

TECHNICAL MEMO

TO: Sandy Hemenway

FROM: Mat Weaver, PE

Date: October 17, 2011

RE: **WR 79-14053 – Water Demand Analysis of City of White Bird**

This memo is a review of my analysis of the City of White Bird's (City) municipal water demand in association with the licensing of water right (WR) 79-14053. The city of White Bird has two wells that are pumped by 7.5 and 10 horsepower (HP) submersible pumps respectively, both of which are set approximately 280 feet below ground surface. The water mains coming off the wells are combined into a single water main inside a nearby pump house where a flow meter has been installed to measure the combined diversion rate of both wells. The combined water main supplies water to two water storage tanks located approximately 2,132 feet southeast of the pump house. Water is provided to the City from the two municipal storage tanks. During the field examination the examiner witnessed a flow rate in the pump house of 88 gallons per minute (GPM) or 0.20 cubic feet per second (CFS). At the time of the observed flow rate only one well was running. An operator of the City's system indicated that it is common to have both wells provide water to the storage tanks simultaneously. Because the field examiner did not observe the system operating with both wells in service simultaneously, the observed flow rate was not indicative of a maximum diversion rate.

To determine a maximum diversion rate for licensing purposes I have relied on my understanding of the municipal water delivery system and the Goulds Pump Model 70L pump curves provided by the City. The City did not provide operating points superimposed on the pump curves. Therefore, I created operating points for each submersible pump based on a total dynamic head (TDH) of 371 feet as calculated based on my analysis and understanding of the system. TDH is comprised of an elevation head, pressure head, and friction head. I assumed an elevation head of 312 feet, which I derived from the depth of the pumps below ground surface (280 feet), the elevation change between the well heads and the storage tanks (12 feet), and the height of the storage tank (20 feet). I assumed a pressure head of 23.1 feet. This value was determined by the examiner's visual observation of a pressure gage reading of the storage tanks' back pressure at the time of the exam. The City's operator indicated the observed pressure reading of 10 pounds per square inch (PSI) was typical of the system. Finally, I assumed a friction head of 19.4 feet. This value was calculated using the Hazen-Williams method. For my analysis I combined friction losses in the well casing and in the water mains downstream of the wells. Inside the well casing I assumed a 3-inch diameter welded seamless steel pipe discharging from the submersible pumps with a length of 280 feet and a Hazen Williams roughness coefficient of 100. For the water main I assumed a 4-inch diameter PVC plastic pipe with a length of 2,152 feet and a roughness coefficient of 130. Because of my lack of a detailed understanding of the plumbing and fittings between the well and the storage tanks I did not attempt to estimate minor losses associated with the system. I assumed TDH to be equal to the sum of the elevation head (312 feet), the pressure head (23.1 feet), and the friction head (35.5 feet). Based on the TDH value I was able to use the pump curves to find a pumping capacity of 34.3 GPM for the 7.5 HP submersible pump and 74.6 GPM for the 10 HP submersible pump. The combined pumping rate of both

pumps is 109 GPM or 0.24 cfs. Refer to the attached calculations, pump curves, and topographic map, which were used in my determination of TDH.

The City of White Bird submitted historical municipal water demand data for 2010. This data is summarized in an attached table titled 'City of White Bird 2010 Municipal Water Pumping Data'. From this data I was able to determine the average day demand (ADD) of 185 gallons per day (GPD) per capita and the maximum month average day demand (MMAD) of 314 GPD per capita for 2010. The City of White Bird did not provide peaking factor estimates. However, by assuming an MMAD to peak hourly demand (PHD) peaking factor of 1.95, as obtained from Table 6 of the RAFN handbook (draft v3), I was able to calculate a PHD of 612 GPD per capita or 45,932 GPD (i.e. 0.07 cfs) for the entire community. An alternative means of estimating PHD is to utilize the methodology summarized in appendix Item 4 of the RAFN handbook (draft v3). Using the methodology from appendix Item 4 I calculated a community PHD of 0.32 cfs assuming no residential irrigation component.

Because storage is used to meet the combined municipal demand of the City, the estimated demand values do not directly correlate with the diversion rate from the wells upstream of the storage tanks. However, it is the diversion rate from the wells upstream of the tanks that must be identified on the water right. Even though there is not a direct correlation, it is helpful to generally compare the two estimated demand values to the combined diversion rate of the two wells. If demand were significantly greater or less than the combined diversion rate from both wells this would be an indication that something was amiss. Conversely, if there is relatively good agreement between estimated demand values and combined diversions, this is an indication that the combined diversion rate has been reasonably identified.

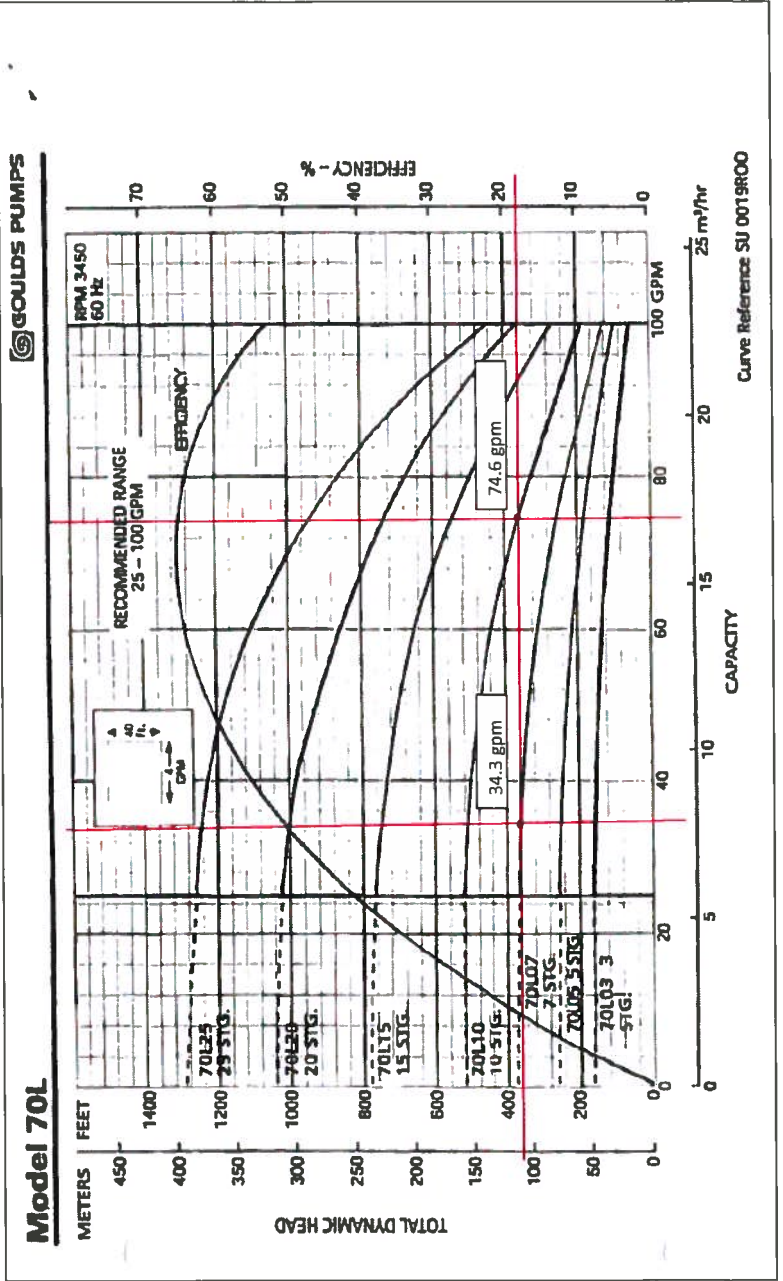
I recommend using the combined diversion rate of both wells, 0.24 cfs, in the licensing efforts associated with water right 79-14053. In my recent email to you dated 10/4/2011, I outlined three scenarios, each of which would result in a different diversion rate identified on the license. I have attached a copy of that email with this memo for your reference. Based on the findings of this memo I would suggest that we should proceed in licensing the WR in a manner consistent with scenario 2. That is, the diversion rate identified on the water right license should equal to the combine diversion of both wells (0.24 cfs) less the diversion rate already established by the City's existing WR 79-7208 (0.14 cfs). Therefore, the current WR 79-14503 should be licensed with a diversion rate of 0.10 cfs. In support of this decision the existing water right (79-7208) will need to be modified via transfer to include the two new wells as recognized points of diversion.

City of White Bird Total Dynamic Head (TDH) Calculation - Well 1 & Well 2

Pump level:	280	feet (depth of pump below grade)
Elev. Diff.	12	feet (elevation change from top of well casing to storage tanks)
Tank Height:	20	feet
Total Elev. Head:	312	feet
Back Press.:	10	psi (pressure in main line to storage tanks)
	23.1	feet
Total Press. Head:	23.1	feet
Length 1:	280	feet (8"φ pipe casing length in well)
Length 2:	2,152	feet (4"φ pipe length from well head to pump house to storage tanks)
Friction Head:	16.4	feet (friction head loss in well casing)
Friction Head :	19.1	feet (friction head loss in water main lines)
Minor Losses:	0	feet (not calculated b/c of lack of information on fittings)
Total Head:	370.6	feet (TDH assuming negligible friction loss)

Combined Flow Calculation

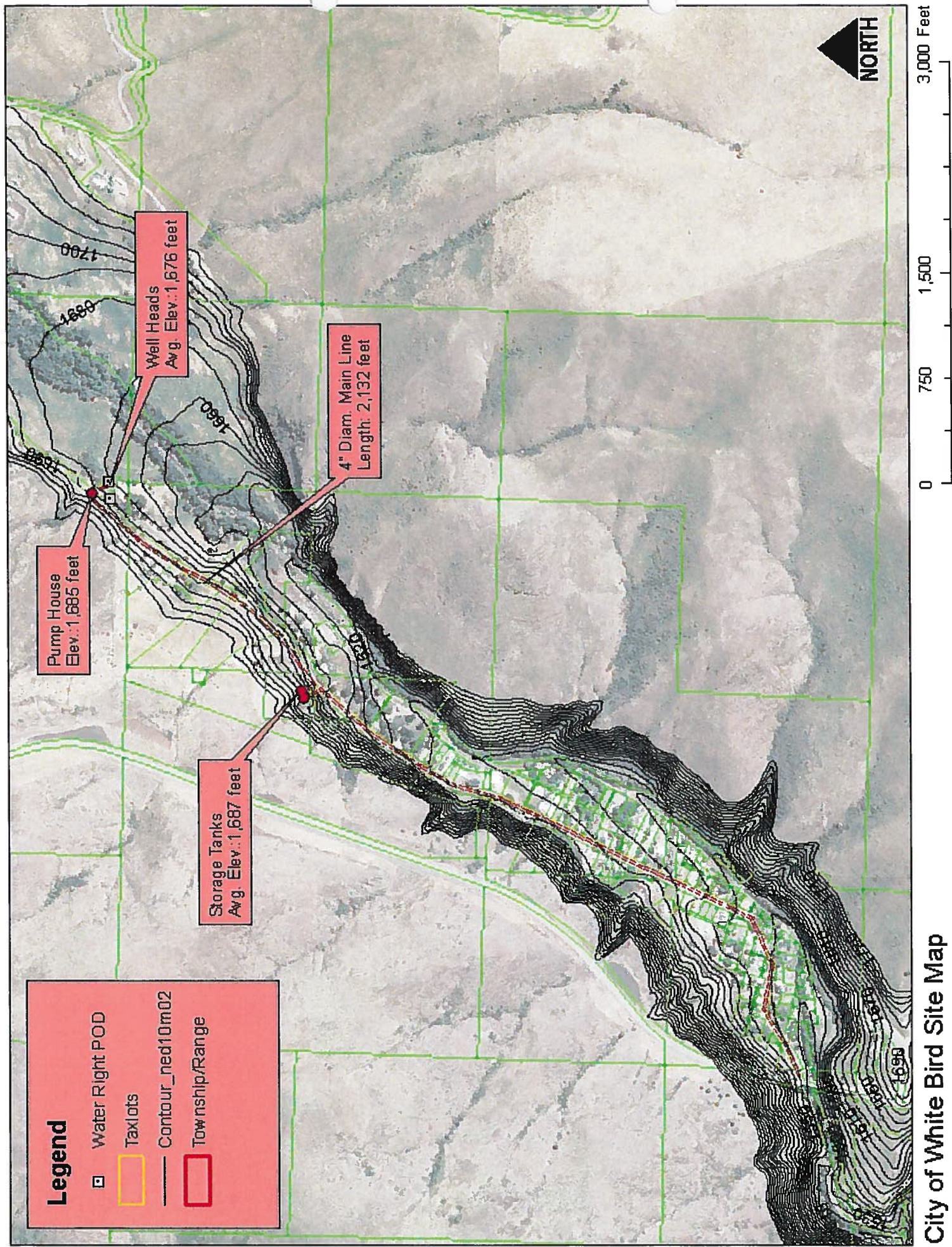
Well 1:	34.3	gpm
Well 2:	74.6	gpm
Total:	108.9	gpm
	0.24	cfs



City of White Bird 2010 Municipal Water Pumping Data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
No. of Days	31	28	31	30	31	30	31	31	30	31	30	31	365
Vol. (gallons)	409,100	375,020	420,090	237,980	454,310	535,000	337,500	730,200	552,300	362,700	328,700	324,700	5,067,600
ADD (GPD)	13,197	13,394	13,551	7,933	14,655	17,833	10,887	23,555	18,410	11,700	10,957	10,474	13,884
ADD/Home (GPD)	176	179	181	106	195	238	145	314	245	156	146	140	185
ADD (GPM)	9	9	9	6	10	12	8	16	13	8	8	7	10
ADD (CFS)	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.04	0.03	0.02	0.02	0.02	0.02
PF*	1.95												3.0
PHD (GPD)	45,932												41,652
PHD (GPM)	32												29
PHD (CFS)	0.07												0.06

Peaking Factors: PHD:MMAD 1.95 and PHD:ADD 3.00 as derived from Table 6 of the RAFN hand book.



Residential Demand Summary

Applicant:

City of White Bird

WR Number:

79-14053

Summary of User Input

W = 2.7 (unit per acre) gross housing density

n = 75 number of residences or residential units

Q_{ADD} Method: Department Default

V₂₀₁₀ = N/A avg. market value of residential unit

Q_{ADD} = 250 (GPD) In-home demand

IDWR Region: Western Administrative region where the proposed community is located.

P_{def} = 0.35 (inches) Precipitation Deficit

L_s Method: User Input

LS = 0.00 (acres) average irrigated area per residential unit

Q_{IRR} = 0 (GPD) Irrigation demand

σ_{MDD} = 272 (GPD) MDD variability term

σ_{PHD} = 410 (GPD) PHD variability term

Citations

Demand Methodology: Linaweaver, F. P., et al. (1967) A Study of Residential Water Use. Johns Hopkins University, for the Federal Housing Administration and the Department of Housing and Urban Development.
Pdef Data: Allen, Richard G. and Clarence W. Robison, 2009. Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho: Supplement updating the Time Series through December 2008, Research Technical Completion Report, Kimberly Research and Extension Center, University of Idaho, Moscow, ID.

Maximum Day Demand Flow Rate (QMDD)

$$Q_{MDD} = Q_{ADD} + Q_{IRR} + 2(\sigma_{MDD})$$

Q_{MDD} = 795 GPD per residential unit

Q_{MDD} = 59,598 GPD total community

Q_{MDD} = 0.09 CFS total community

Peak Hour Demand Flow Rate (Q_{PHD})

$$Q_{PHD} = 334 + 2.02(Q_{MDD}) + 2(\sigma_{PHD})$$

Q_{PHD} = 2,760 GPD per residential unit

Q_{PHD} = 207,001 GPD total community

Q_{PHD} = 0.32 CFS total community

Notes:

W value is based on evaluation of sample block from aerial imagery. Ls is based on evaluation of sample lots from aerial imagery. N based on field exam.

Weaver, Mathew

From: Weaver, Mathew
Sent: Tuesday, October 04, 2011 1:04 PM
To: Hemenway, Sandy
Subject: City of White Bird WR 79-14053

Sandy,

Let me briefly describe the White Bird system as I understand it. Two wells provide water via submersible pumps to two storage tanks for the City of White Bird. Pitless adapters are used in association with both wells and the supply lines coming off of both wells combine into a single line underground prior to entering the pump house. Once in the pump house a flow meter exists that reads the flow rate in the combined line before it exits the building and continues down system where it feeds two storage tanks. The storage tanks are used to meet the demand of the City of White Bird. In this scenario

During your site visit you were able to confirm a measurement reading at the flow meter but only with one pump running. You have indicated that the operator has acknowledged that at times both pumps run simultaneously to meet the storage fill requirement. During your observation of the flow meter it is unknown what head the pumps were working against in the tanks. Therefore, to understand the maximum diversion rate needed for the City of White Bird we need to know the diversion rate from the scenario in which both pumps are running against minimum head. We can estimate this with a theoretical calculation as you have done, but a better means of making this determination is to have the City provide us with their pumps curves superimposed by the operating point(s) of the system.

Depending on the combined flow rate value that we will ascertain from the pump curves the licensing of water right (WR) 79-14053 can go in several directions.

Scenario 1 ($Q < 0.14$ cfs)

If the combined flow rate of both pumps is less than 0.14 cfs then no additional increment of beneficial use has been established and we would in essence license the WR only in recognition of the new PODs. In this scenario we will want to include the following condition on the WR license.

This water right does not represent a rate of diversion in the City of _____ municipal water right portfolio. The diversion rate associated with this water right in combination with all other water rights is limited to the combined diversion rate of all other City of _____ water rights and the diversion rate of this water right shall not be included in any assessment of the combined diversion rate authority of the City of _____ both prior and subsequent to the priority date of this water right.

Scenario 2 ($0.14 \text{ cfs} < Q \leq 0.34 \text{ cfs}$)

If the combined flow rate of both pumps is greater than 0.14 cfs, but less than or equal to 0.34 cfs than an increment of beneficial use has been established and that increment can be completely covered by the existing WR and the pending WR 79-14053. In this instance we would license the pending WR for the difference between the combined flow rate of the pumps and 0.14 cfs (i.e. between 0.01-0.20 cfs). The existing WR of 79-7208 will need to be modified via transfer to include the two new wells as PODs.

Scenario 3 ($Q > 0.34 \text{ cfs}$)

If the combined flow rate of both pumps is greater than 0.34 cfs than an increment of beneficial use has been established as well as a need for a new WR permit application to accommodate the flow rate in excess of 0.34 cfs. In this instance we would license the pending WR for 0.20 cfs, modify WR 79-7208 by transfer to add the two new wells as PODs, and file a new application for permit for the additional use.

Mat Weaver, P.E.
Staff Engineer
Idaho Department of Water Resources
(208) 287-4914