MWH

MEMORANDUM

To: Olen Zirkle, Ducks Unlimited

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Subject: Task 7.1e - Energy Requirements of the Ranney Well Water Supply **(DRAFT)**

Attachment:

Purpose

This memorandum summarizes the energy analysis completed for the proposed M&T Chico Ranch/Rancho Llano Seco Ranney Well Option, estimated operational costs for alternative sources of energy and capital costs for project construction. Assumptions made for this analysis included a total of four collector well caissons pumping at 24.25 mgd (37 cfs) that were spaced 1,000 to 1,500 feet apart from each other, refer to **Figure 1**. Additionally, this evaluation is for pumping to the existing M&T/Llano Seco Pumping Plant only and is based on a condition for pumping of 24.25 mgd per well.

Introduction

The M&T Chico Ranch/Rancho Llano Seco Pumping Plant replacement feasibility study has evaluated several alternatives for ensuring a reliable source of supply for crop irrigation and wildlife habitat. The location of the existing M&T/Llano Seco Pumping Plant is on the Sacramento River (refer to Figure 1) and has in recent years experienced a decline in the sweeping flows due to a large gravel bar forming and a westward river migration.

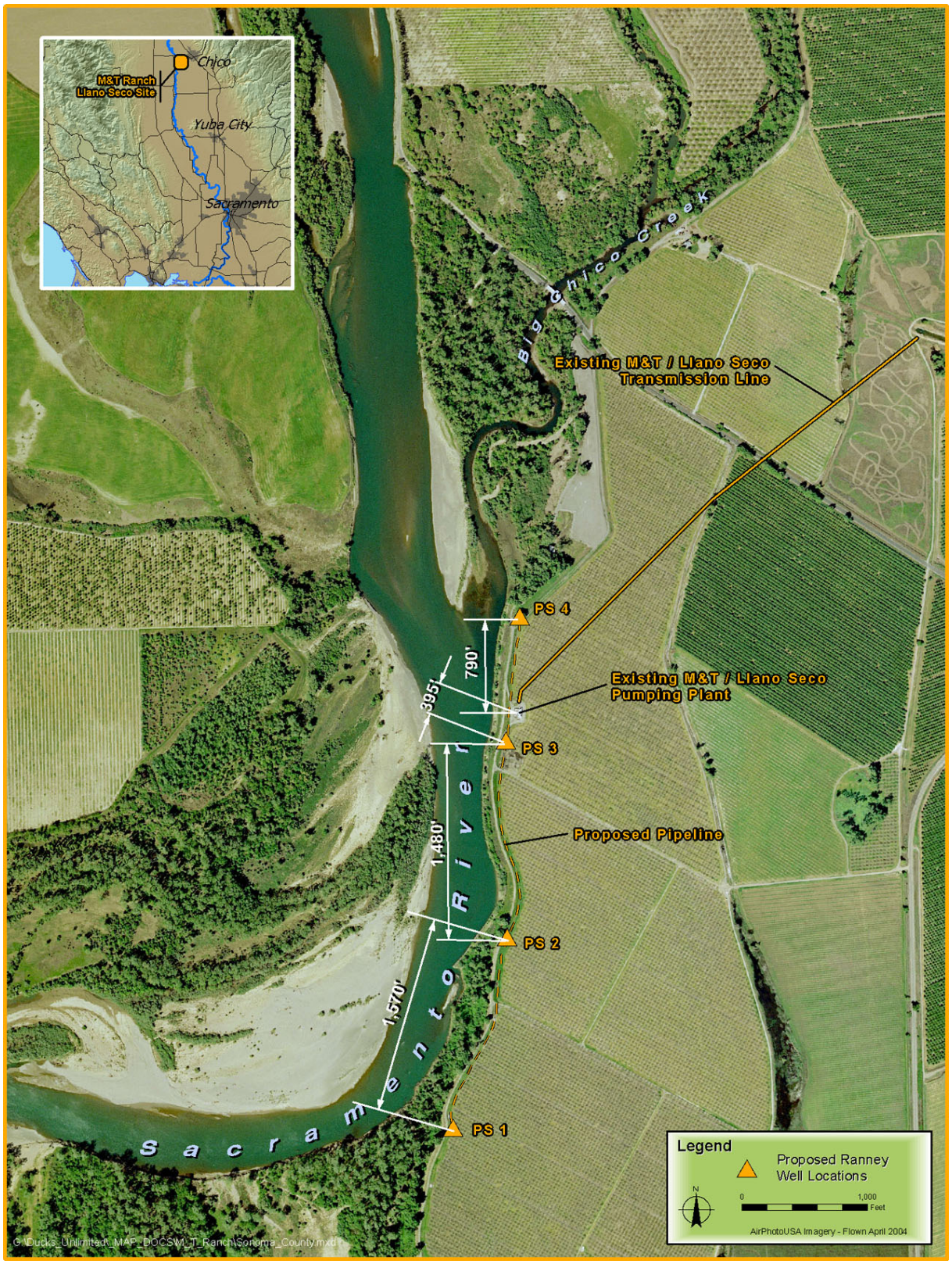

FIGURE 1. Location of Proposed Ranney Wells and Existing M&T/Llano Seco Pumping Plant

One of the alternatives that received evaluation involved construction of four Ranney Wells with a capacity of 24.25 mgd (37 cfs) each to be connected to the existing M&T/Llano Seco Pumping Plant. These wells would be located along the Sacramento River located based on hydrogeologic analysis for optimized pumping yield and proximity to the river. The wells locations would take on a linear configuration along the Sacramento River, three wells south of the existing pump station and one to the north, see Figure 1. The overall system would connect each Ranney Well by a pipeline manifold and have one common connection to the exiting stilling basin to the M&T/Llano Seco Pumping Plant. Several alternatives were considered for sizing of the pipelines, the end result of this analysis considered the cost of construction compared to the required energy for pumping due to the frictional losses experienced along the conveyance route to the delivery point. Since energy usage will be a reoccurring yearly cost, the pipe material and sizing criteria was developed to ensure that the cost for pumping was minimized where possible.

Evaluation

The evaluation considered the cost of several alternative sources of power for operation of the four proposed Ranney Wells. The sources of power that were evaluated for the Ranney Well pump stations included electricity, diesel fuel, natural gas, and gasoline. Each type of energy was evaluated under varying total dynamic head (TDH) and total flow pumped per year. The TDH represents the lift, minor, and frictional losses experienced within the pumping system. For this analysis, 60 feet of drawdown, 20 feet to the point of delivery and 5 feet to keep facilities above the flood elevation represents the total lift. For minor losses and frictional losses in the pump station, discharge piping, valves, fittings and meters, an additional 15 feet was assumed. These losses add up to our baseline TDH without transmission main frictional losses of 100 feet. The total flow pumped per year used for evaluation included a range of flow which generally represents the pumping requirements of the M&T/Llano Seco Pumping Plant. Three annual flow conditions, 20,000, 30,000 and 40,000 acre-feet, were used for developing costs for the alternate types of energy.

The assumptions for the pumping energy consumption, efficiency and cost of energy are listed below in **Table 1**.

TABLE 1: Alternative Energy Cost/Performance Assumptions

Energy	Consumption/ Performance	Pumping System Efficiency (%)	Unit Cost [2]
Electricity	-	75	$0.20/kW-hr
Diesel Fuel	11.1 whp hr/gal	75	$2.25/gallon
Natural Gas	8.5 whp hr/gal	75	$8.60/dekatherm[1]
Gasoline	6.7 whp hr/gal	75	$2.25/gallon

Notes:
(1) Future cost of $8.00/dekatherm plus $0.60 PG&E cost for transmission.
(2) Information provided by Les Heringer, Ranch Manager at M&T Chico Ranch.

The pipe material used for the transmission main piping in this analysis was High Density Polyethylene (HDPE). There are several benefits in using HDPE, one that is favorable for our application is that the pipe has a very high Hazen Williams "C Factor". This type of pipe has a very smooth interior wall and allows water to move through the pipe with very small frictional losses. These frictional losses contribute to the overall energy required to move the water through the pipeline to the delivery point. The sizing criteria for this study included the velocity in the pipe and the subsequent headloss experienced per foot of pipeline. The velocity in the pipe is a function of the diameter of the pipe and the rate of flow. Several diameters were evaluated for the various sections along the pipeline, see **Table 2**. The overall pipeline has combined flow at two locations along the pipeline and a third at the connection to the existing stilling basin. Those sections of pipeline have increased diameters to accommodate the increased flow as required to convey subsequent segments to the stilling basin. For the flow conditions anticipated a comparison of pipe diameters, pipe velocity and headloss is shown in **Table 2.**

TABLE 2: Comparison of Pipe Diameters, Flow, Velocity and Headloss

Segment	Diameter (inches)	Flow (mgd)	Flow (gpm)	Velocity (fps)	Length (ft.)	Frictional Losses (ft/1000 ft)	Friction Losses (ft)
PS1-PS2	30	24.25	16,840	8.7	1,530	5.7	8.7
	32			7.7		4.2	6.4
	36			6.1		2.3	3.6
	42			4.5		1.1	1.7
PS-2-PS3	36	48.5	33,681	12.2	1,480	8.4	12.5
	42			8.9		4.0	5.9
	48			6.1		1.6	2.3
	54			4.8		.9	1.3
PS3-ESW	42	72.75	50,521	13.4	395	8.4	3.3
	48			9.2		3.3	1.3
	54			7.2		1.9	0.7
	63			5.9		1.2	0.5
PS4-ESW	28	24.25	16,840	8.7	780	5.7	4.4
	32			7.7		4.2	3.2
	36			6.1		2.3	1.8
	42			4.5		1.1	0.9

One of the parameters used for the selection of the pipe diameters for the various segments of pipe was maximum velocity. For transmission main piping a standard for design velocity in the pipeline is between 7 to 8 fps. **Table 1** shows the line diameters highlighted that are less 7.5 fps.

The pump station discharge piping is configured to reduce the amount of overall losses that pumps will have to overcome in terms of energy in conveying the water to the delivery point. Typical pump station discharge lines include valves and appurtenances to allow for pump station maintenance and to reduce damage to the pumps on startup and shutdown. The discharge lines for the purpose of this analysis are assumed to have a butterfly valve and a check valve on the individual pump discharge lines prior to connection to a common header that begins the transmission pipeline. These valves also contribute to the overall losses in the piping known as minor losses. Minor losses are a function of velocity in the pipeline and the type of obstruction to flow that the appurtenance creates within the flow path.

Conclusion

The conclusions made within this Technical Memorandum will require further confirmation during future phases of the development for this project. Review of frictional losses in the HDPE pipeline shows that with the short sections of pipeline and the general constraint of velocity not to exceed 7.5 fps, the diameters shown in **Table 3** are recommended.

The baseline for the pumping system total dynamic head (TDH) without pipeline friction, was 100 feet. The frictional losses for the various pipe diameters were added to this baseline of 100 feet for the evaluation of the alternative energy. The results of this evaluation are shown in **Table 3,** natural gas appears to be the least expensive energy available for the alternative selected.

The capital cost of construction for the various sizes of piping is shown in **Table 4**. The combination of pipe diameters used was based on a maximum velocity of 7.5 fps, depicted as Alternative 3. It has been assumed that the pipeline will have isolation valves at 500 foot intervals between connecting pipe from each of the Ranney Well sites. These costs are preliminary and include the cost of material, labor, and dewatering required for the lengths of pipe connecting the Ranney Wells and a single tie-in to the existing stilling basin for the existing M&T/Llano Seco Pumping Plant. The conceptual level capital costs anticipated for construction of the Ranney Wells for the capacities as described previously are shown below in **Table 5**. These costs include caisson construction and well equipment, discharge piping, valves and fittings.

TABLE 5: Conceptual Level Ranney Well Capital Costs

Description	Unit Cost	No.	Cost
Ranney Wells @ 24.25 mgd	$3,737,500[(1)]	4	$14,950,000
Contingency (30%)	$1,121,250	4	$4,485,000
Engineering, admin/legal (30%)	$1,121,250	4	$4,485,000
Total			$23,920,000

Notes:
(1) Costs do not include sitework, primary power feed, and land acquisition.

Table 6 shows a conceptual level cost summary for construction of the Ranney Wells and pipelines for the project. These costs are on a feasibility level only and will require further study and confirmation at future phases of the development of the project.

TABLE 6: Conceptual Capital Costs Summary

Description	Cost
Ranney Wells	$23,920,000
Pipelines	$2,629,500
Total	$26,549,500

The costs estimated for operations and maintenance (O&M) of the facilities and the cost of energy are summarized as the reoccurring annual costs for the new Ranney Well Collectors and Pump Stations in **Table 7**. Refer to Technical Memorandum 7f. for assumptions and descriptions of the estimates for the costs of operations and maintenance for the facilities described.

These costs do not represent the costs associated with the existing M&T/Llano Seco Pumping Plant. All of the information within this Technical Memorandum reflects only the Ranney Well Collectors and associated Pump Stations to deliver water to the existing M&T/Llano Seco Pumping Plant stilling well.

TABLE 7: Operations and Maintenance Costs
Ranney Well Collectors, Pump Stations and Pipelines

Description	Energy Cost	Maintenance/ Services[(1)]	Cost/year	Cost/year/AF
20,000 AF/yr	$444,100	$162,125	$606,225	$30.31
30,000 AF/yr	$666,300	$174,375	$840,675	$28.02
40,000 AF/yr	$888,200	$187,375	$1,075,575	$26.89

Notes:

(1) Maintenance costs were estimated based on the cost of construction of the pumps, motors and controls. These costs include the cost for maintenance for the line valves also. For additional pumping it is estimated that there would be a small increase in maintenance to account for additional wear on parts, taken as approximately 7.5%.