WOOD RODGERS

TECHNICAL MEMORANDUM

TO: Ms. Anna Louzon, Yolo County CSA Administrative Support Team

FROM: Mr. Jeff Lodge, P.E., Wood Rodgers, Inc.
Mr. Jesse J. Patchett, P.E., Wood Rodgers, Inc.

DATE: October 21, 2015

SUBJECT: Willowbank CSA Irrigation System Separation Feasibility Study

INTRODUCTION

In April 2015, the Willowbank County Service Area (Willowbank) requested that Wood Rodgers, Inc. (Wood Rodgers) evaluate the feasibility of constructing separate potable and irrigation water systems from the existing combined potable and irrigation system. In order to accomplish this, Wood Rodgers reviewed historical potable and irrigation water demand information provided by the City of Davis (City) and conducted a preliminary groundwater assessment (under separate cover) in order to verify its suitability in serving the estimated irrigation demands.

This Technical Memorandum presents descriptions for potential alternatives to separate potable and irrigation water, summarizes the feasibility of each alternative based on estimated construction cost, permitting, and constructability, and provides recommendations for a preferred alternative.

BACKGROUND

Potable and irrigation water demands in Willowbank are currently served by the City, and Willowbank residents pay a premium for this reliable, high-quality water supply. However, it is estimated that only about 19% of Willowbank's average annual water demand is for potable uses; the majority of the Willowbank water demands are used for landscape irrigation. Due to projected rate increases, it is estimated that annual landscape irrigation costs could be more than $1,600 per dwelling unit by 2019 (See **Appendix A** for details). Therefore, Willowbank is interested in exploring cost-effective options to serve irrigation demands with non-potable water.

METHODOLOGY

Basis for Evaluation & Assumptions

Bi-monthly demands for Willowbank from 2008 - 2014 were provided by the City. The information provided by the City reflects total monthly usage for the entire community. The Willowbank CSA consists of approximately 121 lots according to data provided by Yolo County. Of these lots, Wood Rodgers understands approximately five lots are undeveloped, one is small lot that used to be the site of an old well, and three lots are on private wells so these do not receive water from the City. Therefore, this technical memorandum assumes the 2014 water usage data was distributed over 112 dwelling units. The average demands provided by the City were divided by the number of dwelling units and by the number of days in each month in order to estimate the total average daily demands (ADD) per dwelling unit.

The total ADD per dwelling unit was then separated into indoor demands and outdoor demands. Indoor usage was estimated to be 75 gallons per capita per day, at an average of 2.1 occupants per dwelling unit. Outdoor usage was estimated by subtracting the indoor usage estimates from the total average daily demands. **Table 1** (below) presents the results.

Table 1 - Average Demands per Day / Dwelling Unit

Month	Total (ccf)	Total (gallons)	Total (gpd/du)	Indoor (gpd/du)	Outdoor (gpd/du)
January	1,213	907,645	261.4	157.5	104
February	1,213	907,645	289.4	157.5	132
March	2,552	1,908,629	549.7	157.5	392
April	2,552	1,908,629	568.0	157.5	411
May	5,819	4,352,345	1,253.6	157.5	1,096
June	5,819	4,352,345	1,295.3	157.5	1,138
July	6,879	5,145,332	1,482.0	157.5	1,324
August	6,879	5,145,332	1,482.0	157.5	1,324
September	4,658	3,484,344	1,037.0	157.5	880
October	4,658	3,484,344	1,003.6	157.5	846
November	1,475	1,103,300	328.4	157.5	171
December	1,475	1,103,300	317.8	157.5	160
Total	**45,191**	**33,803,189**	**9,868**	**1,890**	**7,978**

NOTES: 1) Bi-monthly demands were provided by the City and divided by 2 to yield monthly demand estimates
2) ccf = hundred cubic feet
3) du = dwelling unit
4) gpd = gallons per day
5) 1 ccf = 748 gallons

The average daily outdoor demands shown in Table 1 assume outdoor water usage occurred uniformly over all days of the month. However, for purposes of this report, residential watering

was assumed to occur only three days per week. This assumption results in higher estimated peak flows, which are expected to match how the new system will be operated.

Based on the assumed watering frequency, the average daily outdoor demand estimates shown in Table 1 needed to be adjusted to consider a three-day-a-week period in order to obtain an accurate estimate of current peak outdoor demands. Furthermore, since most irrigation typically occurs between 10pm and 4am, outdoor demands were assumed to occur over a 6-hour period, three times per week, per dwelling unit. The adjusted outdoor demands are shown in **Table 2** (below).

Table 2 - Estimated Actual Outdoor Demands

Month	Avg. Daily Outdoor Demand 2008 - 2014 (gpd/du)	Estimated Usage Per Scheduled Watering Day (gpd/du)	Estimated Usage Over 6-hours (gpm/du)
January	104	242	0.67
February	132	308	0.85
March	392	915	2.54
April	411	958	2.66
May	1,096	2,558	7.10
June	1,138	2,655	7.37
July	1,324	3,090	8.58
August	1,324	3,090	8.58
September	880	2,052	5.70
October	846	1,974	5.48
November	171	399	1.11
December	160	374	1.04

The demands in Table 2 reflect historical usage per dwelling unit in Willowbank. These demands were scaled up to reflect the ultimate potential demands in Willowbank (120 lots). These ultimate demands were used to determine required pipe and pump sizes, and well capacities. The ultimate demands are shown in **Table 3** on the following page.

Table 3 - Estimated Ultimate Demands & Peak Flows

Month	Estimated Usage Per Scheduled Watering Day (gpd/du)	Estimated Usage Over 6-hours (gpm/du)	Estimated Peak Demand* (gpm)
January	242	0.67	40
February	308	0.85	51
March	915	2.54	153
April	958	2.66	160
May	2,557	7.10	426
June	2,655	7.38	443
July	3,090	8.58	515
August	3,090	8.58	515
September	2,052	5.70	342
October	1,974	5.48	329
November	399	1.11	66
December	374	1.04	62

*Peak Demand assumes outdoor watering at 60 lots over a 6-hour period

Required pipe sizes were determined based on the estimated peak demands for the month of July with a maximum flow velocity of 5-feet per second. Pipe friction losses were estimated using the Hazen-Williams equation, based on a friction coefficient values of 130 for new pipe.

The required pump flow rate was based on the peak July and August flows shown in Table 3, and pump horsepower requirements were based on pressure head needed to overcome topography features and pipe friction loses while maintaining minimum pressures 40 PSI throughout the system. A static head lift of 130-feet was assumed on the suction side of the pumps to account for varying source water levels. Finally, a pump efficiency of 77% and a 95% motor efficiency were used to develop horsepower and energy needs for each alternative. Pump and friction loss calculations are included in **Appendix B**.

It should be noted that the basis for evaluation was done using static pressures; detailed dynamic hydraulic modeling was not performed for this evaluation and will be needed during the design phase in order to confirm the preliminary system components developed in this evaluation.

Basis for Costs

To estimate the overall project costs, material quantities were estimated for project components based on the preliminary layouts shown on **Figures 1 and 2** (attached). Unit prices for typical water supply construction costs were determined based upon recent contractor bid summaries for water supply projects in northern California. Where recent bid tabulations were not available, cost-determination publications, such as RS Means' *Heavy Construction Cost Data*, were used to develop costs. Land acquisition costs, where applicable, were assumed to be $150,000/lot based on Zillow.com estimates. Finally, the estimated costs for electrical service assumes the electrical service provider has the capacity to serve the electrical demands associated with each alternative.

The total estimated project costs include a contingency of 30 percent. Planning, Engineering, and Design are included at seven percent, Environmental Permitting at seven percent, and Construction Management at three percent. Cost estimates for each of the alternatives are included in **Appendix C**. Estimated costs for each alternative have also been prepared for the Oakside, Willowbank, and Meadowbrook neighborhoods contained within the Willowbank CSA.

In order to compare the projected annual landscape irrigation costs from the City's supply, the estimated annual costs (EAC) were determined for each alternative. EAC estimates in this report consider the total estimated initial project construction costs, annual operation & maintenance (O&M) costs, replacement at the end of a 40-year design life (excluding pipe), escalation of 1.9%, and a cost of capital of 3%.

DESCRIPTION & EVALUATION OF WATER SUPPLY ALTERNATIVES

Wood Rodgers evaluated the feasibility of four alternatives for serving irrigation demands at Willowbank. Each alternative is described below.

Alternative 1 - No Action Alternative: Under the no action alternative, the City of Davis would continue to supply water for potable, irrigation, and fire flows via the existing distribution system. No improvements are proposed within Willowbank for this alternative.

Alternative 2 - Individual Homeowner Well Alternative: This alternative consists of installing 300-foot deep private wells on each lot that would serve irrigation demands for individual homeowners. The existing water distribution system would continue to be used to provide potable water from the City of Davis to the Willowbank community.

Alternative 3 - One Well Per Neighborhood w/ New Irrigation Main Alternative: This alternative consists of installing a private well in each of the three neighborhoods within the Willowbank CSA. These wells would serve irrigation demands for homeowners in each neighborhood. The existing water distribution system would continue to be used to provide potable water from the City of Davis to the Willowbank community. Fire flows would also continue to be served by the existing distribution system and the City of Davis water supply. There is currently only one existing well site within the Willowbank community. Additional well sites would be needed for this alternative. Please see **Figure 1** (attached) for a graphical depiction of this alternative.

Approximately 9,000 LF of new 4-inch diameter PVC waterline would be installed to serve the irrigation demands at Willowbank. Each parcel would also need a 1-inch diameter service lateral connecting to the existing private landscape irrigation system. Finally, the domestic service into each house would be disconnected from the irrigation system piping.

This option would require three 300-foot deep, 8-inch diameter wells located within the Willowbank community. The wells would each need to be equipped with a 200 gpm, 20 horsepower pump to serve the anticipated irrigation demands. It is also assumed that a chlorine injection system would be needed to meet the California Department of Drinking Water (DDW) requirements. For purposes of this evaluation, an existing parcel on the north side of Montgomery Avenue between Oakside Drive and Willowbank Road is assumed to be available for this new well in the Willowbank neighborhood, but a new parcel would need to be acquired in the Oakside and the Meadowbrook neighborhoods.

Alternative 4 - Irrigation Well w/ New Irrigation Main Alternative: This alternative consists of installing a new standalone irrigation system. A new well and a new irrigation water distribution system would serve irrigation demands for the Willowbank community. The existing water distribution system would continue to be used to provide potable water from the City of Davis to the Willowbank community. Fire flows would also continue to be served by the existing distribution system and the City of Davis water supply. Please see **Figure 2** (attached) for a graphical depiction of this alternative.

Approximately 3,000 LF of new 6-inch and 6,000 LF of new 4-inch diameter PVC waterline would be installed to serve the irrigation demands at Willowbank. Each parcel would also need a 1-inch diameter service lateral connecting to the existing private landscape irrigation system. Finally, the domestic service into each house would be disconnected from the irrigation system piping.

This option would require a 300-foot deep, 12-inch diameter well located within the Willowbank community. The well would need to be equipped with a 515 gpm, 55 horsepower pump to serve the anticipated irrigation demands. It is also assumed that a chlorine injection system would be needed to meet CDPH requirements. For purposes of this evaluation, an existing parcel on the north side of Montgomery Avenue between Oakside Drive and Willowbank Road is assumed to be available for this new well. If this site isn't available or suitable, one of the vacant lots within the community would need to be acquired by Willowbank to accommodate the new well site.

Table 4 (below) summarizes the estimated costs and land acquisition needs for each of the alternatives evaluated. Detailed cost estimates included in **Appendix C** present a breakdown of estimated costs for each neighborhood.

Table 4: Summary of Estimated Water Supply Alternative Needs & Costs

Alternative	Number of New Wells Needed	Length of 6" Diameter Pipe Needed	Length of 4" Diameter Pipe Needed	No. of Service Laterals Needed	Total Est. Cost*
1 – No Action	-	-	-	-	-
2 – Individual Homeowner Wells	117	-	-	-	$8.75M
3 – One Well Per Neighborhood w/ New Irrigation Main	3 (20 hp)	-	9,000	120	$3.48M
4 – Irrigation Well w/ New Irrigation Main	1 (55 hp)	3,000	6,000	120	$2.80M

*Total Estimated Cost includes Planning, Engineering, Design, Env. Permitting, Construction Management, and a 30% contingency.

Table 5 (below) presents the estimated annual cost of each alternative over a 40-year design life, including replacement and O&M costs. Details on these costs are included in **Appendix D**.

Table 5: Estimated Annual Costs of Each Alternative

Alternative	Est. Initial Project Cost	Equivalent Annual Initial Project Cost	Est. Annual O&M Costs	Est. Annual Electrical Service Costs	Estimated Annual Cost to Fund Replacement (Well Only)	Total Est. Annual Cost (2015 $$)
1 – No Action	-	-	-	-	-	$196,440*
2 – Individual Homeowner Wells	$8.75M	$378,589	$60,000	$11,343	$152,049	$601,981
3 – One Well Per Neighborhood w/ New Irrigation Main	$3.48M	$150,423	$4,500	$5,672	$12,671	$173,266
4 – Irrigation Well w/ New Irrigation Main	$2.80M	$121,135	$1,500	$5,873	$8,447	$136,955

*Assumes projected annual irrigation water supply costs of $1,637 per lot for all 120 lots in Willowbank in 2019

POTENTIAL COST SAVINGS MEASURES

The costs in Table 5 include costs for water meters for 120 lots for Alternatives 3 and 4. If these costs are excluded, the Total Estimated Annual Costs are reduced by approximately $5,000.

Additionally, the costs for new irrigation system piping may be reduced for alternatives 3 and 4 if portions of the existing abandoned pipeline within the existing streets are used. This pipe assumed to be iron and asbestos-cement pipe that is approximately 50 years old based on information provided by Willowbank. Details regarding the abandonment of this pipeline are not currently known, but for purposes of this evaluation, it is assumed these pipes were abandoned in place, and were not completely grouted. If the abandoned pipelines were able to be used, this would reduce the total initial costs by approximately $310,000, and reduce the estimated annual costs by approximately $13,000.

Although these cost savings are significant, the existing pipeline is at the end of its useful life which is likely why it was abandoned several years ago. Putting this line back into service has increased potential for leaks, increased O&M costs associated with repairs, and would almost certainly require full replacement sooner than a new pipeline. For these reasons, this is not considered to be a viable cost-savings measure over the long-term.

While putting the existing line back into service is not a viable cost-savings measure, it may be possible to install a small-diameter pipe into the existing abandoned pipe. This is commonly known as sliplining. This option has the greatest potential to reduce costs in the Oakside and

Meadowbrook neighborhoods since the abandoned pipe is within the streets, however it may be possible to slipline the abandoned pipe in the Willowbank neighborhood.

Sliplining would significantly reduce the need to trench within the existing streets since new pipe would be "pulled" through the existing pipe at key locations where access pits could be established. Therefore, sliplining could reduce the overall construction cost if the pipes were abandoned in place and not completely grouted. While the costs of pavement removal/replacement, trenching, and backfill would be mostly eliminated, sliplining costs of pipe cleaning/inspection, sliplining, constructing access "pulling" pits, and the additional effort to excavate a small area at each service lateral offsets these savings. **Table 6** below presents the cost savings potential sliplining has for Alternative 4. **Table 7** below presents the estimated annual costs of Alternative 4B (sliplining option).

Table 6: Estimated Cost Savings Potential of Sliplining

Neighborhood	Estimated Credits*				Estimated Costs*				Net*
	AC Removal	4" AC Paving	4-Inch PVC Water	6-Inch PVC Water	Pipe Cleaning & Insp.	Sliplining (Incl. Labor & Pipe)	Add'l Service Lateral Cost	Access Pits	
Oakside	$14,040	$109,200	$39,000	$39,000	$46,000	$35,000	$50,000	$18,000	$52,240
Willowbank	$17,680	$137,511	$62,400	$32,500	$57,000	$44,000	$59,000	$16,000	$74,091
Meadowbrook	$15,080	$117,289	$42,000	$20,000	$49,000	$38,000	$47,000	$16,000	$44,369

*Costs include 30% contingency

Table 7: Estimated Annual Costs of Alternatives 4 and 4B

Alternative	Est. Initial Project Cost	Equivalent Annual Initial Project Cost	Est. Annual O&M Costs	Est. Annual Electrical Service Costs	Estimated Annual Cost to Fund Replacement (Well Only)	Total Est. Annual Cost (2015 $$)
4 – Irrigation Well w/ New Irrigation Main	$2.80M	$121,135	$1,500	$5,873	$8,447	$136,955
4B – Irrigation Well w/ New Irrigation Main (Sliplining Option)	$2.63M	$113,750	$1,500	$5,873	$8,447	$129,570

The costs in Table 7 reflect the estimated maximum savings potential since it assumes sliplining could occur in the Willowbank neighborhood. It could be slightly more expensive to slipline the Willowbank neighborhood due to the location of the abandoned main along the rear property lines. It should also be noted that costs for sliplining can vary considerably. Costs used for this estimate assumed the average unit cost per LF for sliplining ($13/LF)* and cleaning/video inspection (~$17/LF)*. If this cost-savings measure is selected for further consideration, Wood Rodgers can prepare preliminary designs and review with a sliplining contractor to get a refined cost estimate.

Costs in this evaluation assumed above-ground pumps and motors. Costs for submersible pumps would not be expected to be significantly different (within 5%-10%) since cost savings for removing the sound enclosures and vertical shafts would be offset by increased pump and motor costs. Additionally, for the depths anticipated, we recommend an above-ground configuration.

Finally, the costs in Table 5 for the no-action alternative assume the same average outdoor water use from 2008 - 2014. If less water is used, the estimated monthly expenses for irrigation water supply will be reduced. Potential conservation measures that may reduce irrigation costs are shown in **Table 8** below.

Table 8: Potential Irrigation Water Conservation Measures

Conservation Measure	Benefits
Converting traditional landscape to drought-tolerant shrubs and plants such as xeriscape	May reduce irrigation water needs for the converted lawn area by 50% to 75%
Using mulch around trees and plants	Mulch reduces evaporation and discourages weed growth
Check irrigation system for leaks, overspray, and broken heads and adjust/repair	Broken or misdirected sprinkler heads can waste as much as 500 gallons per month. Positioning sprinklers so that water lands on the landscape reduces water waste
Install smart irrigation system controllers	Smart irrigation controllers have built-in sensors to adjust to the optimal sprinkler run time based on local weather conditions, saving as much as 40 gallons per day
Implement watering restrictions on rainy and/or windy days	Reduces potential for overwatering and water waste.

CONCLUSION

Based on this preliminary evaluation, the Irrigation Well with New Irrigation Main Alternative appears to be the most cost-effective option to provide irrigation water to Willowbank. We estimate the design and permitting of this project may take between ten and twelve months to complete. Construction may take between four and six months to complete.

We recommend Willowbank advance this project to the preliminary design phase in order to confirm some of the assumptions and develop refined system layouts and costs.

APPENDIX A

Monthly Water Demands & Estimated Monthly Costs Through 2019

Historical Bi-Monthly Data Provided by the City of Davis

	2014 CCF	2013 CCF	2012 CCF	2011 CCF	2010 CCF	2009 CCF	2008 CCF	Avg CCF
Jan-Feb	2465	2343	3258	1756	1748	2830	2588	2427
Mar-Apr	3424	5496	3547	5234	3447	6157	8418	5103
May-June	8947	10714	12425	9662	11950	12716	15047	11637
July-Aug	11162	12008	13736	11796	14424	15835	17342	13758
Sept-Oct	7152	7948	9182	8149	10487	10036	12261	9316
Nov-Dec	1989	3987	2233	3369	2518	3364	3190	2950
TOTAL	35139	42496	44381	39966	44574	50938	58846	45191

Estimated Monthly Bill per Lot Based on Average Historical Usage Data and Projected City of Davis Water Rates

	2014 Willowbank Water Demands				2015 Rates			2016 Rates			2017 Rates			2018 Rates			2019 Rates		
	Total	Indoor	Outdoor	Total	$8.88 + $2.92/ccf			$9.87 + 3.44/ccf			$10.97 + 3.98/ccf			$12.20 + $4.61/ccf			$13.07 + $5.01/ccf		
Month	ccf	ccf/du	ccf/du	ccf/du	Indoor	Outdoor	Total	Indoor	Outdoor	Total	Indoor	Outdoor	Total	Indoor	Outdoor	Total	Indoor	Outdoor	Total
January	1213	6.4	4.4	10.8	$28	$13	$41	$32	$15	$47	$36	$18	$54	$42	$20	$62	$45	$22	$67
February	1213	6.4	4.4	10.8	$28	$13	$41	$32	$15	$47	$36	$18	$54	$42	$20	$62	$45	$22	$67
March	2552	6.4	16.4	22.8	$28	$48	$75	$32	$56	$88	$36	$65	$102	$42	$76	$117	$45	$82	$127
April	2552	6.4	16.4	22.8	$28	$48	$75	$32	$56	$88	$36	$65	$102	$42	$76	$117	$45	$82	$127
May	5819	6.4	45.6	52.0	$28	$133	$161	$32	$157	$189	$36	$181	$218	$42	$210	$252	$45	$228	$273
June	5819	6.4	45.6	52.0	$28	$133	$161	$32	$157	$189	$36	$181	$218	$42	$210	$252	$45	$228	$273
July	6879	6.4	55.0	61.4	$28	$161	$188	$32	$189	$221	$36	$219	$255	$42	$254	$295	$45	$276	$321
August	6879	6.4	55.0	61.4	$28	$161	$188	$32	$189	$221	$36	$219	$255	$42	$254	$295	$45	$276	$321
September	4658	6.4	35.2	41.6	$28	$103	$130	$32	$121	$153	$36	$140	$177	$42	$162	$204	$45	$176	$221
October	4658	6.4	35.2	41.6	$28	$103	$130	$32	$121	$153	$36	$140	$177	$42	$162	$204	$45	$176	$221
November	1475	6.4	6.8	13.2	$28	$20	$47	$32	$23	$55	$36	$27	$63	$42	$31	$73	$45	$34	$79
December	1475	6.4	6.8	13.2	$28	$20	$47	$32	$23	$55	$36	$27	$63	$42	$31	$73	$45	$34	$79
Total	45191	76.8	326.7	403.5	$331	$954	$1,285	$383	$1,124	$1,506	$437	$1,300	$1,738	$501	$1,506	$2,007	$542	$1,637	$2,178

NOTES: ccf = hundred cubic feet

du = dwelling unit

Water Rates Obtained From http://cityofdavis.org/city-hall/public-works/water/water-rates on August 4, 2015

Estimated costs for outdoor water use exclude the base rate fee

Between January 2016 and January 2019, annual costs for outdoor water increase an average of 13% per year

APPENDIX B

Pump Horsepower & Pipe Friction Loss Calculations

Willowbank Pump HP Calculations (Alternative 3)

Willowbank CSA Irrigation System Pipe Headloss Estimate						
System Pipe Sizing & Headlosses						
Segment	Length (feet)	Flow (GPM)	Pipe Size (inches)	Headloss (ft) Per 100 LF	Total HL (ft)	Velocity (fps)
All Segments	1500	190	4	2.2	32.7	4.9
Total	1500				32.7	

Willowbank CSA Pump HP Estimate		
Well Pump Requirements		Notes
PS Elevation (feet)	40	Based on topo
HP Elevation (feet)	50	Estimated based on topo
Pipe Headlosses (feet)	32.74	From calcs to the left
Suction Head (feet)	125	70' PWL + 55' seasonal fluctuation
Residual Pressure Needed	115	50 psi = 115'
Total Head Required (feet)	283.12	
Flow Per Pump (gpm)	200	From report, based on estimated Peak Hour Flows
Total Flow Needed (gpm)	200	
Number of Pumps Needed	1	
Pump Efficiency	77%	Assumed
Motor Efficiency	95%	Assumed
Pump HP Required	18.57	
Power Required for Pump Station (kW)	14.58	
Electrical Service Size (Amps)	22	

Willowbank Pump HP Calculations (Alternative 4)

Willowbank CSA Irrigation System Pipe Headloss Estimate						
System Pipe Sizing & Headlosses						
Segment	Length (feet)	Flow (GPM)	Pipe Size (Inches)	Headloss (ft) Per 100 LF	Total HL (ft)	Velocity (fps)
Irrigation Pipe in Montgomery Ave	1500	275	6	0.6	9.0	3.1
Interior Street Irrigation Piping	3000	150	4	1.4	42.3	3.8
Total	4500				51.3	

Willowbank CSA Pump HP Estimate		
Well Pump Requirements		Notes
PS Elevation (feet)	40	Based on topo
HP Elevation (feet)	50	Estimated based on topo
Pipe Headlosses (feet)	51.30	From calcs to the left
Suction Head (feet)	125	70' PWL + 55' seasonal fluctuation
Residual Pressure Needed	115	50 psi = 115'
Total Head Required (feet)	301.68	
Flow Per Pump (gpm)	515	From report, based on estimated Peak Hour Flows
Total Flow Needed (gpm)	515	
Number of Pumps Needed	1	
Pump Efficiency	77%	Assumed
Motor Efficiency	95%	Assumed
Pump HP Required	50.95	
Power Required for Pump Station (kW)	40.00	
Electrical Service Size (Amps)	61	

APPENDIX C

Estimated Costs

WILLOWBANK CSA IRRIGATION SYSTEM SEPARATION FEASIBILITY STUDY
ALTERNATIVE 2
PRELIMINARY COST ESTIMATE

Individual Homeowner Well Alternative

	Description	Unit	Unit Price	Quantity	Cost, $	Contingency (30%)	Total Estimated Cost
	Oakside Neighborhood (39 Lots)						
	300-foot deep well, 4-inch diameter	EA	$45,000.00	39	$1,755,000	$526,500	$2,281,500
	2 HP Well Pump	EA	$3,500.00	39	$136,500	$40,950	$177,450
	Misc Connections to Existing Homeowner Piping	EA	$2,500.00	39	$97,500	$29,250	$126,750
	Planning, Engineering, & Design	LS	5%	1	$99,450	$29,835	$129,285
	Environmental Permitting	LS	5%	1	$99,450	$29,835	$129,285
	Subtotal Oakside Neighborhood Improvements				$2,188,000	$656,000	$2,844,000
	Willowbank Neighborhood (45 Lots)						
	300-foot deep well, 4-inch diameter	EA	$45,000.00	45	$2,025,000	$607,500	$2,632,500
	Well Pump	EA	$3,500.00	45	$157,500	$47,250	$204,750
	Misc Connections to Existing Homeowner Piping	EA	$2,500.00	45	$112,500	$33,750	$146,250
	Planning, Engineering, & Design	LS	5%	1	$114,750	$34,425	$149,175
	Environmental Permitting	LS	5%	1	$114,750	$34,425	$149,175
	Subtotal Willowbank Neighborhood Improvements				$2,525,000	$757,000	$3,282,000
	Meadowbrook Neighborhood (36 Lots)						
	300-foot deep well, 4-inch diameter	EA	$45,000.00	36	$1,620,000	$486,000	$2,106,000
	Well Pump	EA	$3,500.00	36	$126,000	$37,800	$163,800
	Misc Connections to Existing Homeowner Piping	EA	$2,500.00	36	$90,000	$27,000	$117,000
	Planning, Engineering, & Design	LS	5%	1	$91,800	$27,540	$119,340
	Environmental Permitting	LS	5%	1	$91,800	$27,540	$119,340
	Subtotal Oakside Neighborhood Improvements				$2,020,000	$606,000	$2,625,000
				Total	**$6,733,000**	**$2,019,000**	**$8,751,000**

Printed: 10/18/2015

WILLOWBANK CSA IRRIGATION SYSTEM SEPARATION FEASIBILITY STUDY
ALTERNATIVE 3
PRELIMINARY COST ESTIMATE

One Well Per Neighborhood w/ New Irrigation Main Alternative

	Description	Unit	Unit Price	Quantity	Cost, $	Contingency (30%)	Total Estimated Cost
	Oakside Neighborhood (39 Lots)						
	Mobilization	LS	5%	1	$30,340	$9,102	$39,442
	4" AC Paving	SY	$70.00	1,200	$84,000	$25,200	$109,200
	AC Removal	SY	$9.00	1,200	$10,800	$3,240	$14,040
	4-Inch PVC Waterline (Incl. treching & backfill)	LF	$20.00	2,700	$54,000	$16,200	$70,200
	1-Inch diameter irrigation service lateral (up to 200')	EA	$3,500	39	$136,500	$40,950	$177,450
	Misc Connections to Existing Homeowner Piping	EA	$1,500	39	$58,500	$17,550	$76,050
	300-foot deep, 8-Inch diameter well w/ pump, motor & enclosure	EA	$165,000	1	$165,000	$49,500	$214,500
	Blow-off Assemblies / Air Valves	EA	$4,500.00	3	$13,500	$4,050	$17,550
	Misc Valves	EA	$1,500.00	7	$10,500	$3,150	$13,650
	Water Meters	EA	$1,000.00	39	$39,000	$11,700	$50,700
	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Land Acquisitioin	EA	$150,000	1	$150,000	$45,000	$195,000
	Planning, Engineering, & Design	LS	7%	1	$44,600	$13,380	$57,980
	Environmental Permitting	LS	7%	1	$44,600	$13,380	$57,980
	Construction Management	LS	3%	1	$19,114	$5,734	$24,848
	Subtotal Oakside Improvements				$895,000	$269,000	$1,164,000
	Willowbank Neighborhood (45 Lots)						
	Mobilization	LS	5%	1	$34,519	$10,356	$44,875
	4" AC Paving	SY	$70.00	1,511	$105,778	$31,733	$137,511
	AC Removal	SY	$9.00	1,511	$13,600	$4,080	$17,680
	4-Inch PVC Waterline (Incl. treching & backfill)	LF	$20.00	3,400	$68,000	$20,400	$88,400
	1-inch diameter irrigation service lateral (up to 200')	EA	$3,500	39	$136,500	$40,950	$177,450
	Disconnect potable/irrigation service on each lot	EA	$2,500	39	$97,500	$29,250	$126,750
	300-foot deep, 8-Inch diameter well w/ pump, motor & enclosure	EA	$165,000	1	$165,000	$49,500	$214,500
	Blow-off Assemblies / Air Valves	EA	$4,500.00	4	$18,000	$5,400	$23,400
	Misc Valves	EA	$1,500.00	10	$15,000	$4,500	$19,500
	Water Meters	EA	$1,000.00	36	$36,000	$10,800	$46,800
	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Land Acquisitioin	EA	$150,000	0	$0	$0	$0
	Planning, Engineering, & Design	LS	7%	1	$50,743	$15,223	$65,966
	Environmental Permitting	LS	7%	1	$50,743	$15,223	$65,966
	Construction Management	LS	3%	1	$21,747	$6,524	$28,271
	Subtotal Willowbank Improvements				$848,000	$254,000	$1,103,000

Printed: 10/18/2015

WILLOWBANK CSA IRRIGATION SYSTEM SEPARATION FEASIBILITY STUDY
ALTERNATIVE 3
PRELIMINARY COST ESTIMATE

One Well Per Neighborhood w/ New Irrigation Main Alternative

	Description	Unit	Unit Price	Quantity	Cost, $	Contingency (30%)	Total Estimated Cost
	Meadowbrook Neighborhood (36 Lots)						
	Mobilization	LS	5%	1	$31,791	$9,537	$41,328
	4" AC Paving	SY	$70.00	1,289	$90,222	$27,067	$117,289
	AC Removal	SY	$9.00	1,289	$11,600	$3,480	$15,080
	4-Inch PVC Waterline (incl. treching & backfill)	LF	$20.00	2,900	$58,000	$17,400	$75,400
	1-inch diameter irrigation service lateral (up to 200')	EA	$3,500	36	$126,000	$37,800	$163,800
	Disconnect potable/irrigation service on each lot	EA	$2,500	36	$90,000	$27,000	$117,000
	300-foot deep, 8-inch diameter well w/ pump, motor & enclosure	EA	$165,000	1	$165,000	$49,500	$214,500
	Blow-off Assemblies / Air Valves	EA	$4,500.00	3	$13,500	$4,050	$17,550
	Misc Valves	EA	$1,500.00	7	$10,500	$3,150	$13,650
	Water Meters	EA	$1,000.00	36	$36,000	$10,800	$46,800
	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
	Land Acquisition	EA	$150,000	1	$150,000	$45,000	$195,000
	Planning, Engineering, & Design	LS	7%	1	$46,733	$14,020	$60,753
	Environmental Permitting	LS	7%	1	$46,733	$14,020	$60,753
	Construction Management	LS	3%	1	$20,028	$6,008	$26,036
	Subtotal Meadowbrook Improvements				$931,000	$279,000	$1,210,000
				Total	**$2,674,000**	**$802,000**	**$3,477,000**

WILLOWBANK CSA IRRIGATION SYSTEM SEPARATION FEASIBILITY STUDY
ALTERNATIVE 4
PRELIMINARY COST ESTIMATE

New Irrigation Well w/ New Irrigation Main Alternative

Item	Description	Unit	Unit Price	Quantity	Cost, $	Contingency (30%)	Total Estimated Cost
	Oakside Neighborhood (39 Lots)						
0	Mobilization	LS	5%	1	$27,265	$8,180	$35,445
2	4" AC Paving	SY	$70.00	1,200	$84,000	$25,200	$109,200
3	AC Removal	SY	$9.00	1,200	$10,800	$3,240	$14,040
4	4-Inch PVC Waterline (Incl. treching & backfill)	LF	$20.00	1,500	$30,000	$9,000	$39,000
5	6-Inch PVC Waterline (Incl. trenching & backfill)	LF	$25.00	1,200	$30,000	$9,000	$39,000
6	1-inch diameter irrigation service lateral (up to 200')	EA	$3,500	39	$136,500	$40,950	$177,450
7	Misc Connections to Existing Homeowner Piping	EA	$1,500	39	$58,500	$17,550	$76,050
8	300-foot deep, 12-inch diameter well w/ pump, motor & enclosure (prorated)	EA	$97,500	1	$97,500	$29,250	$126,750
9	Blow-off Assemblies / Air Valves	EA	$4,500.00	3	$13,500	$4,050	$17,550
10	Misc Valves	EA	$1,500.00	7	$10,500	$3,150	$13,650
11	Water Meters	EA	$1,000.00	39	$39,000	$11,700	$50,700
12	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
12	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
14	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
15	Planning, Engineering, & Design	LS	7%	1	$40,080	$12,024	$52,104
16	Environmental Permitting	LS	7%	1	$40,080	$12,024	$52,104
17	Construction Management	LS	3%	1	$17,177	$5,153	$22,330
	Subtotal Oakside Improvements				$670,000	$201,000	$871,000
	Willowbank Neighborhood (45 Lots)						
0	Mobilization	LS	5%	1	$32,144	$9,643	$41,787
2	4" AC Paving	SY	$70.00	1,511	$105,778	$31,733	$137,511
3	AC Removal	SY	$9.00	1,511	$13,600	$4,080	$17,680
4	4-Inch PVC Waterline (Incl. treching & backfill)	LF	$20.00	2,400	$48,000	$14,400	$62,400
5	6-Inch PVC Waterline (Incl. trenching & backfill)	LF	$25.00	1,000	$25,000	$7,500	$32,500
6	1-inch diameter irrigation service lateral (up to 200')	EA	$3,500	39	$136,500	$40,950	$177,450
7	Disconnect potable/irrigation service on each lot	EA	$2,500	39	$97,500	$29,250	$126,750
8	300-foot deep, 12-inch diameter well w/ pump, motor & enclosure (prorated)	EA	$112,500	1	$112,500	$33,750	$146,250
9	Blow-off Assemblies / Air Valves	EA	$4,500.00	4	$18,000	$5,400	$23,400
10	Misc Valves	EA	$1,500.00	10	$15,000	$4,500	$19,500
11	Water Meters	EA	$1,000.00	36	$36,000	$10,800	$46,800
12	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
12	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
14	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
15	Planning, Engineering, & Design	LS	7%	1	$47,252	$14,176	$61,428
16	Environmental Permitting	LS	7%	1	$47,252	$14,176	$61,428
17	Construction Management	LS	3%	1	$20,251	$6,075	$26,326
	Subtotal Willowbank Improvements				$790,000	$237,000	$1,027,000

Printed: 10/18/2015

WILLOWBANK CSA IRRIGATION SYSTEM SEPARATION FEASIBILITY STUDY
ALTERNATIVE 4
PRELIMINARY COST ESTIMATE

New Irrigation Well w/ New Irrigation Main Alternative

Item	Description	Unit	Unit Price	Quantity	Cost, $	Contingency (30%)	Total Estimated Cost
	Meadowbrook Neighborhood (36 Lots)						
0	Mobilization	LS	5%	1	$28,241	$8,472	$36,713
2	4" AC Paving	SY	$70.00	1,289	$90,222	$27,067	$117,289
3	AC Removal	SY	$9.00	1,289	$11,600	$3,480	$15,080
4	4-inch PVC Waterline (Incl. treching & backfill)	LF	$20.00	2,100	$42,000	$12,600	$54,600
5	6-inch PVC Waterline (Incl. trenching & backfill)	LF	$25.00	800	$20,000	$6,000	$26,000
6	1-inch diameter irrigation service lateral (up to 200')	EA	$3,500	36	$126,000	$37,800	$163,800
7	Disconnect potable/irrigation service on each lot	EA	$2,500	36	$90,000	$27,000	$117,000
8	300-foot deep, 12-inch diameter well w/ pump, motor & enclosure (prorated)	EA	$90,000	1	$90,000	$27,000	$117,000
9	Blow-off Assemblies / Air Valves	EA	$4,500.00	3	$13,500	$4,050	$17,550
10	Misc Valves	EA	$1,500.00	7	$10,500	$3,150	$13,650
11	Water Meters	EA	$1,000.00	36	$36,000	$10,800	$46,800
12	Chlorine Injection System	EA	$15,000.00	1	$15,000	$4,500	$19,500
12	Pipeline Testing & Flushing	LS	$10,000.00	1	$10,000	$3,000	$13,000
14	Prepare & Implement SWPPP / Erosion Control	LS	$10,000.00	1	$10,000	$3,000	$13,000
15	Planning, Engineering, & Design	LS	7%	1	$41,514	$12,454	$53,968
16	Environmental Permitting	LS	7%	1	$41,514	$12,454	$53,968
17	Construction Management	LS	3%	1	$17,792	$5,338	$23,130
	Subtotal Meadowbrook Improvements				$694,000	$208,000	$902,000
				Total	**$2,154,000**	**$646,000**	**$2,800,000**

Printed: 10/18/2015

APPENDIX D

Estimated O&M Costs

WILLOWBANK CSA IRRIGATION SEPARATION FEASIBILITY STUDY
ALTERNATIVE 2
EQUIVALENT ANNUAL COST ESTIMATES

1. Equivalent Annual Initial Cost Estimate			
		Present Value =	$8,751,000
n	Cost of Capital		
40	3%		
Annual Cost Based Upon 40-Year Life			$378,589.07

2. Estimated Annual O&M Costs		
Est. Cost of Annual Inspection per well	Number of Wells	
$500	120	
Estimated Annual O&M Cost		$60,000.00

3. Estimated Annual Electrical Service Costs			
Cost Per kW	Pump Energy (kW)	Est. Annual Run-time (hr) per du	Number of Pumps
0.15560	1.5	405	120
Estimated Annual Electrical Service Costs			**$11,343.24**

*Assumes 243,000 gallons of outdoor water per year @ 10 gpm pump

4. Well Replacement At End of Design Life (40-years)			
		Present Value =	$5,400,000
	i[1]		
n	3	Future Value[2]	Present Value
40	0.04326	$ 11,464,658	$ 3,514,569.47
Annual Cost Based Upon 40-Year Life			$ 152,048.63

*Assumes $45,000 per well x 120 wells

Total Estimated Annual Cost	$	601,980.94

WILLOWBANK CSA IRRIGATION SEPARATION FEASIBILITY STUDY
ALTERNATIVE 3
EQUIVALENT ANNUAL COST ESTIMATES

1. Equivalent Annual Initial Cost Estimate			
		Present Value =	$3,477,000
n	Cost of Capital		
40	3%		
Annual Cost Based Upon 40-Year Life			**$150,423.29**

2. Estimated Annual O&M Costs		
Est. Cost of Annual Inspection per well	Number of Wells	
$1,500	3	
Estimated Annual O&M Cost		**$4,500.00**

3. Estimated Annual Electrical Service Costs			
Cost Per kW	Pump Energy (kW)	Est. Annual Run-time (hr) per pump	Number of Pumps
0.15560	15.0	810	3
Estimated Annual Electrical Service Costs			**$5,671.62**

*Assumes 243,000 gallons of outdoor water per year, per DU @ 200 gpm per pump

4. Well Replacement At End of Design Life (40-years)			
		Present Value =	$450,000
	i[1]		
n	3	Future Value[2]	Present Value
40	0.04326	$ 955,388	$ 292,880.79
Annual Cost Based Upon 40-Year Life			$ 12,670.72

*Assumes three new wells @ $150,000/well

Total Estimated Annual Cost	$	173,265.63

WILLOWBANK CSA IRRIGATION SEPARATION FEASIBILITY STUDY
ALTERNATIVE 4
EQUIVALENT ANNUAL COST ESTIMATES

1. Equivalent Annual Initial Cost Estimate			
		Present Value =	$2,800,000
n	Cost of Capital		
40	3%		
Annual Cost Based Upon 40-Year Life			$121,134.66

2. Estimated Annual O&M Costs		
Est. Cost of Annual Inspection per well	Number of Wells	
$1,500	1	
Estimated Annual O&M Cost		**$1,500.00**

3. Estimated Annual Electrical Service Costs			
Cost Per kW	Pump Energy (kW)	Est. Annual Run-time (hr) per pump	Number of Pumps
0.15560	40.0	944	1
Estimated Annual Electrical Service Costs			$5,873.52

*Assumes 243,000 gallons of outdoor water per year, per DU @ 515 gpm per pump

4. Well Replacement At End of Design Life (40-years)				
		Present Value =		$300,000
	i[1]			
n	3	Future Value[2]		Present Value
40	0.04326	$ 636.925	$	195,253.86
Annual Cost Based Upon 40-Year Life			$	8,447.15

*Assumes one new well @ $300,000/well

Total Estimated Annual Cost	$	136,955.33

WILLOWBANK CSA IRRIGATION SEPARATION FEASIBILITY STUDY
ALTERNATIVE 4B
EQUIVALENT ANNUAL COST ESTIMATES

1. Equivalent Annual Initial Cost Estimate			
		Present Value =	$2,629,300
n	Cost of Capital		
40	3%		
Annual Cost Based Upon 40-Year Life			$113,749.77

2. Estimated Annual O&M Costs		
Est. Cost of Annual Inspection per well	Number of Wells	
$1,500	1	
Estimated Annual O&M Cost		$1,500.00

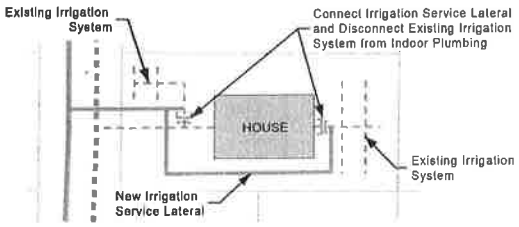
3. Estimated Annual Electrical Service Costs			
Cost Per kW	Pump Energy (kW)	Est. Annual Run-time (hr) per pump	Number of Pumps
0.15560	40.0	944	1
Estimated Annual Electrical Service Costs			$5,873.52

*Assumes 243,000 gallons of outdoor water per year, per DU @ 515 gpm per pump

4. Well Replacement At End of Design Life (40-years)			
		Present Value =	$300,000
	i[1]		
n	3	Future Value[2]	Present Value
40	0.04326	$ 636,925	$ 195,253.86
Annual Cost Based Upon 40-Year Life			$ 8,447.15

*Assumes one new well @ $300,000/well

Total Estimated Annual Cost	$	129,570.44



1 TYPICAL LOT CONNECTION DETAIL

ONE WELL PER NEIGHBORHOOD ALTERNATIVE

WILLOWBANK CSA
YOLO COUNTY, CALIFORNIA
AUGUST, 2015

- Meadowbrook Neighborhood
- Willowbank Neighborhood
- Oakside Neighborhood
- Proposed Well Location
- Alternate Well Locations
- New Irrigation Water Main
- Existing Water Main to Provide Potable & Fire Flows Only

NEIGHBORHOOD	No. OF LOTS	4" PIPE	6" PIPE
MEADOWBROOK NEIGHBORHOOD	35	2800	0
WILLOWBANK NEIGHBORHOOD	45	3400	0
OAKSIDE NEIGHBORHOOD	39	2700	0

NOTE: The three most western lots on Montgomery were never part of the Oakside Water District that was terminated in 1999+/-. For purposes of this evaluation, they are assumed to be included in the Oakside Neighborhood.

PRELIMINARY

WOOD RODGERS

FIGURE 1