

Memo

Adaptive Resources, Inc.

To: Western Water Use Management Modeling Joint Board
From: Thad Kuntz, P.G.
CC:
Date: 4/3/2015
Re: Quality Assessment and Calibration of the Regionalized Soil Water Balance Model

INTRODUCTION

The Western Water Use Management (WWUM) Modeling update through April 2014 included a quality assessment of the estimated ground water only well pumping provided by the Regionalized Soil Water Balance (RSWB) model. Additionally, the commingled pumping in North Platte Natural Resources District (NPNRD) that was calculated by the StateCU soil water balance model (SWB) was analyzed to determine if there are trend changes that occur before and after the collection of metered information.

The ground water only modeled pumping was compared to the metered pumping information from NPNRD and South Platte Natural Resources District (SPNRD) to determine if any calibration adjustments of the RSWB model are necessary. This assessment was completed by the WWUM Modeling team that includes Adaptive Resources Inc. (ARI), The Flatwater Group (TFG), and Wilson Water Group (WWG). This memorandum was produced to document the data considered, results, and conclusions.

For background documentation on the WWUM Modeling refer to the *WWUM Modeling Chronological Index of Documentation* (Kuntz, October 2016).

GROUND WATER ONLY PUMPING QUALITY ASSESSMENT

The quality assessment was designed to determine any adjustments that are warranted to the pre-metered time period (1954 to about 2007) ground water only pumping estimated by the RSWB model for each crop grown throughout NPNRD and SPNRD. Calibration adjustments to the RSWB model will be determined by comparing the modeled pumping to the metered pumping records from each NRD.

To complete this analysis, the comparison of modeled pumping estimates and metered pumping information was constrained to include:

- Lands that only have one crop type throughout the entire parcel.
- The irrigation method for the parcel must encompass the entire parcel.
- Only the crop consumptive use portion of the pumping will be considered.

The crop consumptive use portion of the irrigation is defined as the amount of the pumping that is utilized by the crops and not returned to the system. Throughout the timeframe of this analysis, 65% of the irrigation deliveries by flood irrigation is considered to be available for crop consumption where 35% of the irrigation delivery is either recharged to the aquifer or runs off of the edge of the field. Likewise, 85% of the irrigation deliveries by pivot sprinkler irrigation is



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considered to be available for crop consumption where 15% of the irrigated water is either recharged to the aquifer or runs off the edge of the field.

The metered data used in this analysis includes NPNRD meter information from 2009 through 2013 and SPNRD meter data from 2009 and 2010. The NPNRD Pumpkin Creek meter information was excluded from this analysis because of possible physical constraints of the aquifer that may limit the amount of water that can be pumped and restrict meeting the full crop demand if capable.

The comparison outlined above for ground water only pumping is provided in Table 1 for NPNRD and Table 2 for SPNRD.

Table 1 – NPNRD: Comparison of Metered and Modeled Pumping for Each Crop Type by Year (inches / acre)

Year	Corn		Alfalfa		Small Grains	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	10.67	11.38	10.45	20.73	6.14	7.25
2010	12.25	11.40	10.98	20.24	8.80	7.96
2011	12.09	10.58	12.45	23.66	6.56	10.32
2012	20.14	21.84	22.98	43.43	17.85	23.89
2013	14.84	15.16	15.79	30.16	9.78	14.81
Average	14.00	14.07	14.53	27.64	9.83	12.85
Modeled/Metered		1.00		1.90		1.31
Year	Grass - Pasture		Sugar Beets		Sunflowers	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	9.00	13.58	17.26	16.54		
2010	10.82	15.77	12.51	17.27	11.44	8.68
2011	9.62	18.77	14.94	18.75		
2012	19.97	33.03	18.50	29.29		
2013	15.13	23.87	13.89	24.48		
Average	12.91	21.00	15.42	21.27	11.44	8.68
Modeled/Metered		1.63		1.38		0.76
Year	Dry Beans					
	Metered	Modeled				
2009	8.24	7.95				
2010	10.18	10.48				
2011	8.99	7.38				
2012	17.14	13.87				
2013	11.46	9.03				
Average	11.20	9.74				
Modeled/Metered		0.87				



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Table 2 – SPNRD: Comparison of Metered and Modeled Pumping for Each Crop Type by Year (inches / acre)

Year	Corn		Alfalfa		Small Grains	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	10.75	12.18	9.29	18.09	4.11	5.95
2010	12.68	11.51	12.00	21.48	4.59	7.48
Average	11.71	11.85	10.65	19.79	4.35	6.71
Modeled/Metered		1.01		1.86		1.54
Year	Grass - Pasture		Sugar Beets		Sunflowers	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	9.56	11.48	11.14	14.29	4.16	4.67
2010	8.28	15.14	17.81	17.46	6.71	4.10
Average	8.92	13.31	14.47	15.87	5.44	4.38
Modeled/Metered		1.49		1.10		0.81
Year	Dry Beans					
	Metered	Modeled				
2009	6.87	7.98				
2010	9.26	9.54				
Average	8.07	8.76				
Modeled/Metered		1.09				

Table 3 provides the average ratio in percentage of the modeled pumping to the metered pumping for each NRD.

Table 3 – NPNRD and SPNRD Percentage of Modeled to Metered Pumping.

Average	Corn	Alfalfa	Small Grains	Grass - Pasture	Sugar Beets	Sunflowers	Dry Beans
NPNRD	100%	190%	131%	163%	138%	76%	87%
SPNRD	101%	186%	154%	149%	110%	81%	109%

The conclusion from the analysis in the above tables demonstrates that the RSWB model provides an adequate ground water only pumping estimate of corn and dry beans. The estimate of pumping on sunflowers was low compared to the metered values. The estimate of pumping on sugar beets was greater compared to metered pumping. However, the SPNRD pumping for sugar beets is much closer to the metered value. Alfalfa, small grains, and grass-pasture modeled pumping are consistently greater than the metered pumping.

COMMINGLED PUMPING QUALITY ASSESSMENT FOR NPNRD ONLY

The commingled pumping assessment for NPNRD only lands was completed by analyzing annual pumping data to determine if the pumping changed significantly from the pre-metered data to the metered data years. Figure 1 provides the annual commingled pumping in acre-inches/acre for all commingled acres from 1953 through 2013.



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Figure 1 – Annual Commingled Pumping from 1953 to 2013

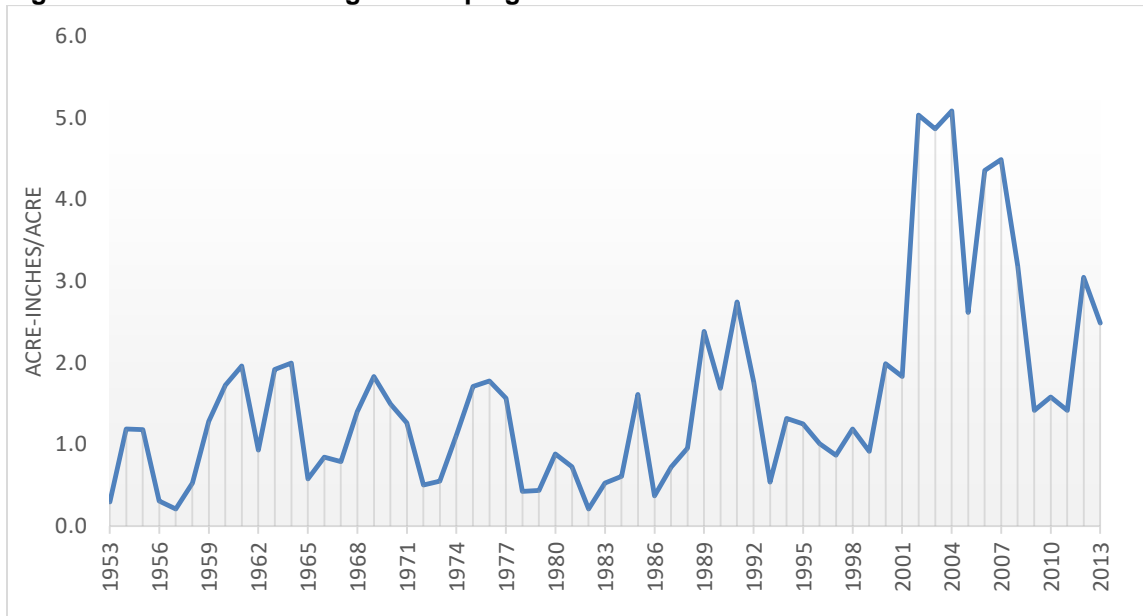
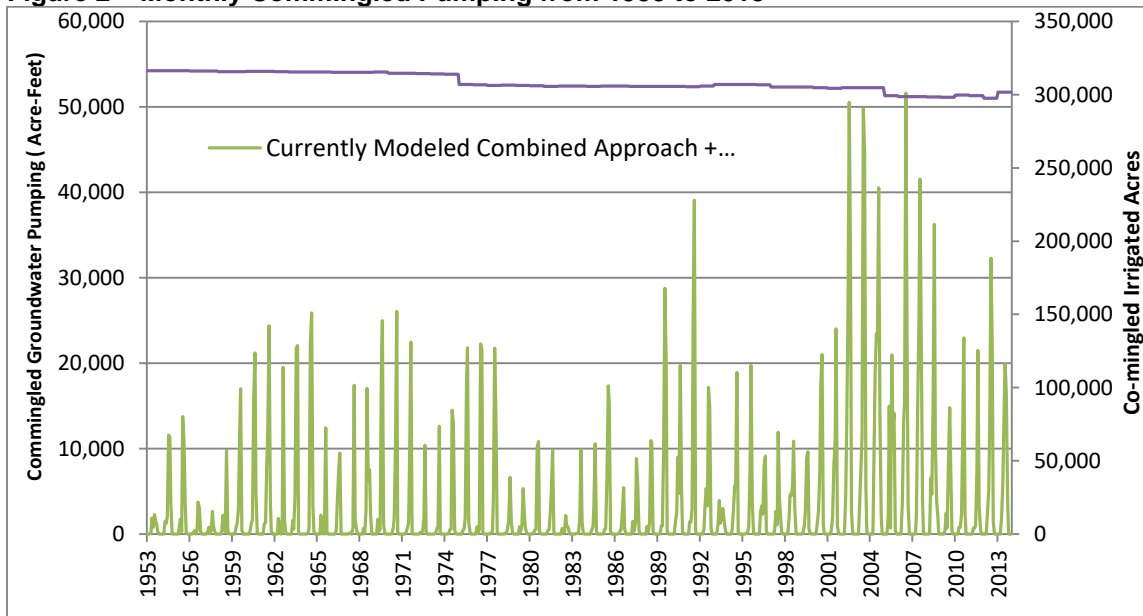
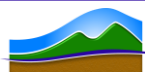


Figure 2 provides the monthly pumping on NPNRD commingled lands from 1953 through 2010.

Figure 2 – Monthly Commingled Pumping from 1953 to 2013



Figures 1 and 2 are a graphical representation of commingled pumping as estimated by the SWB model from 1953 through 2008 and metered data from 2009 and 2013. This comparison differs from the ground water only pumping quality assessment because the parcels have two sources of water, ground and surface water. Surface water irrigation is not measured except at the headgate on the river or stream at the diversion, so the modeling distributes the pumping equally to the lands that have surface water rights. Since it is not known exactly how much surface water is applied to each parcel, a comparison of expected ground water pumping on each parcel will not



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provide a valuable assessment. Instead, trends in the ground water pumping data through both the pre-metered and metered time period were reviewed. As seen on these graphs, there are no significantly different trends from pre-metered and metered time periods. However, the wet and dry cycles are represented, but no other conclusions are drawn.

CONCLUSIONS AND CALIBRATION ADJUSTMENTS

As seen in the ground water only and commingled pumping quality assessments, the RSWB and SWB models provide adequate estimates of pumping for the WWUM Modeling effort. There are no changes needed to the SWB model's commingled pumping estimates. Likewise, the RSWB model provides adequate estimates of ground water only pumping on corn and dry beans which are the two of the three most abundant crops in the modeling area. Additionally, the RSWB model estimate of pumping on sugar beets is higher than the metered data, and the model estimate of sunflowers is lower than the metered data. Finally, the RSWB model estimate of pumping on alfalfa, grass pasture, and winter wheat is significantly different from the metered data.

The modeling team's recommendation to NPNRD and SPNRD is to adjust the calibration of the RSWB model for ground water only pumping on alfalfa, grass pasture, and winter wheat. The team did not recommend sugar beets and sunflowers to be adjusted due to the small number of acres that these crops represent (3% and 1% respectively for 2006 through 2010 time period).

TFG provided an adjusted to the group of 80% of maximum net irrigation requirement (NIR) or consumptive use pumping for ground water only alfalfa, grass pasture, and winter wheat. Table 4 is the adjusted estimate of pumping for NPNRD.



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Table 4 – NPNRD: Comparison of Metered and Adjusted Modeled Pumping for Each Crop Type by Year (inches / acre)

Year	Corn		Alfalfa		Small Grains	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	10.67	11.38	10.45	17.46	6.14	6.11
2010	12.25	11.40	10.98	17.04	8.80	6.70
2011	12.09	10.58	12.45	19.92	6.56	8.69
2012	20.14	21.84	22.98	36.57	17.85	20.12
2013	14.84	15.16	15.79	25.39	9.78	12.47
Average	14.00	14.07	14.53	23.28	9.83	10.82
Modeled/Metered		100%		160%		110%
Year	Grass - Pasture		Sugar Beets		Sunflower	
	Metered	Modeled	Metered	Modeled	Metered	Modeled
2009	9.00	11.44	17.26	16.54		
2010	10.82	13.28	12.51	17.27	11.44	8.68
2011	9.62	15.80	14.94	18.75		
2012	19.97	27.82	18.50	29.29		
2013	15.13	20.10	13.89	24.48		
Average	12.91	17.69	15.42	21.27	11.44	8.68
Modeled/Metered		137%		138%		76%
Year	Dry Beans					
	Metered	Modeled				
2009	8.24	7.95				
2010	10.18	10.48				
2011	8.99	7.38				
2012	17.14	13.87				
2013	11.46	9.03				
Average	11.20	9.74				
Modeled/Metered		87%				

Information for SPNRD was not updated for this analysis as the results for NPNRD was sufficient to implement the calibration adjustment. The updated WWUM Model from 1953 through April 2014 includes this adjustment to NIR and pumping estimates.

REFERENCES

Kuntz, T.A., 10/21/2016, Western Water Use Management Modeling Chronological Index of Documentation, Report to Western Water Use Management Modeling Joint Board

