

To: File

From: Mat Weaver

Date: December 27, 2011

RE: WR Permit 63-31243 - Technical Review of the BU Field Report's Recommended Diversion Rate

This memo is a summary of my technical review of the diversion rates calculated and presented in the field exam of water right permit 63-31243.

Recommended Combined Diversion Rate

During the field examination SPF Water Engineering (SPF) did not measure or observe a flow rate equal to the permitted diversion rate of 2.60 CFS. In place of a measured flow rate, SPF relied on pump curves to determine a combined flow rate based on estimated total dynamic heads (TDH). I was unclear of some of the details in SPF's estimation of TDH, which I will elaborate on below for each well.

Belmont Well #1 (9RCHC (7 stage, 50 hp) Goulds Pump)

My review of the flow rate calculation left me with several questions. Specifically, I was unsure of where the draw down value of 22.5 feet used to calculate the specific capacity term came from. I was also unsure of where the values used for deriving friction head loss and minor losses came from. In general, I was unsure why SPF assumed a TDH and solved for a discharge pressure, instead of calculating a TDH based on actual conditions and using the pump curves to determine the respective pumping rate.

In my review I assumed that TDH is equal to the sum of the vertical head, pressure head, friction head, and minor losses.¹ I assumed vertical head is equal to the static water surface elevation and the draw down associated with a specific pumping rate, which can be determined by the specific capacity relationship. The maximum pumping rate can be assumed to occur at minimum system pressures. In my calculations I assumed a minimum system pressure of 40 psi, which is identified as a minimum allowable operating pressure for new systems in the Idaho Rules for Public Drinking Water Systems (IDAPA 58.01.08 552.01.b.v). I relied on the common engineering practice of using the Hazen-Williams equation to calculate the friction head. My calculations of friction head assumed a Hazen-Williams Roughness Coefficient of 130. Regarding minor losses, without knowing the specific plumbing configuration, I was unable to determine a value and therefore assumed that it was zero.

The process for determining flow rate from the pump performance curves is iterative, as both draw down and friction head are dependent on flow rate, which in turn is dependent on draw down and friction head values for the determination of TDH. I required three iterations to solve

¹ I assumed velocity head was negligible.

for a flow rate that changed by less than 0.1% between iterations. I solved for a TDH of 202.7 feet (vertical head = 107.3 feet, pressure head = 92.4 feet, and friction head = 3.0 feet), which from my analysis of the pump performance curves corresponded to a flow rate of 740 GPM (i.e. 1.65 CFS).

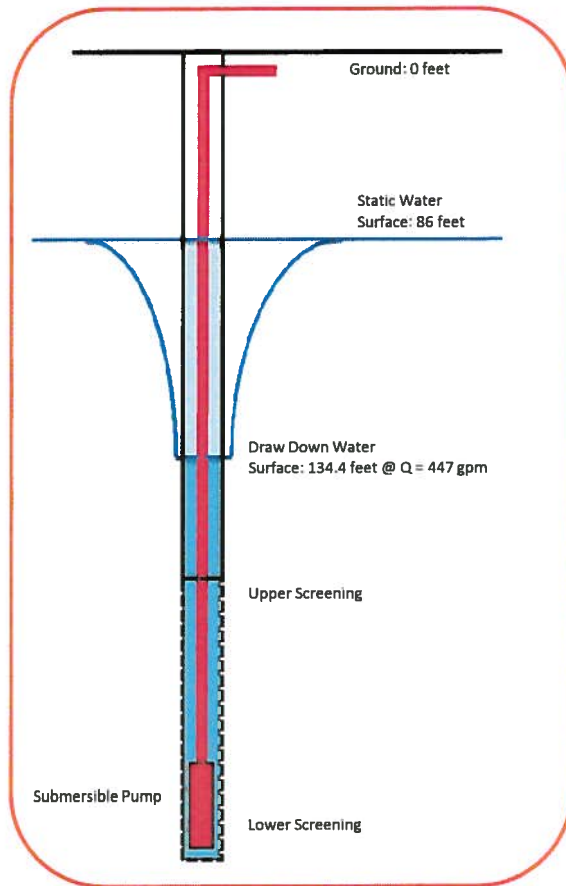
Belmont Well #2 (8RJLO (4 stage, 40 hp) Goulds Pump)

Similar to Belmont Well #1, I was unsure of where the values used to calculate friction head and head loss came from. It also appeared to me that there was some inconsistency in the flow rates used to calculate various values (e.g. 425 GPM vs. 455 GPM vs. 435 GPM).

Using the same approach I outlined for Belmont Well #1, my review required 5 iterations to solve for a flow rate that changed by less than 0.1% between iterations. I solved for a TDH of 246.1 feet (vertical head = 134.4 feet, pressure head = 92.4 feet, and friction head = 19.3 feet), which from my analysis of the pump performance curves corresponded to a flow rate of 447 GPM (i.e. 1.00 CFS).

My approach for estimating the combined diversion rate yielded a value of 2.65 CFS for both wells. My value is very close to the 2.60 CFS proposed in the report, giving me confidence in the values and methods implemented by the field examiner. Because the permit authorized a diversion rate of 2.60 cfs it is appropriate to license the water right for the full permitted diversion rate. I have included two summary sheets (one for each well) of my calculations in deriving a combined flow rate of 2.65 cfs based on the pump curves, well logs, and physical descriptions provided in the field examination report.

City of Nampa - Belmont Well #2



Relevant Well Completion Elevations

Grade:	0.0	feet (ground surface elevation)
SWE:	86.0	feet (static water surface elevation)
DDE:	134.4	feet (draw down water surface elevation)
USE:	398.0	feet (upper screening interval elevation)
LSE:	473.0	feet (lower screening interval elevation)
PIE:	473.0	feet (pump intake elevation)

Total Dynamic Head

Vertical Head:	134.4	feet
Pressure Head:	40.0	psi
	92.4	feet
Friction Head:	19.3	feet
Velocity Head:	0.0	feet (assumed to be zero)
Minor Losses:	0.0	feet (assumed to be zero)
TDH:	246.1	feet

Specific Capacity ($Sc = Q/D$) From Well Driller Report

Q =	425.0	gpm (pumping rate)
D =	46.0	feet (draw down)
Sc =	9.2	gpm/ft

Summary of Pump Operating Condition

Goulds Turbine 60 hz
 8RJLO (4 stages)
 Impeller Diam. 4.5 inches
 Pump Line = 5 inch diameter
 TDH = 246.1 feet
 From Pump Curves Q = ~447 gpm (i.e. 1.00 cfs)

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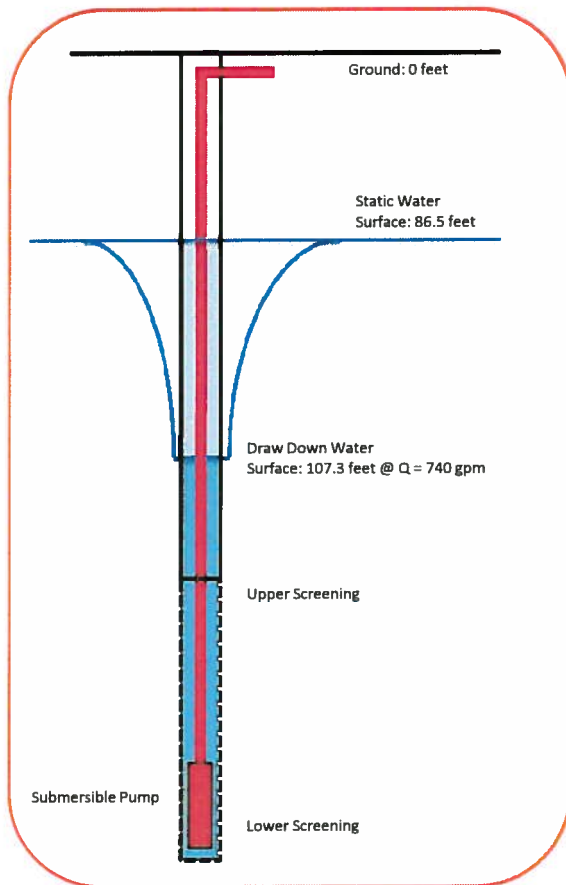
Summary of Iterative Calculations

Iterations	DD (ft)	TDH (ft)	Q (gpm)	% Δ
	--	--	455.0	--
#1	49.2	247.5	443.7	2.5%
#2	48.0	245.4	447.9	0.9%
#3	48.5	246.3	446.1	0.4%
#4	48.3	245.9	446.9	0.2%
#5	48.4	246.1	446.5	0.1%
#6	48.3			100.0%
#7	0.0			#DIV/0!
#8	0.0			#DIV/0!
#9	0.0			#DIV/0!

Notes/Comments

Although my approach and methods for determining the likely operating point flow rate was different than the field examiner's report I arrived at a very similar values (455 vs. 447 gpm). Therefore I recommend 1.00 cfs be used in establishing the combined diversion rate.

City of Nampa - Belmont Well #1



Relevant Well Completion Elevations

Grade:	0.0	feet (ground surface elevation)
SWE:	86.5	feet (static water surface elevation)
DDE:	107.3	feet (draw down water surface elevation)
USE:	236.0	feet (upper screening interval elevation)
LSE:	285.0	feet (lower screening interval elevation)
PIE:	285.0	feet (pump intake elevation)

Total Dynamic Head

Vertical Head:	107.3	feet
Pressure Head:	40.0	psi (if not known assume 40 psi)
	92.4	feet
Friction Head:	3.0	feet
Velocity Head:	0.0	feet (assumed to be zero)
Minor Losses:	0.0	feet (assumed to be zero)
TDH:	202.7	feet

Specific Capacity ($Sc = Q/D$) From Well Driller Report

Q =	800.0	gpm (pumping rate)
D =	22.5	feet (draw down)
Sc =	35.6	gpm/ft

Summary of Pump Operating Condition

Goulds Turbine 60 hz
 9RCHC (7 stages)
 Impeller Diam. 6.6875 inches
 Pump Line = 8 inch diameter
 TDH = 202.7 feet
 From Pump Curves Q = ~740 gpm (i.e. 1.65 cfs)

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Summary of Iterative Calculations

Iterations	DD (ft)	TDH (ft)	Q (gpm)	% Δ
	---	---	710.0	--
#1	20.0	201.7	741.3	4.4%
#2	20.8	202.7	740.0	0.2%
#3	20.8	202.7	740.0	0.0%
#4	20.8			
#5	0.0			
#6	0.0			
#7	0.0			
#8	0.0			
#9	0.0			

Notes/Comments

Although my approach and methods for determining the likely operating point flow rate was different than the field examiner's report I arrived at a very similar values (710 vs. 740 gpm). Therefore I recommend 1.65 cfs be used in establishing the combined diversion rate.