SPDSS Groundwater Technical Peer Review Committee Meeting 4, April 21, 2008

Meeting Minutes

Meeting Attendees (according to sign in sheet)**:**

Last Name	First Name	Organization
Ahrens	Brian	Colorado Division of Water Resources
Alaa	Aly	Intera
Alexander	Judi	Farmer
Altenhofen	Jon	Northern Colorado Water Conservancy District
Bau	Domenico	Colorado State University
Bennett	Ray	Colorado Division of Water Resources
Decker	Jim	Former well user
Eisel	Leo	Brown and Caldwell
Flory	Val	Clear Water Solutions, Inc.
Ford	Jon	Leonard Rice
Frank	Joe	Lower South Platte Water Conservancy District
Gullapalli	Lavanya	Brown and Caldwell
Hahn	Bill	Lytle Water Solutions
Halepaska	John	Halepaska
Halstead	Mary	Colorado Division of Wildlife
Hein	Michael	DWR
Hemenway	Courtney	Hemenway Groundwater Engineers
Leaf	Chuck	Well/groundwater user
Longenbaugh	Bob	Retired Engineer
Lytle	Bruce	Lytle Water Solutions
Martindale	Dee	Well/groundwater user
Martindale	John	Well/groundwater user
McCluskey	Mark	CDM
McCurry	Gordon	CDM
Moore	Andy	Colorado Water Conservation Board
Musleh	Shaden	AMEC
Palumbo	Mark	HRS Water Consultants
Queint (?)	Vic	?
Sanchez	Chris	Bishop-Brogden
Schreuder	Willem A.	Principia Mathematica
Simpson	Hal	H.D. Simpson Consulting/CDM
Wilson	Erin	Leonard Rice Engineers
Yu	Chunming	Colorado Division of Water Resources

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The following table summarizes the questions asked and responses provided during the meeting and via follow up email, as well additional responses from the SPDSS team providing more information or resources. An acronyms list is provided following this table.

ID	Comment or Question, Answer, and Additional Response	
1	**Comment**	Noted wide range of applications for data/tools.
2	**Q**	Where did the >10 foot saturated thickness come from?
	A	The data came from many sources: In the mainstem of the South Platte much of the information came from maps developed by Hurr and Schneider (1972); the various Designated Basin reports from the 1950's and 1960's were another source; the USGS (Robson) Front Range alluvial mapping Hydrologic Atlas report from 1996 provided data along the western edge of the study area; and SPDSS studies conducted under Tasks 35, 37 42.3 and 44.3 included additional drilling, water level measurements, compilation and mapping of the base of alluvium and water table surfaces. In addition the SPDSS work included the analysis of hundreds of borehole logs from well permits on file at the State Engineers Office.
	Additional Response	Numerous other reports were used in the mapping of the base of the alluvial aquifer and the water table surface and are listed in the SPDSS Task 42.3 and Task 44.3 technical memoranda.
3	**Q**	Using the SFR2 or SFR package of Modflow?
	A	This model is using the newer SFR2 package.
4	**Q**	How do you handle phreatophytes? Is it a function of ET?
	A	This model is simulating the effects of phreatophytes, defined as plants whose roots go down to the water table and obtain some of their consumptive use requirements from shallow groundwater. This model is not simulating ET from irrigated acreage since that is already included in the StateCU calculations, but is simulating groundwater ET from non-irrigated parcels.
5	**Q**	How is channel flow modeled?
	A	The flow in stream channels is simulated using the SFR2 package of Modflow. The flow in each modeled stream cell is the sum of inflow from upstream cells, inflow from any tributaries that may join a given cell, flow out of the cell due to diversions and flow into the next downstream cell, plus gains or losses to the underlying aquifer. Gains and losses with the aquifer are computed from the difference in simulated stream stage and the groundwater level at a cell, and the flux computed by streambed conductance.
6	**Q**	Are you using standard CU figure?
	A	The model is not using a standard CU but ones that vary spatially and over time. It takes the results from StateCU model, which looks at what crops need on a monthly basis and how much of this need is provided for by precipitation and irrigation.

7	**Q**	Precipitation based recharge - concerned that even though it may be small, it affects a large area so may be a large term in the basin water balance. Also concerned about the land use coverage being modeled.
	A	More detail will be given on this model input later; precipitation-based recharge is small on a per-unit-area basis but can be large overall. Regarding the land use coverage and how irrigated acreage is defined, the model inputs are based on 5 snapshots of land use available for the study period (1950-2006); Sprinkler irrigation looks like it started in 1960s. The StateCU model does a linear interpolation between each pair of land use coverage snapshots to estimate changes in land use over time. In some cases there is a long period of time between these snapshots.
8	**Q**	Are you considering the time variant components? How are you getting this represented in model? Conversion of agricultural water use efficiency from 1970s?
	A	Yes, recharge components are time variant; one of them considers climate data. Water potentially available for recharge is computed monthly.
9	**Q**	Change from flood to sprinkler irrigation - how is it handled?
	A	Using 5 snapshots to identify changes; interpolation between time periods. Using average over season; taking into account that it's usually more efficient early on and less efficient later.
10	**Q**	Was there a process to differentiate canals/drains from natural drainages? Can you account for gains to canals from a high water table?
	A	The model is not simulating canal explicitly but accounts for canal seepage via estimated losses. Natural stream channels are simulated and do take into account the interaction between the stream and aquifer.
11	**Q**	What if it's dry here but raining a couple of miles away? Can you look at small scale (i.e. individual farms)?
	A	The model uses cells that are 1000 on a side (about 23 acres) so it does not simulate inputs such as localized precipitation at a more refined scale than this. The model also uses a monthly timestep so short-term inputs like a single afternoon thunderstorm are also not simulated. However, we do simulate the effect of localized inputs to the extent that their effects show up in groundwater levels and averaged monthly streamflow at gages. This is meant to be a region model from which more detailed models (in both space and time) can be built from in the future.
12	**Q**	In your recharge package, how are you dealing with non-irrigated recharge (augmentation)?
	A	Augmentation recharge pits are not simulated directly; the diversion amounts for augmentation are included as water potentially available for recharge on a structure-by-structure basis on this recharge water is distributed over the area of the structure.
13	**Q**	Heard that StateCU water doesn't account for pit storage, is that true?
	A	Water that is diverted to recharge pits is considered, but it is distributed or "recharged" over irrigated acreage, not specific pits. The next Phase will refine this to distribute recharge to pit locations.
14	**Q**	Concerned that some of the recharge augmentation water will be assumed by StateCU to be consumed by crops if there is a crop consumptive use demand, when really that water is not consumed because it is going directly to recharge pits. Noted that State has GPS'ed all pits and are in Hydrobase.
	A	The State notes this is an issue and will look into it in Phase 5.

15	**Q**	Recharge pits are new phenomenon in last 5 years or so. You need to be able to account for spreading. Need to be able to account for excess water that is unneeded to meet crop demands that goes to recharge. I think the point is to be able to account for excess irrigation water that goes to recharge
	A	There may be some inaccuracy in how recharge pit water is modeled, since this water is not accounted for at such a detailed level.
	Additional Response	We will be handling recharge pits in more detail in the next phase.
16	**Q**	Concerned how gains/losses are simulated since some are quick returns, and therefore just surface water return, and not groundwater return; lagging becomes a problem.
	A	We will be evaluating the modeled gains/losses during calibration. If there are large discrepancies we will look for the presence of structures or other reasons to explain differences. Again though, this is a regional model on a monthly time step so many detailed processes will not be simulated.
17	**Q**	Are the details of diversions and augmentation plans going into a memo?
	A	Yes, LRE has finalized a memo summarizing the approximately 20 largest augmentation plans. It is on the WEB site.
18	**Q**	How is phreatophyte water being accounted for? Are you lumping the farmer's CU with the phreatophyte?
	A	The model will be accounting for agricultural and phreatophyte ET separately. The model allows ET from GW when it is > 13 ft below land surface with no when the depth to the water table is below 13 ft.
	Additional Response	The groundwater model simulates water consumed from the alluvial aquifer by sub-irrigation in irrigated areas and by phreatophytes in non-irrigated areas. The StateCU model was used to determine crop CU and irrigation water demands.
19	**Q**	Are you doing a weighting on canal leakage for each grid cell? With canals, will that be on GW side as far as conductance and leakage - happen during calibration or done now? Concerned that calibration will adjust leakage to values that are not realistic
	A	Canal leakage estimates can be done during the calibration process. If there is difference in observed and simulated groundwater levels a weighting factor can be applied to an entire structure. Canal loss estimates are usually from decree or user info.
20	**Q**	In groundwater modeling, recharge and conductance are usually used to adjust the simulated heads to match observed values; in Nebraska regional modeling these input parameters would creep out of reality during the calibration process because there is no ground-truthing.
	A	Recharge and streambed conductance, like all model calibration parameters, will be varied within predetermined ranges based on observed data and engineering judgment. At future meetings we would like to hear the feedback from the PRC group on the input values used in the calibrated model.

21	**Q**	How many variables are you going to be using to calibrate the model?
	A	We have a large number of groundwater level measurements throughout the simulation period that will be used. We will also calibrate to stream gains and losses - these have been estimated for 9 major reaches. There is a good mix of data to use in calibrating this regional model.
	Additional Response	The calibration process will also include a comparison of simulated and estimated groundwater ET, stream diversions, and overall water balance.
22	**Q**	Do you have hydraulic conductivity data?
	A	There are a lot of hydroconductivity tests that have been conducted; discussed in previous meetings.
23	**Q**	Can you define the 'extinction depth' of 13 feet?
	A	The extinction depth of 13 feet is depth below ground surface of the modeled water table that no there will be no groundwater ET plants.
24	**Q**	Describe dealing with uncertainty.
	A	During model calibration process, we systematically alter model input variables we know are uncertain (usually due to less data), have a wider range over which we can change the input value in order to improve the model results. We vary parameters within realistic ranges in a systematic way.
25	**Q**	How much of your dataset will you use to validate the model?
	A	This was discussed at the last meeting. We will be calibrating the model using smaller periods of data, 1991-1994 as being representative of longer term steady-state conditions, and 1999-2005, including the 1999 wet year and the 2002 dry year, for transient conditions. Once the model is calibrated to these two periods we will validate the results against the full study of 1950 to 2006.
26	**Q**	Cottonwoods are well known to pull water at 25 feet, salt cedars to 35 feet, and Alfalfa can go to 15 ft once established. This is somewhat a function of soil type. Suggested looking again at the decision to use a 13 feet cutoff as your extinction depth for groundwater ET.
	A	The extinction depth was determined based on the work of Groenveld; however, we will take a look at this.
27	**Q**	What about irrigated areas outside the model footprint?
	A	Water entering the active model area from irrigated land and canals outside model domain are included through lateral boundary inflows. Maps were shown of irrigated areas and canals outside the active model area.
28	**Q**	What kinds of crops are accounted for in subirrigated areas?
	A	2 subirrigated areas - alfalfa and subirrigated meadows
29	**Q**	What pumping was assumed for augmentation wells?
	A	Currently the groundwater model doesn't include this. We have looked at some recent records to help understand what is being pumped by augmentation wells.
	Additional Response	Augmentation well pumping will be considered in the next Phase
30	**Q**	Who is augmenting the phreatophyte CU? Seems unfair that 400,000 AF of water that phreatophytes are using get charged to farmer.
	A	That is why we are doing this model, to look at things that may have been overlooked before.

31	**Q**	Well pumping - what does the model show for this and for phreatophyte use?
	A	Phreatophytes use is about 250,000 AF/year and pumping is substantially more than that. We're still compiling the pumping and phreatophyte inputs now.
32	**Q**	Groenveld estimates 490K AF for phreatophytes, and then adjusts for precipitation; and data used in this analysis was from just one flyover; encourage the State to look at diurnal fluctuations; study at CU Davis showed much higher ET with greater uniformity.
	A	Will consider going back and adjusting coverages on this.
	Additional Response	The 490,000 AF/yr ET value includes ET from precipitation; the 250,000 AF/yr value is only ET from groundwater.
33	**Q**	USGS has run 2 sites in NE with ET, currents, lysimiters, etc; recommend the modeling team look into this.
	A	Will take a look.
34	**Q**	Is outflow calculated? Because that would be downstream gage, right? Typical gain/loss study done by walking river?
	A	Outflow of both the South Platte River and alluvial groundwater are outputs of the model and will be used as calibration criteria by comparing the simulated outflows against measured and calculated outflows. The Task 46 tech memo provides details of the gain/loss analysis performed within the study area; it did not include walking river.
	Additional Response	The gain/loss study undertaken as Task 46 developed estimates of monthly flows to or from the South Platte River over 7 reaches from Chatfield Reservoir to Julesburg and for two tributaries for the 1950-2006 study period. Daily flow data from stream flows, tributary inflows, discharges, diversions and outflows were compiled and used to compute the gain/loss.
35	**Q**	Lined gravel pits act as barrier to return flow - will cause significant impact in upper reaches.
	A	Including the gravel pits in the model was considered but it was decided to not include them in the current model. This may be something that we look at in Phase 5 or in the future.
36	**Q**	How are you handling stream gain and loss in calibration?
	A	Stream gain/loss is one of the parameters we are including in the model calibration; it is an important parameter so will be given a relatively large emphasis when evaluating the modeling results. Other calibration parameters include groundwater levels, diversions, stream flow, groundwater ET and overall model mass balance.
37	**Q**	Does M&I pumping have to augment like Ag wells?
	A	The model does not accounting for augmentation pumping for M&I wells.
38	**Q**	Why did you go with the well package to simulate the inflows? What about lateral cells?
	A	We went with well package because it's easier to keep track of the various inflows or outflows being simulated with this package; this will help us during the model calibration process. We also could have used recharge package but this was just an operational choice. The Well package is being applied at the outermost active cells in the model to represent lateral boundary inflows.

39	**Q**	Glover has limitations - why not get drain package or other package?
	A	The Glover gives us a reasonable method to estimate the timing and amount of flow at the edges of the active model domain. We are using the bounded Glover method which directs the flow in the downgradient direction towards the active model area. We have used reasonable physical properties in the Glover (three sources of hydraulic conductivity, for example, from Aeolian sands, alluvium and upland gravels.).
40	**Q**	Where are you applying the boundary for the Glover Equation?
	A	The Glover equation is being used at each model cell outside the active model domain. The boundary is applied at the upgradient edge of each model cell. All applied water will flow down gradient. We evaluated different distances for the boundary and the upgradient cell made the most sense.
41	**Q**	What is total amount of water for lateral inflows?
	A	Still working on it, only have initial estimates now
42	**Q**	Basic idea of Glover is that it helps determine the timing for seasonal irrigation recharge and background precipitation?
	A	Yes; but we're finding that seasonal variability gets damped out pretty rapidly due to 1000 ft grid cell size of this regional model. Agricultural recharge inputs from StateCU along with precipitation and leakage from canals and reservoirs drive the amount and timing of lateral boundary inflows.
43	**Q**	Are areas with lateral boundary inflows where there is > 10ft in saturated aquifer thickness?
	A	Areas where there are surface and/or groundwater inflows are accounted in the model stream inflow and/or GW underflow.
44	**Q**	Does area of reservoir change with time and storage?
	A	Not right now; the groundwater model has reservoir leakage as a constant. That is something that could be added as a later model enhancement.
45	**Q**	Is it assumed that reservoirs are fairly well sealed so this would impact (reduce) leakage?
	A	Yes, we have assumed a silt/clay layer exists at the bottom of most reservoirs so the permeability of the reservoir soils is much smaller than that of the surrounding soils. Overall reservoir leakage is a small amount compared to other sources of water into the aquifer. A couple of reservoirs may be in more communication with the aquifer and we will evaluate this during the model calibration.
46	**Q**	Could use state, release information to estimate leakage at reservoirs?
	A	Could potentially do that in next Phase.
47	**Q**	Need to reconcile the difference between saying this is a regional model with limitations, and saying that it can be used on a small case (which implies administration).
	A	There are a lot of things (such as flood vs. sprinkler irrigation) that have changed and impacted groundwater, we want to see how the system works on a regional level before proceeding beyond this; we are developing a planning tool to examine broad items such as the impact of droughts and change in water use. The State (both the DWR and CWCB) don't have a vision to use this as an administrative tool but to use it to look at water supply issues on a large scale.
48	**Q**	When are we going to see Denver Basin model?
	A	The USGS is reviewing the model and report internally right now. The State has a memo of understanding that precludes the model from being made public prior to review.

49	**Q**	Will the USGS model be available for peer review?
	A	The State has shared a lot of the data with the USGS that was in Hydrobase and coordinated with them on data sets; this model will be the subject of peer review down the road; The State can commit to having a peer review meeting and inviting USGS after report is out; will add this to the Phase 5 scope.
50	**Q**	Do you foresee changing the factors in SB5 as a result of Denver Basin model?
	A	No, but the legislature could do this. We would be happy to commit to a review of the USGS model. See no problem to one peer review meeting of the USGS meeting in response to USGS model.
51	**Q**	Concerned with discrepancy in number for phreatophyte ET consumption (240k vs. 490k)
	A	490,000 AF is total consumption including from precipitation; 250,000 AF is net consumption from GW.
52	**Q**	Do you have plans to make compacts with other states? Since Romer's 3-states agreement for birds? Are there any more things coming up where there will be more commitments to water?
	A	Not aware of any other ones. Noted silvery minnow in Rio Grande Basin.
53	**Q**	How are reservoirs dealt with in stream package? Inflow and outflow?
	A	The model currently does not simulate reservoirs dynamically, including things such as stage/storage changes; we have diversions to reservoirs included in the model and reservoir leakage included in a separate package.
54	**Q**	Do you have daily data from reservoir companies?
	A	We have some data and we're using the data we have to estimate reservoir storage.
55	**Q**	Question about transient calibration in light of the well shut-downs in 2003-2005.
	A	We need to work on : (1) reduction in pumping in recent years due to Empire Lodge and (2) more use of recharge Pits
56	**Q**	In 2005, gravel pit issues and transmountain diversions - significant to reach. Gave South Adams County example.
	A	Can you give specific list to the SPDSS team? We will look into these issues.

Acronyms List

Acronym	Definition
AFY	acre-feet per year
Central	Central Colorado Water Conservation District
CU	Consumptive use
CWCB	Colorado Water Conservation Board
DWR	Division of Water Resources
ET	Evapotranspiration
GW	Ground water
LRE	Leonard Rice Engineers
MAF	million acre-feet
NASS	National Agriculture Statistics Service
NNT	Not nontributary
NT	Nontributary
PRC	Peer Review Committee
QAL	Alluvial deposits
SPDSS	South Platte Decision Support System
SW	Surface water