and larger-sized direct potable reuse.	Phases 1 and 2 GW (2,280 AFY)	Brackish GW (650 AFY) + NPR (615 AFY)	DPR/RA large (7,200 AFY)	10,745

Table ES-7 Objectives, Sub-Objectives, Weightings and Metrics

Objective	Weight	Sub-Objective	Sub Weight	Metric
1. Water Reliability	30	New Local Supply	60	Percent of local supply
		Certainty of Local Water Supply	40	Certainty score*
2. Cost-Effectiveness	30	Lifecycle Cost	50	Present value cost ($M)
		Capital Cost	40	Capital cost ($M)
		Potential for Outside Funding	10	Funding score*
3. Implementation Ease	15	Institutional Complexity	40	Institutional score*
		Permitting Complexity	30	Permitting score*
		Customer Acceptance	30	Acceptance score*
4. Operational Ease	10	Operational Complexity	100	Operational score*
5. Environmental	10	Impact to Creek's Ecosystem	55	Creek score*
		Impact to HCTP	35	HCTP score*
		Carbon footprint	10	Marginal Energy (kWh/acre-foot)
6. Water Quality	5	Water Hardness	100	Hardness score*

* Represents a standardized qualitative score from 1 to 5, where 1 = poor performance and 5 = superior performance.

Table ES-8 Ranking Sensitivity of Alternatives

Ranking Sensitivity	Total Decision Score[1]								
	Alt. 1 No Action	Alt. 2 Exploratory	Alt. 3 Low Unit Cost	Alt. 4 Low Unit Cost Plus	Alt. 5 Higher Reliability	Alt. 6 Higher Reliability Plus	Alt. 7 Full Res. Utilization A	Alt. 8 Full Res. Utilization B	Alt. 9 Full Res. Utilization C
Preferred Weights[2]	0.474	0.561	0.619	0.620	0.627	0.616	0.609	0.489	0.547
High Cost Weight[3]	0.445	0.510	0.662	0.653	0.640	0.617	0.608	0.479	0.519
High Reliability Weight[4]	0.341	0.509	0.552	0.571	0.593	0.595	0.588	0.545	0.657
Implement-ation Issues Resolved[5]	0.474	0.561	0.619	0.620	0.627	0.616	0.609	0.584	0.641
Average Score[6]	0.434	0.555	0.613	0.616	0.622	0.611	0.604	0.524	0.591

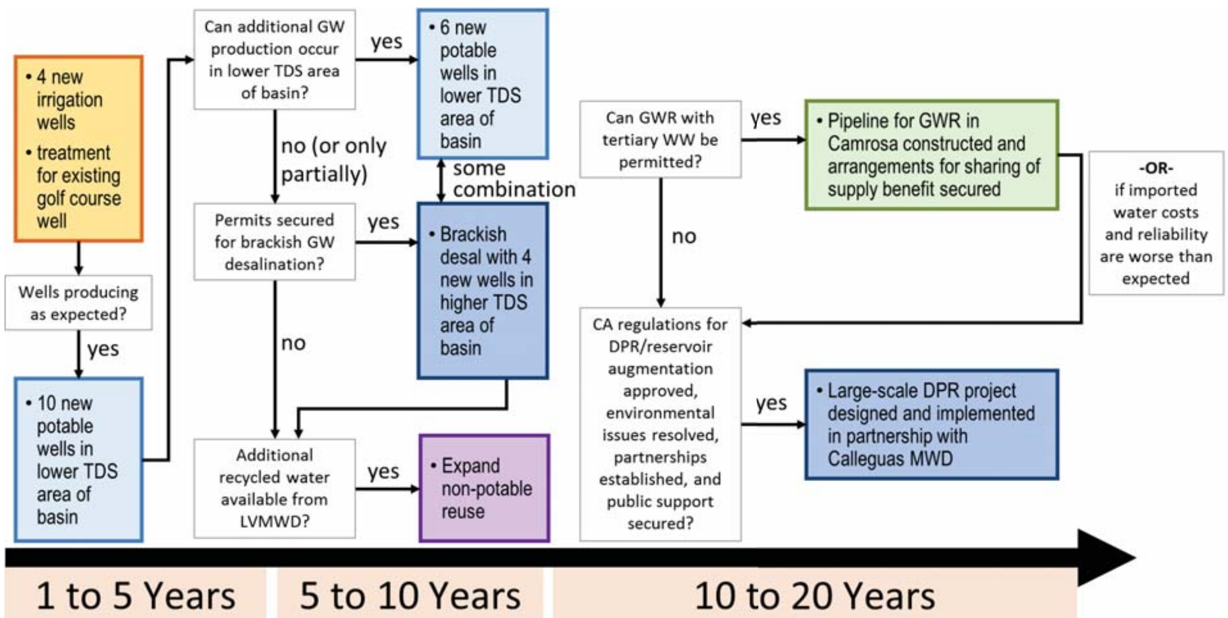
Notes:

1) Total decision scores; the higher the score the better the alternative ranks.
2) See Table ES-7.
3) Objective 2 Cost-Effectiveness is weighted at 50% and the other five objectives are all weighted at 10%.
4) Objective 1 Water Reliability is weighted at 50% and the other five objectives are all weighted at 10%.
5) Implementation and operational issues (scores) resolved for alternatives with DPR/RA.
6) Average of four decision scores.

Based on the average decision score shown in Table ES-8, the three top-scoring alternatives are: Alternatives 5, 4, and 3 in that order. Because the future is uncertain with regard to effectiveness and quality of pumping from the basin, regulations and public acceptance regarding DPR/RA, and other institutional arrangements for implementation of local projects, an adaptive management strategy was developed.

The adaptive management strategy for implementation (see Figure ES-1) starts with the initial implementation of irrigation wells in the lower TDS area of the groundwater basin. If production and water quality levels are as expected, then additional wells with disinfection would be constructed for potable use within the next five years. If groundwater production can be sustained in this same lower TDS area of the groundwater basin, then additional potable wells can be constructed within the 5-10 year planning horizon. However, if groundwater analysis shows that spreading wells throughout the basin improves sustainability of the basin then brackish groundwater desalination along with wells in the higher TDS area of the basin would need to be implemented instead. For the longer-term planning horizon (10 to 20 years), either groundwater recharge in Camrosa or DPR/RA could be implemented.

Figure ES-1 Adaptive Management Strategy



ES.5 Next Steps

The following are key next steps to advance the findings of this Study and develop local water supplies for the City:

- Under Sustainable Groundwater Management Act (SGMA), determine the designated agency or agencies to be the Groundwater Sustainability Agency (GSA). Form the CVGB Users Group and start developing Groundwater Sustainability Plan (GSP) with input/support from relevant stakeholders.
- Identify and make changes to the CTO groundwater ordinance and/or agreement with the County of Ventura on well permitting, inspection, and recordkeeping responsibilities.
- Apply for outside funding opportunities, especially the SGWP Grant Program, funded by the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1).
- Continue developing planning documents and move into pre-design for Groundwater Phase 1 (three new wells and Los Robles Golf Course partial RO treatment facility).

- Identify the appropriate CEQA compliance approach for each Groundwater Phase and prepare and adopt environmental documentation for each project or group of similar projects implemented at the same time (e.g. multiple wells in the same phase).

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