APPENDIX 4.4

CECorps Design Report for Walnut Avenue

October 2016

APPENDIX 4.4 WALNUT AVENUE DESIGN REPORT

This addendum summarizes the results of the design report prepared by Community Engineering Corps team from the AWWA California/Nevada Section dated 10/3/2016 as well as additions to the original report prepared by Peter Waugh, consulting engineer, and the Salinas Valley Water and Wastewater Planning Project Team. Table 1 summarizes the results of the combined work with the intent of providing important cost information for the Walnut Avenue property owner and residents.

Table 1 Summary of Capital Construction and Operation/Maintenance Costs for Walnut Avenue

	Alt 1: Consolidation	Alt 2: New Well
Capital Cost	$870,000	$480,000
Annual O&M Cost	2,500[1]	$3,900
Net Present Value[2]	$914,000	$548,000
Estimated average monthly cost/home	$35[3]	$54

[1] The operation and maintenance cost was estimated to be the same as the cost of water service to the residents. This was calculated by multiplying the estimated annual water cost per home by the number of homes.
[2] Net Present Value calculations were updated by the Project Team to be consistent with all other CECorps team reports and updates.
[3] Based upon five residents using 100 gallons per person per day and current City of Greenfield water rate schedule effective as of August 1, 2016. Assumes 5/8" water meter charge.

Summary of CECorps Design Report

Walnut Avenue Water System #2 is located about a half mile west of the City of Greenfield on Walnut Street between 13th and 14th Street, in the central Salinas Valley. The community consists of six dwellings (one house and five mobile homes) with an estimated population of 20 – 30 residents, including many children. Walnut Ave Water System #2 consists of an active well and storage tank that provides unchlorinated potable water. The water system has levels of nitrate more than three times the maximum contaminant level (MCL). 1,2,3-TCP is also present at levels higher than the recently adopted MCL. A number of alternative solutions were considered for bringing the water supply into compliance with applicable water quality standards: 1) consolidation with the City of Greenfield, 2) drill a new supply well, and 3) a variety of different treatment options. The preferred alternative is consolidation with the City of Greenfield water system. A summary of costs for the consolidation and new well alternatives is presented in Table 1 above.

Additions/Revisions to the Original Design Report

a) Standardized Water Demand

A standard method for calculating water demand has been developed for use in the water supply system analysis for each community. This method is summarized in Appendix 4.14 Engineer's Memorandum. Table 2 shows the water demand for each alternative in Walnut Avenue.

Table 2 Water Demand for Walnut Avenue Alternative Water System Improvements

Alternative	Design Water Demand[1,2, 3]
Alternative 1 – Consolidation	ADD = 3,000 gpd, MDD = 6,750 gpd, PHD = 422 gph
Alternative 2 – New supply well	18 gpm

Notes:
[1] ADD = average daily demand, MDD = maximum daily demand, PHD = peak hour demand, gpd = gallons per day, gph = gallons per hour, gpm = gallons per minute
[2] Note that consolidation water demand may be modified by the consolidation partner if they have historic water demand data to support using a different value.
[3] This assumes that there are 30 residents in 6 homes.

b) Net Present Value and Monthly Cost Per Household

The economic evaluation for Walnut Avenue was updated to include net present value and projected monthly cost per household using the Johnson Road CECorps team's methodology. Monthly costs per household for Walnut Avenue were based on an estimate of six people living in each house. Page 20 of Appendix 4.2 Johnson Road CECorps Design Report describes this methodology:

> "The economic evaluation also includes a comparison of the Net Present Value (NPV) of each alternative, which assumes an O&M inflation rate of 1.9% and annual discount rate of 3.1% over a 20 year term. The costs presented in this evaluation are in 2016 dollars, and the backup for these cost estimates can be found in Appendix F... To evaluate each alternative's cost impact on the community members, the estimated annual O&M costs were divided to show the amount that would be paid by each household on a monthly basis."

Walnut Ave Water System #2
Nitrate Mitigation Study

Technical Memorandum

October 3, 2016

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Introduction

Walnut Ave Water System #2 (System) is served by one groundwater well which serves 6 dwellings for domestic use. The System is located just west of the City of Greenfield, on Walnut Street, between Thirteenth and Fourteenth Street. Figure 1 shows Walnut Ave Water System #2's location in relation to the City of Greenfield, as denoted by the yellow dashed boundary.

Figure 1. Aerial map of Walnut Ave Water System #2, Greenfield, Monterey County, California

The System Well (Well) has nitrate concentrations above the State of California maximum contaminant level (MCL). The Well also has historical bacterial contamination; the source of bacterial contamination is unknown. Please note that as of July 16, 2015, the State of California uses a nitrate MCL consistent with the United States Environmental Protection Agency (EPA) MCL of 10 mg/L of nitrate as nitrogen (NO_3-N). Prior to July 16, 2015 the MCL was 45 mg/L of nitrate as nitrate (NO_3). This is not a change in the regulatory limit, rather a change in notation.

Nitrate concentrations above the MCL pose an acute health risk; the major health concern of nitrate exposure through drinking water is the risk of methemoglobinemia, or "blue baby syndrome." Due to the nature of the infant digestive system, nitrate is reduced to nitrite which can render hemoglobin unable to carry oxygen (SWRCB, 2010).[1]

[1] State Water Resources Control Board, Division of Water Quality, GAMA Program (2010). "Groundwater Information Sheet: Nitrate/Nitrite." Accessed Sept. 3, 2014, 2010 via <http://www.swrcb.ca.gov/gama/docs/coc_nitrate.pdf>.

In addition to drinking water impairment, the System also faces wastewater management challenges. The System contains two active septic systems with one system experiencing periodic ponding in the leach field due to overloading. The recommendations for the wastewater system are in a separate document titled “Wastewater Evaluation”.

This report describes the drinking water system; summarizes the historical water quality of the System’s well; describes the nitrate-related regulatory drivers; provides an overview of relevant nitrate non-treatment and treatment solutions and costs.

Drinking Water and Wastewater System Description

The Walnut Ave Water System #2 consists of an active well and storage tank along the northwest edge of the System property. The well provides unchlorinated potable water for 20 to 30 residents including approximately 18 children. Water for crop irrigation is purchased separately from local irrigation canals. Walnut Ave Water System #2 also contains an inactive well, and two septic systems with leach fields located on opposite sides of the property.

Figure 2 shows a map of the locations of this infrastructure. One note of importance is the live animal enclosure between the destroyed well and the western-most septic system. In the State of California, wells are mandated to be at least 100 feet away from septic systems, and 50 feet away from live animal enclosures.

Figure 2. Aerial map of water and wastewater infrastructure at Walnut Ave Water System #2

Table 1 summarizes the Well's characteristics. The System is located in the Salinas Valley Basin and Forebay Aquifer Subbasin (Basin Number 3-4.04). In this subbasin, the primary water-drawing units include a 180-foot aquifer, 400-foot aquifer, and 900-foot aquifer. The Well draws water from the 180-foot aquifer, which has an average thickness of 100 feet. This aquifer has a known history of high nitrate concentrations, stemming from extensive non-point source nitrate contamination from agricultural production in the Salinas Valley. The 900-foot aquifer, which is an attractive possibility to avoid nitrate contamination when considering the alternative of drilling a new well, has experienced little development except near the coast, where more shallow aquifers experience seawater intrusion.[2]

Table 1. Walnut Ave Water System #2 Well characteristics

Sanitary Seal Depth (ft)	Screened Interval (ft)	Total Depth (ft)	Well Capacity (gpm)	Year Constructed
20	165 to 248	252	16	1974

[2] California Department of Water Resources, California's Groundwater: Bulletin 118 (2003). "Salinas Valley Groundwater Basin, Forebay Aquifer Subbasin." Accessed June 15, 2016, via <http://www.water.ca.gov/groundwater/bulletin118/basindescriptions/3-04.04.pdf>.

Historical Water Quality

Complete water quality results were obtained in May 2016 from Monterey Bay Analytical Services. Results for analytes of interest and associated MCLs and Secondary Maximum Contaminant Levels (SMCL) are included in Table 2. Nitrate and Total Coliform bacteria are both present in the Well Head at unacceptable concentrations. 1,2,3-trichloropropane (TCP) is also an analyte of interest because, although not currently regulated, it is expected that the State of California will begin regulation in the near future. The Well's concentration of 0.023 µg/L TCP is above the current Notification Level (NL) of 0.005 µg/L.

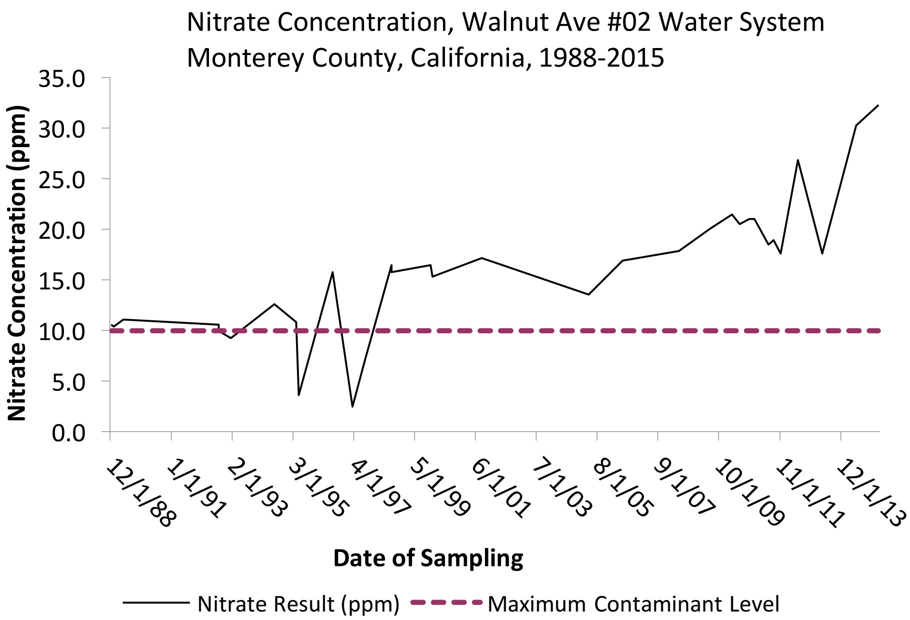
E. Coli and Total Coliform bacteria were also sampled at three additional locations (the Storage Tank, Owner's Home, and the Green Trailer). At all of these locations, *E. Coli* and Total Coliform bacteria were <1 MPN/100mL; only at the Well Head was there bacterial contamination. This could indicate that the well sample is not representative of the well water quality and the tap should be replaced with a non-threaded, downturned, stainless steel tap.

Table 2. 2016 Water quality data for analytes of interest, taken from the well head

Analyte	Unit	Result	MCL	SMCL
		Microbial		
Total Coliform (Quantitray)	MPN/100mL	816		
E. Coli (Quantitray)	MPN/100mL	<1		
		Inorganic		
Chloride	mg/L	153		250
Iron	µg/L	37		300
Manganese, Total	µg/L	Not Detected		50
Nitrate as NO_3	mg/L	160	45	
Nitrate as NO_3-N	mg/L	36.2	10	
Nitrite as NO_2-N	mg/L	0.3	1.0	
Perchlorate	µg/L	2.7	6.0	
Sulfate	mg/L	241		250
Conductivity at 25C	µS/cm	1,530		1,600
Total Dissolved Solids	mg/L	997		500
		Organic		
TCP Low Level	µg/L	0.023	0.005 NL	

Historical trends in nitrate levels, obtained from historical sampling reports, are further illustrated in Figure 3. Shown in the figure, nitrate concentrations have been above the MCL since 1988 and are increasing with time. Current concentrations are now over three times the MCL.

Figure 3. Historical trends in nitrate levels



Time series sampling for nitrate at startup, 5 min, 15 min, 30 min, 1 hour, and 2 hours was also completed at the Well Head. Over the course of two hours, nitrate levels did not change significantly with an average nitrate concentration of 36.2 mg/L NO_3-N and standard deviation of 0.3 mg/L NO_3-N. A change in nitrate concentrations over time could be indicative of different depths in the well receiving water with varying concentrations of nitrate. The consistent nitrate concentration during the time series sampling is an indicator that well modification is unlikely to be a viable solution.

Regulatory Drivers and Project Goals

Since nitrate poses an acute health risk, DDW generally requires that treatment provides concentrations delivered to the distribution system with a 20% margin of safety, meaning less than 8 mg/L as N. As such, the water quality goal for this project is <8 mg/L as N.

With respect to water production, the goal is to meet the existing water demands. Due to the drought, the residents of the System have limited the use of water for non-potable services including laundry. It would be ideal to provide more water than is currently produced by the well.

Overview of Nitrate Mitigation Alternatives

Both non-treatment and treatment solutions can be considered for nitrate mitigation in groundwater supplies (Jensen et al., 2012[3], Seidel et al., 2011[4]). Non-treatment options include source abandonment,

[3] Jensen V., Darby, J, Seidel C., Gorman C. "Drinking Water Treatment for Nitrate- Technical Report 6; Addressing Nitrate in California's Drinking Water." California State Water Resources Control Board, 2012.

source modification, the development of alternative sources, and blending. The feasibility of non-treatment options can be limited by various factors including location, budget, source availability, and variability of water quality (i.e., fluctuations in nitrate levels), resulting in the need for treatment to remove or reduce nitrate. Current treatment methods include strong base anion exchange (SBA-IX), reverse osmosis (RO), electrodialysis / electrodialysis reversal (ED/EDR), and biological denitrification (BD). The following sections describe each of these potential non-treatment and treatment methods and their applicability for Walnut Ave Water System #2.

Non-Treatment Alternatives

City of Greenfield Pipeline Extension

One option to serve the community is pipeline extension and connection to the City of Greenfield's system. The existing well would be disconnected from the domestic system and either destroyed or put on standby for use in agriculture.

On May 10, 2016, staff from Environmental Coalition for Water Justice, EJCW, (Heather Lukacs, Vicente Lara, and volunteer Charis Thompson) and volunteers from CEC (Tarrah Henrie, Sarah Plummer and Erin McCauley) met with Community Development staff from the City of Greenfield (Mic Steinmann, Community Services Director, and Arturo Felix, Public Works Utilities Manager.) Karen McBride from the Rural Community Assistance Corporation participated via phone. At this meeting, the City staff confirmed the closest points for tie in to City infrastructure. The City has adequate water supply to accommodate new customers. Their water system is in compliance with all federal and state regulations. For more detailed water quality information please refer to the 2015 Annual Water Quality Report, which is included in Appendix A.

Source Modification

Modification of impacted source wells by limiting screened intervals to regions of better water quality can in some cases allow for withdrawal of water with lower nitrate levels. Down hole remediation requires characterization of the water quality profile to determine screening depth ranges with potentially better quality water. Specialized monitoring equipment and techniques are available that can be used without removing pumps. With water profile characterization, existing wells can potentially be selectively screened using a packer/plug to limit withdrawal from unwanted regions.

In most applications, the primary drawback of this alternative is the associated loss of production capacity. In this location, source modification is unlikely to be successful because of the nitrate present in the shallow aquifer, where the well is completed.

Blending

The dilution of a nitrate impacted source with an alternate low nitrate concentration source – blending – can, in certain cases, be a cost effective option to produce compliant potable water. Blending can be applied without or with treatment. Blending is sometimes applied to produce compliance potable water,

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[4] Seidel, C., Gorman C., Darby, J., Jensen, V. "An Assessment of the State of Nitrate Treatment Alternatives." American Water Works Association, http://www.awwa.org/Portals/0/files/resources/resource%20dev%20groups/tech%20and%20educ%20program/documents/TECNitrateReportFinalJan2012.pdf, 2011.

but relies on the availability of another low nitrate concentration source and the consistency of nitrate levels in both supplies to avoid MCL violations. Since an alternate supply does not exist to dilute the nitrate concentrations to below the MCL, this alternative is not considered further.

Development of Alternative Sources

Developing a new water source could be considered to replace the production from the existing well. In this case, new well of equal or greater capacity would need to be drilled in an area that can easily be piped to the existing homes. Given the presence of wells with low nitrate in other parts of the City of Greenfield system, this is a viable alternative that will be examined further.

Selection of a new well site location is impacted by required sanitary separations from existing water and wastewater infrastructure as well as livestock or animal enclosures. Detailed minimum horizontal separation distances between the new well and known or potential contamination sources are given in Table 3. Using these minimum separation distances, Figure 4 illustrates potential locations for a new well based on required sanitary separations highlighted in red. All areas not highlighted in red are potential locations for a new well and would require further evaluation.

Table 3. Required sanitary separation for new well[5]

Potential Pollution or Contamination Source	Minimum Horizontal Separation Distance Between Well and Known or Potential Source
Any sewer (sanitary, industrial, or storm; main or lateral)	50 feet (15.24 m)
Watertight septic tank or subsurface sewage leaching field	100 feet (30.48 m)
Cesspool or seepage pit	150 feet (45.72 m)
Animal or fowl enclosure	100 feet (45.72 m)

5 http://www.water.ca.gov/groundwater/well_info_and_other/california_well_standards/wws/wws_combined_sec8.html

Figure 4. Possible locations of a new well for Walnut Ave Water System #2

Treatment Alternatives

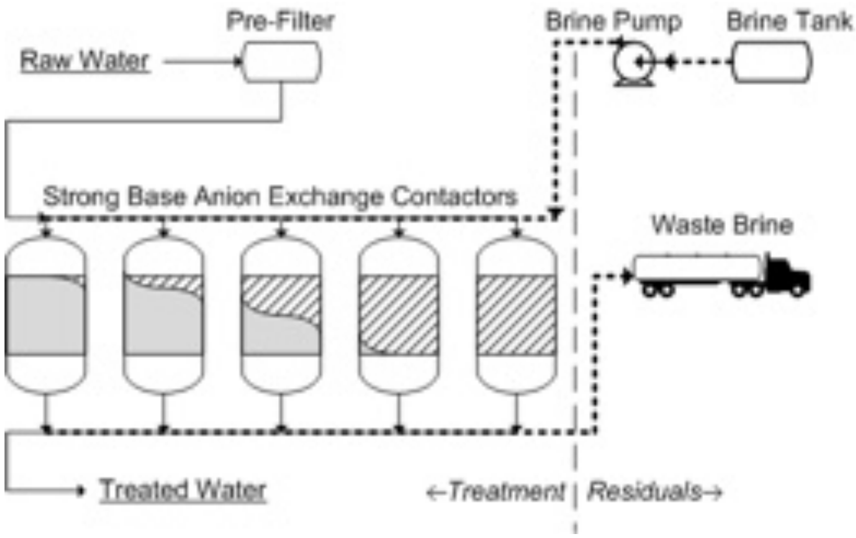
The nitrate treatment alternatives of strong base anion exchange, reverse osmosis, and electrodialysis / electrodialysis reversal all transfer nitrate ions from water to a concentrated waste stream that requires disposal. USEPA lists these three processes as accepted potable water treatment methods for nitrate removal (USEPA, 2010[6]). In contrast, through biological denitrification, nitrate is converted to nitrogen gas, rather than displaced to a concentrated waste stream that requires disposal.

Strong Base Anion Exchange (SBA-IX)

Strong base anion exchange (SBA-IX) treatment is the most common form of active nitrate treatment in the United States and has been implemented throughout California. SBA-IX is also a common treatment method for perchlorate, arsenic, and uranium and is an emerging technology for hexavalent chromium. As shown in Figure 5, raw water is typically pre-filtered to remove any particulate that may be present. SBA-IX resin is housed in contactors and removes the contaminant of concern. Once the resin capacity is exhausted, it is regenerated with a brine solution, typically sodium chloride (NaCl), to restore the exchange capacity.

[6] U.S. EPA (United States Environmental Protection Agency). Basic Information about Nitrate in Drinking Water, http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm, 2010.

Figure 5. Typical SBA-IX treatment process schematic.



The disposal of the regenerant brine is often the greatest challenge to implementing SBA-IX treatment systems. Disposal options depend on the availability of high strength liquid waste discharge (e.g., > 25 g/L chloride) and metals disposal limits (e.g., total and/or Cr(VI)). In the absence of a brine line for ocean discharge or acceptable local wastewater discharge, waste brine is typically trucked off-site for disposal at an appropriately licensed facility.

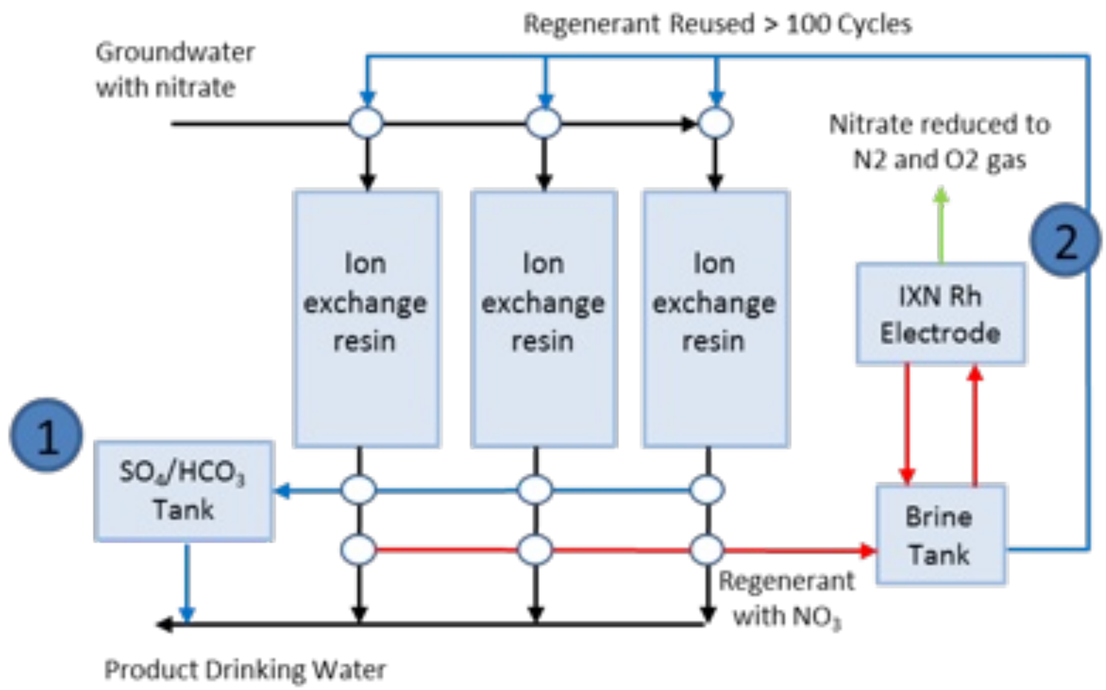
For nitrate treatment at the Walnut Ave Water System #2 well site, approximately 150 – 200 bed volumes of treatment can be expected between regenerations, as modeled by SBA-IX equipment provider IonexSG. This value is governed by the nitrate and sulfate concentrations in the raw water.

Advances in SBA-IX Treatment

Several recent advances have been made in SBA-IX treatment, but perhaps the most striking is the near zero liquid waste process patented by IonexSG. The advances developed by IonexSG focus on brine minimization and are accomplished via a segmented regeneration that allows for two processes: sulfate return and brine reuse. The reuse of SBA-IX regenerant brine has always been limited by sulfate and nitrate accumulation. The segmented regeneration approach allows for the segregation of the sulfate and bicarbonate from the brine. Because this portion of the brine almost exclusively contains sulfate, bicarbonate and sodium chloride, it can safely be metered back to the treated water in the sulfate return process, and, in fact, has secondary benefits of reducing the corrosivity of the treated water. The sulfate return process has conditional approval from the DDW for potable use in California and the first full-scale system is now operational.

Brine reuse is accomplished by destroying the accumulated nitrate in the brine via an electrolytic nitrate reduction cell which reduces the nitrate to nitrogen gas. These processes enable the recovery and reuse of the remaining brine fraction as depicted in Figure 6. Since the primary operational cost for SBA-IX is the disposal of regenerant brine, these process improvements can drastically reduce the lifecycle cost of the SBA-IX process for nitrate removal. The economic benefits of sulfate return are applicable to all system sizes; however, brine reuse is not typically considered for systems treating less than 500 gpm given the added complexities and relatively smaller brine disposal volumes for smaller systems.

Figure 6. Schematic of the IonexSG SBA-IX process.



There are two major concerns with implementing SBA-IX at Walnut Ave Water System #2. The chloride concentration was 153 mg/L in the most recent sample collected. This is a high chloride concentration. With SBA-IX treatment the water is expected to have a 300 mg/L concentration during routine operation, and a concentration of about 450 mg/L after regeneration. Section 64449, of the California Code of Regulations Title 22 contains the Secondary Maximum Contaminant Levels (SMCLs). SMCLs are established to protect the aesthetics of the water. Chloride has a recommended SMCL of 250 mg/L, with an upper limit of 500 mg/L.

The increase in chloride also creates the potential for corrosion of lead. One indication of water corrosivity is to look at the Chloride to Sulfate Mass Ratio (CSMR). With SBA-IX treatment the CSMR would be about 1.24. A pilot study would be needed to determine if the CSMR creates corrosion.

The last issue with implementing SBA-IX treatment is that it does not remove 1,2,3-Trichloropropane (TCP), which was found during the most recent water quality sampling. TCP is the next compound that is planned for regulation in California. The most common treatment method for TCP is granular activated carbon.

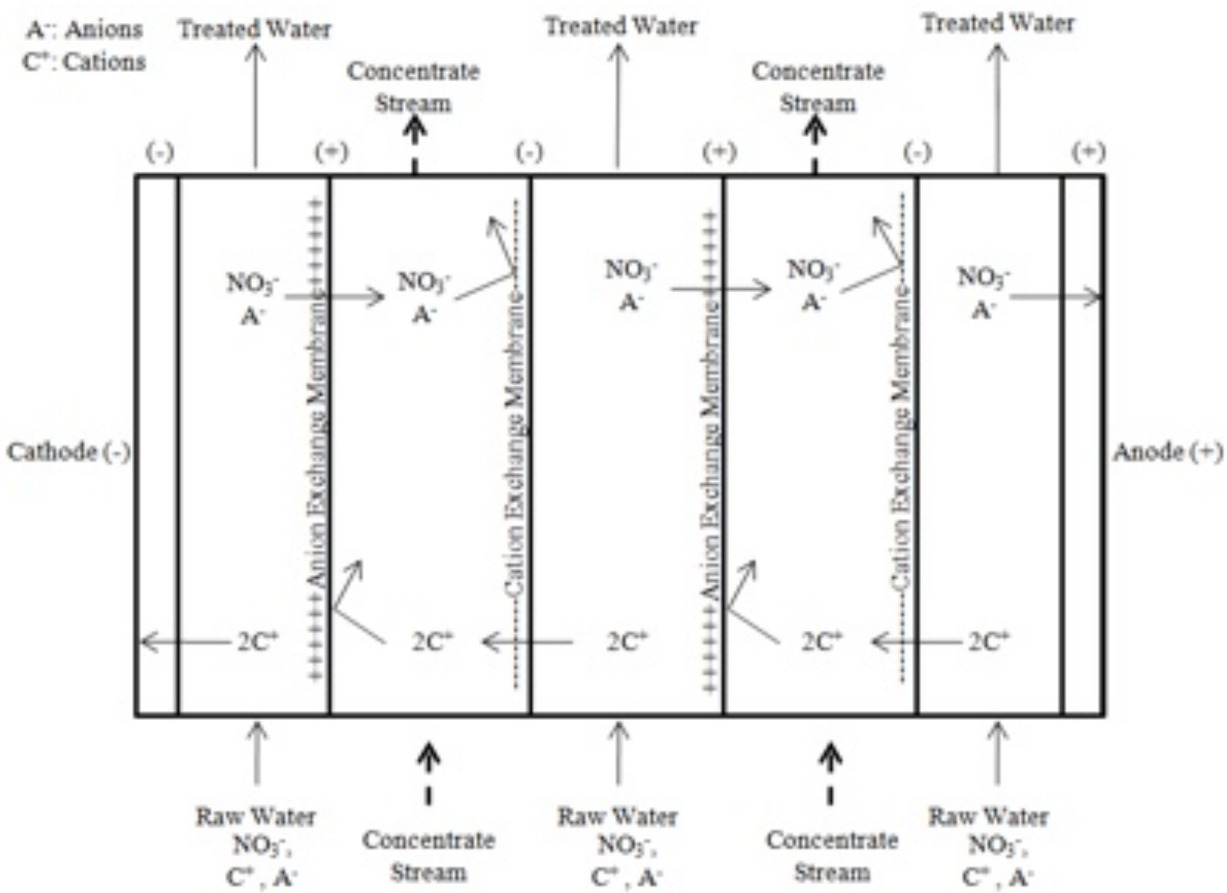
Reverse Osmosis

Reverse osmosis (RO) is a pressure driven membrane process in which the applied pressure is used to overcome an osmotic gradient allowing purified water to be passed through semi-permeable membranes while ions, including nitrate are rejected. Rejected ions accumulate in the concentrate stream which requires disposal. For inland communities without access to an ocean outfall, disposal options are limited to direct sewer disposal (if available), drying beds, or deep well injection. The volume of the concentrate stream can approach 30% of the produced water. Due to this volume of water loss and corresponding concentrate disposal limitations, RO is not further considered for Walnut Ave Water System #2. RO may also be result in TCP removal, but further investigation is required.

Electrodialysis

Nitrate removal by electrodialysis is accomplished by passing an electrical current through a series or stack of anion and cation exchange membranes, resulting in the movement of ions from the feed solution to a concentrated waste stream. Illustrated in Figure 7, nitrate ions (and other anions) move through the anion exchange membrane toward the anode. Continuing toward the anode, nitrate is rejected by the anion-impermeable cation exchange membrane and trapped in the recycled waste stream. Cations can be removed in a similar manner, migrating toward the cathode through the cation exchange membrane and rejected by the cation-impermeable anion exchange membrane. Nitrate selective membranes allow for treatment without significantly altering the balance of other ions in the water.

Figure 7. Illustration of ED membrane stack.



While ED/EDR is considered a viable technology for nitrate removal, like RO, its drawback is the need to dispose of high volumes of waste concentrate. ED/EDR systems also are operationally complex. For these reasons there are few ED/EDR systems operating for the purpose of nitrate removal in the United States. As such, this technology is not considered further in this analysis for Walnut Ave Water System #2.

Biological Denitrification

Biological denitrification in potable water treatment is more common in Europe with full-scale systems in France, Germany, Austria, Poland, Italy and Great Britain; however, in recent years, this treatment technology is gaining recognition as a viable nitrate treatment alternative for California drinking water systems. Substrate and nutrient addition is necessary and post-treatment can be more intensive than for SBA-IX. Biological denitrification offers the ability to address multiple contaminants and the avoidance of costly waste brine disposal, since the nitrate is completely reduced to nitrogen gas. That said, biological denitrification requires several unit processes and operations are more demanding than that of a SBA-IX system. Typically, the unit processes can include a combination of the following: substrate addition (phosphoric and or acetic acid), biological contactor, re-oxygenation, media filtration, and disinfection. The process also requires the management of backwash waste water which is typically sent to a local sewer, when available, and may require adsorption with GAC to resolve taste and odor issues.

Common configurations of the biological contactor include fixed bed, fluidized bed, or membrane bioreactors. Fixed bed biological contactors operate in up-flow or down-flow systems and would operate under pressure. Typically, pressure vessels are loaded with sand, gravel, plastic media or GAC to support biomass growth. As treatment progresses, the excess biomass accumulates in the biological contactor and must then be backwashed. Fluidized bed contactors operate in up-flow mode with light weight support media that, as the name suggests, are fluidized while operational. With no packed media bed in this configuration, head loss is minimized and the system does not require backwash since the biomass is removed as a function of the water moving through the vessel. Last, membrane bioreactors (MBRs) can also be used as the denitrification contactor. In this configuration membranes serve as the biomass substrate for denitrification and as a means to achieve filtration without addition of another unit process. MBRs can provide additional operational control and a smaller treatment process when compared to fixed or fluidized bed at the expense of additional capital costs.

Biological denitrification capital costs are substantially higher than traditional SBA-IX capital costs; and the treatment requires a savvy operator. Therefore, this technology is not considered further.

Residential Treatment using Point of Entry / Point of Use (POE/POU)

POU and POE water treatment devices can be used on a short-term basis to address high nitrate levels and other constituents of concern (e.g. TDS, sulfate, chloride, other inorganic contaminants) at the residential scale. A POU treatment device is installed for the purpose of reducing contaminants in drinking water at a single tap, typically the kitchen tap. A POE treatment device is installed for the purpose of reducing contaminants in all water entering a house or building.

Water systems using POU/POE devices for compliance are responsible for meeting federal, state, and local requirements. Section 116380, of the California Health and Safety Code limits the use of POU and POE treatment to public water systems with fewer than 200 service connections and for temporary use only. POE/POU could be considered as a temporary treatment measure. It is not discussed further in this report, since the goal of this report is to consider long term solutions.

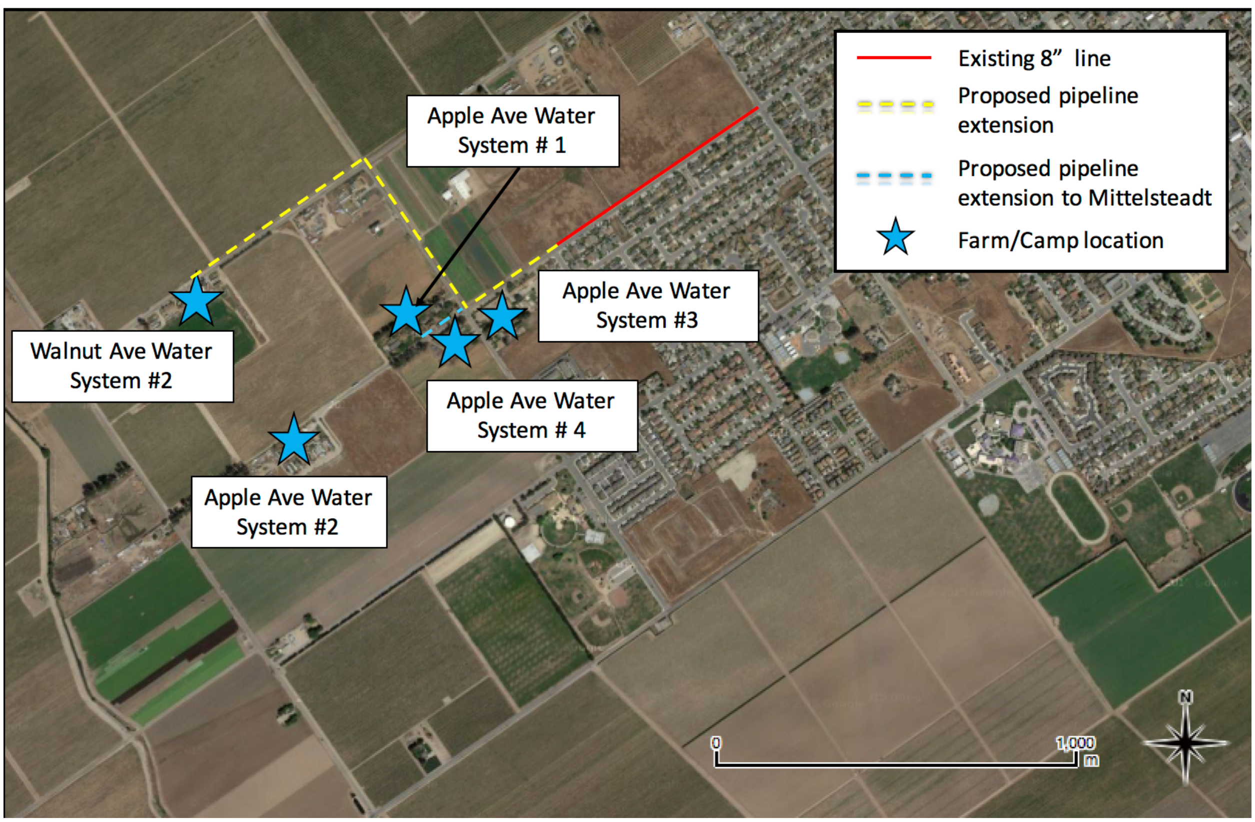
Summary of Treatment and Non-Treatment Alternatives

Regarding non-treatment alternatives, the development of new groundwater sources will be considered. Consolidation with the City of Greenfield will be considered further. One treatment option, SBA-IX, will be considered further although it does not remove TCP, and there are concerns about the finished water chloride concentrations. Other treatment technologies such as RO, biological denitrification and ED / EDR are not considered at full-scale due to the high rate of water waste and corresponding disposal challenges. Last, POE/POU systems are not considered further given the prohibition of their use for long-term compliance. Costs associated with the development of new groundwater sources, consolidation and SBA-IX treatment are further developed below.

Consolidation Cost Estimates

The pipeline extension to Walnut Ave Water System #2 would be approximately 4,510 feet long and connect to the City's system at the intersection of Victorian Circle and Apple Avenue, which is the closest point where a tie in can be located. Figure 8 below illustrates the proposed pipeline extension, highlighted by the yellow-dashed line.

Figure 8. Proposed City of Greenfield pipeline extension



To fund the project, the City was willing to be the grant applicant for Proposition 1 funding. As the City lacks staff to administer a grant, an outside grant administer would be needed. These costs are included in the cost summary for the consolidation options. The City also contracts engineering services to Doug Pike from MNS Engineering; the contracted engineer would need to review the design and perform field inspections and these costs are included in the estimate.

Although a more complete review would be needed before making a determination, the City staff thought this project would likely be exempt from CEQA (California Environmental Quality Act) and associated costs are not included in this estimate.

For properties near the borders, the City would normally prefer that the property be annexed into the City before providing water and sewer service. However, there are exceptions and staff indicated a willingness to work with the project team to come up with a plan.

Annexation would need to be approved by Monterey County Local Area Formation Commission (LAFCO.) Annexation may have some impacts to the community. Garbage service would be provided by the City rather than the County, although the property owner indicated that the pricing for both services is similar. Any future permits needed for construction at the property would be through the City not through the County. Per the LAFCO website, complete applications are processed in three to four months for a non-controversial project.

The City recommended that fire protection be considered and that fire hydrants be installed as part of a consolidation project. It should be noted that the larger supply pipeline would result in higher water age. As the property owner would like to keep his existing well for irrigation purposes, the plumbing systems for the well and the domestic service would need to be physically disconnected. For the purpose of budgeting, this report assumes a backflow prevention device would also need to be installed at each service point. The pipeline would need to include isolation valves and a blow off valve at the end to be used for flushing.

The City prefers individual, one-inch meters for each of the homes on the property. This will require some re-plumbing within the property to separate the services to each home, which is included in the cost estimate.

Operations costs for this option would be borne by the City of Greenfield and paid for by residents through water rates. The City may raise rates in the future and surcharges may also be applied for various reasons, such as during periods of drought. Additionally, if a backflow prevention device is installed on each service, it would need to be tested annually. Cost for this testing is included in the annual cost for the customers.

Adjacent Communities

While the initial purpose of this project was to provide safe water supply and sanitation for the residents of Walnut Ave Water System #2, there are several other communities along the pipeline route who may also be able to benefit from the project. The locations of these communities are shown in Figure 8.

The first community is Apple Ave Water System #3, a farm labor camp within the City limits with a contaminated well. This community applied for SRF funds for consolidation with the City water system.

The engineering design was completed, but funds were not available for installation. There are 14 units on this property, each of which would require an individual meter. No additional street piping would be needed to include this property in the project.

On the opposite corner from the Apple Ave Water System #3 property are five to six properties, called the Mittelsteadt Properties. The Properties consist of two water systems, Apple Ave Water #1 and Apple Ave Water System #4, as depicted in Figure 8. The well serving these properties has had declining yield and is also contaminated with nitrate. An additional 750 feet of pipeline would be needed in order to serve all these dwellings with meters located at the property line.

The Apple Ave Water System #2 is southwest of the point of connection on Apple Avenue. This community recently constructed a well which is compliant with Water Quality standards, and therefore there is not a compelling reason to consider consolidation for this water system. Beyond the Mittelsteadt property, an additional 750 feet of pipeline would be needed in order to connect to this property. Additional piping and meters may be needed to serve each dwelling with an individual meter.

Pipeline Extension Scenarios

For pipeline extension cost estimates, three scenarios representing consolidation options with the City of Greenfield were evaluated. Table 4 provides a description of each pipeline extension scenario. For each scenario, costs for installed capital equipment, service connections, fire hydrants, backflow prevention devices, permitting, design, construction, and management are included. As Walnut Ave Water System #2 should be eligible for grant funding, expected costs for grant application and administration are also included.

Table 4 Pipeline extension scenarios

Scenario	Description
Option A	Pipeline extension to Walnut Ave Water System #2 only
Option B	Pipeline extension to Walnut Ave Water System #2 and Apple Ave Water System #3
Option C	Pipeline extension to Walnut Ave Water System #2, Apple Ave Water System #3, and Mittelsteadt properties

Cost estimates for all three pipeline extension scenarios are summarized in Table 5. As seen in Table 5, the total installed capital cost for pipeline extension to Walnut Ave Water System #2 alone is estimated at $0.87M, with a total 20-year net present worth of $0.92M. The cost adder for additional pipeline and service to the Mittelsteadt property is $0.19M, resulting in an installed total pipeline extension capital cost of $1.07M and total 20-year net present worth of $1.11M for Option C.

Although the addition of pipeline and services to the Mittelsteadt property results in an overall $19K increase in installed capital costs, the total 20-year net present worth of pipeline extension per system is decreased from $0.48M to $0.40M. Average costs per system for all three pipeline extension scenarios are shown in Table 6. Annual operations and maintenance (O&M) costs of $2.8K for all three scenarios is estimated using average per capita use and the City of Greenfield's 2016 residential water rates.

Table 5. Summary of total capital and O&M costs for pipeline extension

	Option A (Walnut Ave Water System #2 only)	Option B (Walnut Ave Water System #2 and Apple Ave Water System #3)	Option C (Walnut Ave Water System #2, Apple Ave Water System #3, and Mittelsteadt)
Total Installed Capital Costs	$0.87M	$0.87M	$1.07M
Annual O&M Costs	$2.8K	$2.8K	$2.8K
10-Year NPW Costs	$0.90M	$0.90M	$1.09M
20-Year NPW Costs	$0.92M	$0.92M	$1.11M
30-Year NPW Costs	$0.94M	$0.94M	$1.13M

Table 6. Summary of average capital and O&M pipeline extension costs per system.

	Option A (Walnut Ave Water System #2 only)	Option B (Walnut Ave Water System #2 and Apple Ave Water System #3)	Option C (Walnut Ave Water System #2, Apple Ave Water System #3, and Mittelsteadt)
Total Installed Capital Costs	$0.87M	$0.44M	$0.36M
Annual O&M Costs	$2.8K	$2.8K	$2.8K
10-Year NPW Costs	$0.90M	$0.46M	$0.38M
20-Year NPW Costs	$0.92M	$0.49M	$0.40M
30-Year NPW Costs	$0.94M	$0.50M	$0.42M

New Groundwater Source Cost Estimates

There are several cost categories that must be considered to evaluate the option of replacement wells. In addition to the well drilling, equipping and instrumentation, land acquisition, and destruction of the contaminated wells must be considered.

The existing well is 252 feet deep and perforated from 165 to 248 feet with mill slots. It has a cement grout sanitary seal to 20 feet. The City of Greenfield wells are approximately 800 feet deep and are perforated starting at approximately 500 feet deep. These wells are in compliance with drinking water standards.

Based on this information it is likely that a newly constructed well, approximately 800 feet deep and sealed to 500 feet deep would provide water of acceptable quality. Monterey County requires separation from new wells and potential sources of contamination including septic systems, sewers and animal enclosures. Additionally, a new well must be separated from the existing wells on the property. This limits the available area on the property where a new well can be constructed, as shown previously in Figure 8.

Capital costs for installing a new well are detailed below in Table 7. This includes extension of electrical service to the new well, a new pump and motor, well controls and piping to connect the well to the existing system. A 15 horsepower motor was assumed for the project. Additional costs for existing well destruction, design, construction, grant administration, and project management are also included.

Note that during drilling of the new well, it may be necessary to shut down the existing well to avoid pulling drilling mud into the existing well. This would have an impact on the residents during the construction period, and the costs of providing other sources of water during construction are not included in the construction estimate.

O&M costs for the new well option would be borne by the property owner. This includes power costs and periodic replacement of the pump and motor. These costs would be similar to what the owner is paying now to operate the existing water system.

As seen in Table 7, the total installed capital cost for drilling a new well is estimated at $0.48M, with a total 20-year net present worth of $0.54M. It should also be noted that a new well at approximately 800 feet will not guarantee nitrate and TCP avoidance.

Table 7. Summary of capital and O&M costs for new well

	New Well
Total Installed Capital Costs	$0.48M
Annual O&M Costs	$3.9K
10-Year NPW Costs	$0.51M
20-Year NPW Costs	$0.54M
30-Year NPW Costs	$0.57M

Treatment Cost Development

The cost request provided to the equipment provider included water quality details as described above. Due to unavailable historical water production data, the 2008 King City Water Supply and Facilities Master Plan (WSFMP) per capita residential use, maximum day factor, and peak hour factor are used. The cost information from the equipment provider was compiled to develop conceptual level capital and annual operational and maintenance cost estimates for each of the treatment alternatives. Sales tax of 7.5% was applied to equipment purchase costs.

Standard engineering multipliers were applied to the initial treatment equipment costs to develop estimates of the total installed equipment capital costs. The installed treatment equipment cost multipliers that were used in this analysis are shown in Table 8.

Table 8. Installed capital cost multipliers.

Category	Denotation	Percentage	Formula
Initial Treatment Equipment Capital	A	**1**	
Installation	B	30%	A x 0.30
Electrical and I&C	C	25%	A x 0.25
General Site Civil	D	20%	A x 0.20
Subtotal	**E**	**1.75**	**A + B + C + D**
Overhead and Profit	F	15%	E x 0.15
Contingency	G	25%	E x 0.25
Total Construction Capital Costs	**H**	**2.45**	**E + F + G**
Planning, Engineering, Legal and Admin	I	15%	H x 0.15
Construction Admin	J	10%	H x 0.10
Total Installed Capital Equipment		**3.1**	**H + I + J**

Net present worth costs are shown for a 10-, 20-, and 30-year period with a 1.0%, 1.2%, and 1.5% interest rate respectively[7]. The level of accuracy for the cost estimates corresponds to a Class 4 Estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. This level of engineering cost estimating is generally made with limited information, including process block diagrams, preliminary equipment lists, and indicated layout, and it is appropriate for feasibility study evaluations. Cost estimates prepared at this level of engineering are generally considered to have an accuracy range of +50/-30 percent.

SBA-IX Treatment Cost Estimates

Installed SBA-IX treatment system costs have been developed for well head treatment system of the Walnut Ave Water System #2 well. Based on water production and water quality data, as discussed in previous sections, the design basis for the scenario is listed in Table 9.

Table 9. SBA-IX design scenario.

Parameter	Units	Walnut Ave Water System #2 Well
Well Capacity	gpm	12
Average Daily Use	gal/day	1,925
Maximum Yearly Utilization	gal/year	1,265,000
Nitrate	mg/L NO_3-N	36.2
Sulfate	mg/L	241
Chloride	mg/L	153
Alkalinity	mg/L as $CaCO_3$	192

[7] https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c, November 2015 version, accessed March 7, 2016.

Capital and operational cost estimates of SBA-IX equipment were solicited from one equipment provider, IonexSG, who has delivered and operated larger sized SBA-IX systems for other California community water systems.

Based on the water quality and production data provided, IonexSG developed capital and O&M costs for SBA-IX. The O&M costs shown are inclusive of hazardous waste brine management and disposal at $0.16/gallon, and NaCl salt supply. For each treatment system, an annual labor cost of $25,000 was applied to account for operating the system based on a 0.25 Full-time Equivalent (FTE) with an annual rate of $100,000. The treatment process for the well head system is estimated by IonexSG to be 98.90% efficient in this application.

Cost estimates are summarized in Table 10. As seen in Table 10, the total installed capital cost for well head treatment is estimated at $1.19M, with a total 20-year net present worth of $1.71M.

Table 10. Summary of capital and O&M costs for SBA-IX centralized treatment.

	IonexSG
Treatment Equipment	$357K
Sales Tax (7.5%)	$27K
Treatment Equipment Plus Sales Tax	$384K
Total Installed Capital Costs	**$1.2M**
Annual O&M Costs	**$29.4K**
10-Year NPW Costs	**$1.47M**
20-Year NPW Costs	**$1.71M**
30-Year NPW Costs	**$1.90M**

Costs Covered by Grants

The Drinking Water State Revolving Fund (SRF) is administered by the State Water Resources Control Board (State Water Board) and is designed to assist public water utilities in water quality and infrastructure improvement. All SRF loans possess interest rates between 0% to 50% of the average interest rate of general obligation bonds from the prior year. Applications for DWSRF loans are accepted year round and repayment begins within one year of project completion and is up to 30 years or the useful life of the project for disadvantaged community (DAC) water systems. Water systems whose service area is classified as a DAC are also eligible for principal forgiveness, with up to 100% principal forgiveness for schools servicing a severely disadvantaged community (SDAC). For treatment systems with large capital costs, a DWSRF loan may be pursued.

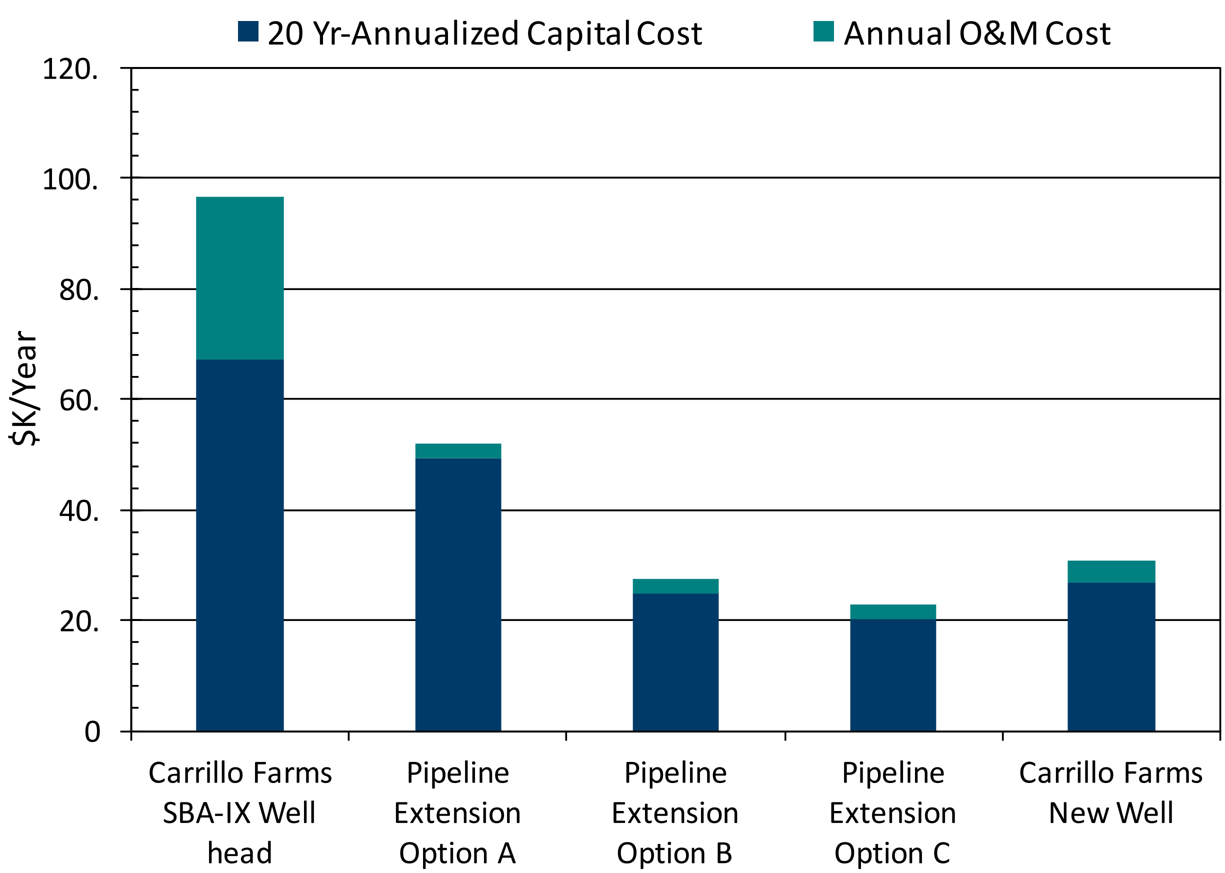
Capital cost can be paid for with SRF funding, however ongoing operations and maintenance costs cannot. This is an important consideration for water systems that select a treatment option with significant operational costs. The State Water Board has specific money allocated to system consolidation, and does want to see smaller systems consolidated with nearby larger utilities. Treatment for contaminants, such as nitrate, should be grant eligible. Further discussion with the State Water Board Division of Financial Assistance (DFA) would be needed to determine if a new well would be eligible for grant funding.

Summary of Nitrate Mitigation Options and Costs

The EJCW is working with each community to assess the options and come to a decision about which solution is best. Therefore, the Community Engineering Corps volunteer team is not making a specific recommendation. Rather this section provides a summary of the benefits and costs of options that were evaluated.

20-year annualized capital costs and annual O&M costs of all non-treatment and treatment compliance options evaluated are shown in Figure 9. For the pipeline extension scenarios, the average cost per system is shown and a description of each scenario can be referenced above in Table 4. It should also be noted that the annual O&M cost for pipeline extension is the expected yearly water bill for all Walnut Ave Water System #2 residents.

Figure 9. Annual capital and O&M costs of nitrate mitigation options



To ameliorate the nitrate and TCP contamination in the well the lowest cost options on a 20-year net present worth basis are drilling a new well ($0.54M) and consolidating with the City ($0.92M - $1.11M). The consolidation option can include one to two other nearby water systems with nitrate contamination and should qualify for grant funding.

A new well is less costly, however there is no guarantee that the water will meet all state and federal standards. Further discussion with DFA would be needed to determine if this project would be grant eligible.

Treatment with SBA-IX is not recommended because of the high cost ($1.71M on a 20-year net present worth basis), and the concern that the treated water will be corrosive due to the high chloride concentrations. Additional treatment would also be needed to remove TCP. Thus, treatment is not a viable option for Walnut Ave Water System #2.