ESHMC Meeting Notes December 12th, 2011

Item 1 - Introductions were made, and an attendance list was circulated. The following were present at the meeting:

- Rick Raymondi
- Allan Wylie
- Sean Vincent
- Jennifer Sukow
- Chuck Brockway
- David Blew
- Janak Timilsena
- David Hoekema
- Jim Brannon
- Mike McVay
- Bryce Contor
- Rick Allen
- Jon Bowling
- Jairo Hernandez
- Dave Colvin
- Harvey Walker
- Bill Kramber
- Margie Wilkins
- Director Spackman*

***Present at meeting but did not sign attendance sheet.**

Willem Schreuder, Chuck Brendecke, Greg Sullivan, Stacey Taylor, Roger Warner, and John Koreny joined the meeting via polycom.

Jairo Hernandez and Dave Colvin were introduced to the committee.

Item 2 – Stacey Taylor began the meeting with a review of the data that she is assimilating for the model validation efforts. She went through the diversion data that had been collected and indicated what was still missing. Portions of the Northside Canal, Reno Ditch, and Southwest Irrigation District were mentioned as incomplete. Stacey indicated she has received data from Mud Lake, and it still needs to be processed. She said that she needed to compare Agrimet data for 2009/ 2010 with ET Idaho data and that it is possible that she could use the Agrimet data for other water budget files. She said that she had received the NIR files from Bryce, but more work must be done before it can be fully completed. There was a little more work to do on the PCH file. Once the ET data estimates for 2009-2010 are completed using AgriMet ET data, the OFF, FPT, and ETI files will be close to completion.

Item 3 – Mike McVay presented an evaluation of METRIC data from the western end of the ESPA vs. the ESPAM ET calibration data for 2000, 2002, 2006, and 2008. The

western ESPA includes the Northside and AFRD2 service areas. Mike began with a statement of the problem: "Could differences in modeled spring discharge (2006-2008) be the result of an ESPAM2 underestimation of ET?" He said that during his presentation, he would compare Bill Kramber's METRIC analysis of ET of the western end of the ESPA to the ESPAM version 2 estimates. He added that there is an implicit assumption that METRIC is our best estimate of ET. Mike then said that the METRIC and the ESPAM2 ET estimates cannot be compared directly because ESPAM2 employs a global coefficient to incorporate edge effects from irrigation. He indicated that edge effects can be due to advection of heat into the irrigated lands as well as overspray and runoff from irrigated lands. He went on to say that the development of the global coefficient employed the GIS analysis of ET on buffers extending 70 m and an additional 200 m beyond the irrigated land layers. He then provided details regard the buffer analysis that he performed and showed the irrigated lands as determined for 2002.

Then Mike showed summary graphs of the model input vs. METRIC total ET volume, model vs. METRIC ET per acre, and Bill Kramber's determination vs METRIC for irrigated acreage for the 2000, 2002, 2006, and 2008 irrigation seasons. Mike said that the model overestimates ET for each of those four years. Rick Allen asked why the acreage is different for the model vs. METRIC. Mike said that the irrigated lands for 2000 were determined differently, and that 2008 was determined with preliminary CLU data. He added that 2006 and 2002 are nearly the same. Then Rick Allen asked why Kramber's acres were so different between 2000 and 2002 (296,636 vs. 313,806 acres). Bill Kramber said the original irrigated lands mask for 2000 was developed with a different method than the other years, before the model was the intended use. For this analysis, preliminary irrigated lands data for 2000 was developed by using the 2002 irrigated lands data and then computing the mean 2000 seasonal ET by field. Fields with ET below 1.5 ac-ft/acre were considered non-irrigated. Rick asked whether we could be missing the ET on lands irrigated for winter wheat.

Bryce said that the hypothesis was that the model left out ET which resulted in higher modeled flows vs. measured flows. He added that Mike's data show that the model has too much ET. Chuck Brockway asked if the conclusion is that the model has more ET, then what are the other plausible hypotheses. Mike said that he believes there is an upward or increasing slope to ET, but it is a flat value in the model. Mike showed a slide of the departure from modeled vs. measured flow at Rangen spring and said the ESPAM 2 calibrated ET exhibits a slope of +0.02%. He added that if the true slope of ET over time is steeper, the model may compensate by adjusting spring discharge. Rick Allen suggested that the measured low spring discharge is due to hydraulically controlled diffuse flow. He said that in 2008, the water levels in the aquifer were lower than previously, so the discharge is under different hydraulic controls.

Jairo Hernandez asked how ET was obtained for other years, and Bryce said from ET Idaho data. Rick Allen said that during the drought, the plants pulled water from

greater depths and changed the recharge conditions. Allan Wylie asked whether it could be more recent cultivars that require more water. Rick said that would be true only if the leaf area is increasing. Bryce said he thinks that there is more matter, thus more ET. Rick responded that the harvestable yield per biomass is up, but not necessarily more biomass. Rick offered that he believes that better water application uniformity with irrigation systems increases ET rather than attributing it to cultivars. He said that corn plants are different today from what was planted 30 years ago. He said today's crops will have higher ET. Rick then asked if it is possible to put a time-based filter on PEST, and Allan said yes, but not for this version of ESPAM.

Chuck Brockway suggested that we evaluate whether all the springs demonstrate higher modeled vs. measured flow. Mike said that he believes the departure is evident in all the springs. Jim Brannon said it is more pronounced in the higher elevation springs. Then Mike showed a slide that asked the question "What can cause ET to increase over time?" The slide included 5 explanations, and Bryce said items 1 and 2 (Climate Change and Crop Mix Changes) should be in the model. Mike agreed, and then he said that the Agrimet station at Twin Falls for alfalfa data shows no slope (ET vs. time), but the values for other stations (USBR and NWS) have an increasing trend.

Mike's next slide indicated that if climate change is not adding significant slope to ET, then it will be difficult to quantify the remaining suspects (crop mix changes, cultivar changes, efficiency changes, and changes in practices), and he gave the reasons why. Chuck Brendecke asked if we are still using county crop statistics in the model, and Mike said yes. Mike added that he thought the spatial distribution of crops could affect the high elevation springs. He asked Chuck Brockway what changes have occurred regarding canal systems. Chuck Brockway said that in the last 5 years, there have been changes in practices to reduced return flows, but he was not aware of significant canal lining projects. Chuck added that he wasn't sure if the effort to reduce returns has been successful, and he didn't think it was significant.

Chuck then said looking at all the potential changes to ET, is that enough to cause the differences in the measured vs. modeled ET? Mike said probably not. Chuck then asked if it is 200,000 AF in ET changes, how many cfs is that. Bryce said about 300 cfs. Mike said from the perspective of water level changes, he thought 200,000 AF would make a difference. Jim Brannon said that he thinks the high elevation springs show the departure first. Willem asked what other springs show the departure. Allan said the greatest departure is evident at Box Canyon Springs, Clear Lakes Springs, Devil's Washbowl Spring, and the Rangen Hatchery Complex. Willem concluded it is not just local but regional.

Allan said that if ET is too high in 1980, then PEST will increase ET in the later years to get the right slope. Rick Allen said that the farmers could be tightening up the amount of water applied resulting in a reduction of flux to the aquifer. Allan agreed and added that there are synergistic effects. Willem asked what parameters we allow PEST to adjust. Allan said we have to make sure we give PEST the correct tool.

Willem asked if we want PEST to figure this out or do we figure it out. Allan said it would be beneficial for us to know that we gave the right parameters for PEST to adjust and that he would like to see the METRIC results for 1986. He added that he is not sure how to adjust canal leakage.

Allan recommended that the water level data for a couple of wells should be reviewed to see how the aquifer responds to canal leakage. Jim Brannon asked if the purpose of this effort was to corroborate that aquifer heads show flattening oscillations, and Allan said yes. Jennifer Sukow said that residuals in the Kimberly to King Hill reach are higher in later years of the model period. Jairo asked what the relationship of precipitation to recharge is. Bryce said that it is linear. Jairo asked if the phenomenon was geographical. Bryce said that it is more predominant in the western end of the aquifer where there is more irrigation. Allan said that in the middle of the plain there is lots of non-irrigated land. He added that in calibration, we are trying to match the interaction of the aquifer and the river and the aquifer and the springs.

Rick Allen asked if there are wells close to Rangen that show the departure in observed vs. modeled heads. Allan said yes that the head trend is the same as the spring discharge departure. He added that if the well measurements start in 1980, the modeled heads are too low in the beginning and too high at the end. If the measurements start in 2006, the match is good. Jennifer Sukow asked if we should plot residuals to see how it comes out. Rick Allen asked if well hydrographs were available for the committee to review. Allan said not today.

Allan said that with validation, we will be looking at 2009 and 2010. He said he hoped that the departure (modeled vs. measured) in the spring flows will not get worse. He thought that the departure could be addressed in the next version of ESPAM along with Bryce's technique of using METRIC and NDVI data to represent ET in the model. Jim Brannon asked if we should look at diversions and canal losses over time using PEST. Allan said he would like an independent verification first. Bryce said there are some canal managers that become more efficient in water deliver every year with less leaks. Chuck Brockway said parts of the canals seal themselves with time, and they sometimes do repairs on leaking reaches but not on Northside. Rick Allen said that the use of center pivots eliminates some laterals. Chuck Brockway said that he did not think it was a high percentage of the total. Rick Allen said he thought you could see this on some aerials, especially near the rim.

Item 4 - Bryce Contor presented a method of Temporal Interpolation for Applying METRIC ET to the next version of ESPAM. He was assisted in the development of this method by Eric Rafn, formerly of IDWR. Bryce first indicated that the equations related to his discussion include:

$$ET\ depth = (Reference\ ET\ depth) \times (Crop\ Coefficient\ or\ [Kc])$$

$$ET\ depth = ETr \times ETrF$$

Bryce said the ESPAM version 1.1 components of practice for ETrF/Kc are:
– Crop mix from NASS/Idaho Ag Statistics
– ETrF by crop from ET*Idaho*
– ET Adjustment Factors to compensate for nonstandard conditions
- Set by professional judgment
- Confirmed by METRIC (one year of data)
- One pair (sprinkler/gravity) for entire study area
- Did not change over time
- Ad Hoc manual adjustments for acute water stress

He showed the same components for ESPAM version 2.0:
– Crop mix from NASS/Idaho Ag Statistics
– ETrF by crop from ET*Idaho*
– ET Adjustment Factors to compensate for nonstandard conditions
- Calculated using METRIC (two years of data)
- One pair (sprinkler/gravity) for each irrigation entity
- Do not change over time
- On Farm Algorithm adjustments for acute water stress

Then Bryce discussed why using METRIC data is attractive to the ESHMC modeling effort. He made the following points regarding advantages of METRIC:
- 30 meter to 60 meter pixels (instead of whole counties)
- Implicitly reflects
  – crop mix
  – stress (moisture or other)
  – variations in varieties or methods
  – non-irrigated inclusions
- Some compensation for imprecision in irrigated lands data

Bryce said that the temporal interpolation is necessary because METRIC ETrF values won't be available for all years. He described methods regarding how the interpolation could be done which are summarized as follows:
- Naïve method which assumes some other year's METRIC ETrF/Kc values are pretty good for this year
- Direct Calculation of ETrF/Kc from NDVI (Normalized Difference Vegetative Index)
- Using NDVI to constrain the application of another year's METRIC (NDVI Scaling)

Then he described how to calculate Kc from NDVI:
Obtain Kc values from METRIC or other crop coefficient data sources.
1) Use remote sensing to calculate NDVI values.
2) Create equations to relate Kc and NDVI.

Bryce provided statistical and practical test results. He compared the statistical test results and found the equations were not equivalent. For the practical test results, he

used three NDVI/Kc equations from sites in Colorado to calculate Kc for Landsat path 39, he used ETref and Kc to calculate ET depth for path 39, and then he compared ET depths with METRIC ET depths. The calculated ET depths were within +/- 10% of the METIC depths. He discussed the temporal applicability regarding full-season ET estimation and said that Tasumi et. al (2006) reported that NDVI/Kc equations from 1989 produced good results for the same locate when applied to 2000 data. Bryce and Eric Rafn found that NDVI/Kc equations develop in Colorado in 1989 produced good results when applied to 2000 path 39 data.

Bryce then introduced an NDVI Scaling Method as an attempt to capture the theoretical advantages of METRIC including evaporation from bare soil, crops with a full canopy but some agronomic stress (moisture or other), crops that have similar leaf area but different vigor or agronomic characteristics. He said this could be accomplished by using other-year METRIC ETrF rasters. He added that as an attempt to capture acute target-year conditions that naïve interpolation cannot, the NDVI scaling method would provide consideration of acute target-year water supply conditions and crop rotation conditions. Bryce said that this could be accomplished by scaling METRIC ETrF by NDVI Kc rasters. Finally, Bryce said that using a scaled METRIC ETrF could be used to bridge cloudy-image dates because a date without data for METRIC likely won't have data for NDVI either.

Next he offered a conceptual explanation and said that suppose for the dates I have data, Pixel X has an NDVI-derived Kc from the target year, which is 110% of the NDVI Kc from the source year. Bryce said that this might be explained by:

– Maybe there is better water supply
– Maybe this is alfalfa and it used to be barley
– Maybe farmer Tom has retired and farmer Sally takes better care of the place.

As Key conceptual assumptions, he said that this tidbit of information tells us more about pixel X than simply relying on some other year's ETrF for the pixel. He added that the other-year METRIC ETrF still contains useful information about the months that we don't have NDVI. Regarding application of his method, Bryce said that for the target year and for this pixel, we use 110% of the source year METRIC ETrF for all the dates we don't have data, and for the next pixel, we use the fraction calculated for it.

Rick Allen said that the change from year to year is more likely crop changes rather that water supply differences. Bryce responded that he is not happy with agricultural statistics for an entire county. Rick Allen suggested that the NDVI from the AVHR satellite could be used and that it has daily imagery.

Bryce went on to describe a test where the 2006 METRIC results were accepted as fact, and 2002 METRIC ETrF and various 2006 NDVI Kc data were uses to calculate 2006 ET estimates. He described 2002 as the source, and 2006 as the target. The 2006 data was assumed as missing. The steps for the test were described as follows:

• Apply the Naïve method and calculate average ET depth.

- Apply the NDVI Scaling method and calculate average ET depth for 7 summer months.
  - Assume 5 months data will be available (2 tests)
  - Assume 3 months data (2 tests)
  - Assume only one month data (4 tests)
- Compare the results to 2006 METRIC ET depth.

Bryce showed graphs of results. Rick Allen asked how the interpolation was done, and Bryce said using a step function. Janak Timilsena asked Bryce to define NDVI, and an explanation was provided. Rick Allen said that the NDVI cannot be used to pick up evaporation from bare soil.

Bryce's recommendations include the following:

- Use METRIC for all years it is available
- Interpolate between METRIC images for intervening years
  - Use NDVI Scaling method if even one month of NDVI data are available
  - Use Naïve method otherwise
- Extrapolate 1986 METRIC to earlier years
  - Same NDVI/Naïve criteria as interpolation

He offered the following other options to consider:

- The use of SEBAL for 1982 – 1985 doesn't require weather data for internal calibration
- Use an average of METRIC years instead of a single year.
- Use NDVI directly w/o scaling when there is enough data.
- Use NDVI scaling for months near the month of an NDVI image, Naïve for months distant.

Rick Allen said that he did not favor the use of SEBAL. A discussion followed regarding the difference between METRIC and NDVI. Mike McVay asked if the NDVI scaling would work with the monthly time step. Bryce said that he would not recommend breaking the NDVI from seasonal to monthly. Allan again questioned whether you can obtain monthly ET, and Bryce said no, you get ET by a certain date. Allan suggested that ET would be constant until data for a new date was obtained. Bryce said he recommends developing a seasonal curve by interpolating between dates and using the curve to apply stress to the model. Rick Allen agreed with using a curve rather than a linear interpolation.

Rick Raymondi suggested setting up a subcommittee to recommend an approach to the next version of ESPAM. Chuck Brockway said Bryce's methods are worth pursuing and should be adopted. He said there is the potential for an improvement to the model. Bryce summarized the benefits by indicating the improvements to the spatial and temporal representations of ET and most departures from actual stress would be captured. Rick Allen said that if you step back far enough that all the spatial and temporal distributions should even out. Bryce then discussed the

advantages of capturing the spatial distributions and said that the reductions for non-irrigated inclusions are not very good. Bryce also said that previously, the boundaries of fields were averaged to get rid of stray pixels. He said that if we could compensate for the buffers by applying METRIC.

Jim Brannon asked if Bryce had thought about the surface water to ground water split in context of his ET work. Bryce said he had not thought of this. Chuck Brockway said that the development of datasets should be quicker, and Bryce agreed. Chuck asked if we will have actual data on ground water pumping, and Bryce conceded that information would help. Jim and Chuck Brockway said that there are a whole host of features in the model to consider and resolve. Bryce agreed.

Item 5 - John Koreny presented information related to the collection of spring elevation data in the Thousand Springs area. John had recommended to the committee that new spring elevations be obtained with a GPS unit, and he indicated that he communicated with Allan Wylie in planning the effort. HDR, IDWR, and hatchery representatives cooperated, and the new elevations ranged between 2950 and 3150 ft msl, which were generally 5 to 10 feet higher than what was in ESPAM. Elevations were obtained in the area of the Thousand Springs power plant, the National Fish Hatchery, and the Jones and SeaPac facilities.

Jim Brannon asked if there were any large differences, and Allan said the surveys for the National Fish Hatchery had the biggest difference. Allan said there is quite a bit of talus in this area, and he may have to make some adjustments to get the resolution back. Jim Brannon asked if PEST would make the adjustments, and Allan said the higher elevation springs show greater seasonal amplitude, and if the spring elevation is off, PEST would choose between ground water elevations in wells and spring discharge amplitude. Willem Schreuder asked if it helps to have better spring elevations when there are two drains in a cell so that we obtain better drain conductance. Allan said yes. Jim asked if you make the elevation higher, and Allan said that he first uses a lower elevation to see what PEST does, and then if necessary, he raises the elevation to obtain the seasonal variability. Jennifer Sukow mentioned a cell where the high elevation drain was lowered because of the talus.

Rick Allen suggested the true spring elevation is at the top of the water table where the water is going over a restriction in the talus. John Koreny said he told the field crew to measure the elevation where there was evidence of the emergence of the spring. Chuck Brendecke asked if the field crew tried to measure every spring or was a map used. John said that the crew coordinated with the hatchery manager to get springs with discrete outflows. Allan said the information was posted on the ESHMC web page. Dave Blew asked if there was a question of accuracy. John said that on a spreadsheet from the GPS vendor, it indicates the unit has a vertical accuracy generally within 1 to 2 feet. John added that all points were collected in one day. Chuck Brendecke asked if the Jones area elevations were in the shape file, and Allan said yes. Jennifer Sukow said that there is a shape file posted for Jones.

Item 6 - Allan Wylie led a discussion of ground water underflow that discharges from the ESPA between Milner and King Hill. He reviewed the Covington and Weaver report and other sources of information regarding the springs, and explained the ESPAM version 1.1 vs. version 2 approach to the springs. Then he discussed the adjustments made to Covington and Weaver including the issue related to an apparent decline in the Thousand Springs Power Plant discharge between 1980 and 1995. He also discussed the re-examination and correction made to the Jones and SeaPac ESPAM version 2 cells. Allan added that Jennifer Sukow checked for other errors comparing Covington and Weaver discharges with water rights, but she did not find any more significant issues.

Then Allan compared the average Snake River gain between Milner and King Hill to the modified Covington and Weaver discharge, and he indicated that there is a difference of 984 cfs that the model is representing as being discharged from class C target spring cells. He said this causes the C target springs to significantly exceed the Covington and Weaver estimates, and he indicated that adding more A & B targets makes this worse. Allan also showed the impact of the changes and redistribution of spring flow on model transmissivity for versions 1.1 and 2.0.

A conceptual diagram was presented, and Allan explained the concept of underflow to the committee. He proposed to account for the unmeasured underflow using a general head boundary and said it will show up as a separate water budget item in the MODFLOW output. He also proposed using specific targets to measure underflow where we know it exists (e.g., Thousand Spring and Crystal) and evenly spreading the remainder between three reaches – Kimberly to Buhl, Buhl to Lower Salmon Falls, and Lower Salmon Falls and King Hill. Chuck Brockway asked how a general head boundary works, and Allan said similar to a river or spring with the head in the Snake River being held steady and the conductance of the boundary being adjusted to obtain the flow.

Allan discussed the quantification of the underflow in the area of Crystal Springs using data from USGS measurements in March 2011. Chuck Brockway asked how many model cells were involved, and Allan said one. Allan said the estimated underflow as determined by the USGS was 116 cfs. Rick Allen said that the underflow could be as low as 30 cfs and as high as 200 cfs. Dave Blew asked what the total flow in the river was, and Jennifer said about 5000 cfs.

Jim Brannon suggested that Covington and Weaver made the numbers add up, and Allan said that he thought that it was amazing. He said this is an issue, but going forward, Covington and Weaver have to be part of the model.

Chuck Brockway asked if Allan distributed the residual over one large reach, and Allan said no. He briefly showed Chuck the three reaches, but said he wanted to talk about Thousand Springs before discussing the reaches. At Thousand Springs, Allan said there are 14 measurements above and below the spring within the model calibration period. He indicated the average underflow is 494 cfs.

Allan moved to the subject of river reach gains and said the gains have the Southside underflow and returns subtracted out as well as the Northside returns subtracted. In calculating the underflow, he added average discharges for the A & B springs to the C springs for a model reach. He assigned the underflow to the general head boundary (GHB). Allan said that he assigned underflow according to gauged river reaches - Kimberly to Buhl, Buhl to Lower Salmon Falls, and Lower Salmon Falls to King Hill. He showed the accounting for each of these three reaches and how many cfs in underflow was assigned to each model cell.

A long discussion followed. Jim Brannon suggested letting PEST determine the conductance of the (GHB). Willem asked if the GHB should be in cells with springs or any cells adjacent to the river. John Koreny asked if the river is truncating through the basalts and whether the underflow is above or in the river. John followed up by stating that there is not one right answer, and that the hatchery managers say the flow is under the bank flowing through talus or alluvial deposits. Bryce agreed and wondered whether the underflow is in the talus or discharging directly into the river.

John Koreny asked why Allan did not increase the target by some percentage. Allan said he thought it would be worth having a separate water budget column (underflow and spring discharge). John said he appreciated Allan's approach and asked if he would be giving PEST more discretion with this approach vs. simply giving each spring some additional flow (e.g., 5%).

Willem said there were implications with this approach given stress in the X, Y, and Z directions, the GHB would be another that you would see change. Then Willem returned to the discussion of where the GHB should be located and said the river is far from Rangen. Allan said the water can go under the Glens Ferry and come out. Dave Blue said that Blue Heart Spring fits the description of underflow. Chuck Brockway said he likes the idea of separate accounting, but he was not sure about the river vs. spring issue. He also wanted a spatial distribution of where the underflow enters the river. Allan said we will take advantage of the river flow data that we have.

Bryce suggested that the conductance should be used in the GHB that gives you the flows that you want. Willem said set a low conductance, because he did not expect the number to change much, and let PEST dial in the number. Chuck Brendecke said that since we are still using the A and B targets, it is important that this does not become any more complicated. He added that the discharge reflect spatial distribution with some opportunity to reflect temporal variability. Willem said he was concerned with using the same conductance throughout the system, and that PEST should be given the opportunity to adjust conductance.

Chuck Brendecke said that aerial photos show a difference in the color of the river with no evidence of discharge on the canyon wall. He thought that there could be more underflow in these areas. Willem asked if this discharge could be from the west

or the south, and Chuck Brendecke answered that it might be along the bank in a river cell or by a spring cell. Allan suggested that every cell that butts against the river had discharge. Willem said let PEST assign the conductance in every cell in the long reaches with the exception of Thousand Springs and Crystal Springs. Chuck Brockway thought that discharge was limited to cells with springs, and that below Bliss to King Hill, there was no underflow. He said he thought it would be a mistake to let pest adjust conductance below Bliss. John Koreny agreed. Chuck Brockway said the underflow should be assigned to spring cells in all reaches. John Koreny expressed concern with assigning water where there is no spring discharge. Rick Allen said that maybe the springs cause no underflow. Willem expressed concern with the fact that ground water is discharged in the Malad gorge and Box Canyon far upstream from the river. Jim Brannon said this redistribution of underflow puts a lot of weight on the reach target, and Allan agreed.

Allan said that a GHB would be assigned to cells with springs that butt against the river, except for cells along the Hagerman Valley. He suggested that Crystal and Thousand Springs flow be assigned separate water budgets, and the underflow would be a separate target with less weight than the C target springs. Allan concluded that there are 2 things that we don't know well, the C target springs and the underflow. He added that he has confidence in the reach gains. Bryce suggested the underflow water budget should match reach gains. Willem said that we are establishing a double target that is not necessary. He said that there should be a separate group that is the underflow targets. Allan agreed.

Allan asked what model reaches should be used. Willem said we want to be consistent in specifying targets, and we don't want to over specify. Allan said it doesn't hurt to show information in multiple ways. Greg Sullivan said that when you add targets, it changes the weighting relative to one another. Allan agreed and said we will have to change targets and weights. Jim Brannon said that the underflow targets won't change the gains, and Allan said it only changes where it comes out.

Bryce thought that instead of a separate column, the underflow should be added to spring targets. Allan said the advantage is that the separate accounting allows you to understand the components better. Chuck Brendecke agreed with a separate accounting. He added that there is something to be said with respect to underflow having a similar distribution as the observed springs. Rick Raymondi asked if the gains could be shaped by low elevation springs, and Allan said no, the underflow should have seasonality but less seasonality than the springs.

The committee completed the discussion and agreed that a GHB would be assigned to cells with springs that butt against the river, and for cells along the rim of the Hagerman Valley. Crystal, Thousand Springs flow would be assigned separate underflow targets as would the discharge from Blue Heart Spring. The underflow would be a separate target with less weight than the C target springs. The model reaches for distributing underflow would be Kimberly to Buhl, Buhl to Lower Salmon Falls, and Lower Salmon Falls to King Hill.

Item 7 - Rick Allen presented an idea for estimating recharge to the aquifer under the basalt to the committee. He intends to find a site within the Craters of the Moon National Monument where there is accurate precipitation data. He could difference evaporation from precipitation to determine the recharge flux through the basalt. Rick said that from NSF grants, he has already deployed equipment to measure the heat flux and water vapor flux from sage brush, cheat grass, and lodge pole pine. Allan Wylie asked how large of an area would be tested, and Rick said he would use a single tower 3 to 4 meters high, and the air stream would be tested reaching out a few hundred meters. Rick added that he thought the existing weather station is too high up on a hill.

Willem said he like the idea, as did Chuck Brockway. Chuck asked when the testing would be done. Rick said that he would set up in March or April. Mike McVay asked if moisture would sublimate during the winter, and Rick said it would with a tiny signal.

Item 8 - Allan began a discussion of predictive uncertainty starting with providing reasons to conduct the analysis. He said that the ESHMC chose an approach to evaluate predictive uncertainty that could be completed given our time and budget. Allan then outlined the factors that affect predictive uncertainty including conceptual uncertainty, parameter uncertainty, internal calibration uncertainty, and exterior calibration uncertainty. He also talked about spatial variability in the model, and reviewed the method that is being followed. Finally he presented the limitations of the predictive uncertainty analysis underway.

Allan presented the results of the predictive uncertainty analysis runs where a constant stress was applied on the centroid of Water District 120 and the maximum and minimum possible impact on Clear Lakes Springs was determined. He summarized the impact as follows: WD120 +107%/-12.6% and indicated that PEST attempted to raise the conductance beneath American Falls Reservoir and lower the riverbed conductance between Near Blackfoot to Neely. Chuck Brockway asked why PEST picked those 2 parameters to tweak, and Allan said that those two have the biggest impact. Willem asked how we know where the impact went. Allan said the impact is forced to go elsewhere but we are monitoring the impact on Clear Lakes. Greg asked what if the impact was 3%, and how sensitive is this analysis. Allan said it is not linear. Bryce said the analysis defines how much room we allow PEST to move within. Allan said he picked what was recommended in the PEST manual.

Willem asked given the objective function we gave PEST, is this result the best that we can obtain, and if we gave PEST different weights, would we get another answer. Allan said that the committee made an effort to limit the scope of the uncertainty evaluation to get the analysis done in a reasonable amount of time while still satisfying the due diligence on the model. He added that we are looking for weakness in the model, and it is a way to make future model versions stronger. Allan gave the

example that looking at the conductance of American Falls Reservoir bottom might be more important to future versions.

Chuck Brockway asked about the purpose of predictive uncertainty and if it will define areas that should be looked at as part of calibration. Allan said that in order to make it part of calibration, you would need prior knowledge about problem areas. Willem said that in this case, how do I evaluate the 107%, and at what point do I care. Greg asked if Allen present the results prior to scaling up acres. Allan said the acres were multiplied by a factor of 2. He added that no weights were placed on the prediction at Clear Lakes, and the objective function is the same.

Willem said that there should be a better way to present the reference value. Jim Brannon said that we are just trying to find out the amount of wiggle room, so it's just an interval or value to compare with each other. David Hoekema said it is also valuable to know what PEST was tweaking. Bryce said it tells us that the conductance of American Falls Reservoir is important. Jim Brannon said that he believes there is an underflow issue and that the C targets could impact the amount of water that PEST can adjust. Allan agreed and said we are learning a lot more as we do these runs.

John Koreny said he was struggling, and although he sees the utility, he thinks that the predictive uncertainty analysis doesn't really address the uncertainty that concerns the Director. John went on to say that the analysis provides a good bracket, but does not address model uncertainty. He added that it is not good to put this analysis at the end of the model development process, and he realizes this comment is at odds with the committee procedure. Allan asked John to explain his approach to uncertainty. John said that his procedure would be to develop data, calibrate the model, perform uncertainty, re-calibrate the model, and then you would be done. Allan said that he agreed with John 100% that the path the committee is taking does not address model uncertainty, but it does address predictive uncertainty.

John said that, in the PEST procedure, how you frame the model and define the targets all have uncertainty. John felt that the committee has sufficiently dealt with the uncertainty issue and that it is difficult to put a number on it. Chuck Brockway said that Chuck Brendecke gave the committee his thoughts on model uncertainty, and he gave us the components. Chuck Brendecke said that his thought is that the predictive uncertainty is a subset of all those uncertainties, and it is a limited subset. He added that predictive uncertainty is useful, and how best to portray the results will be meaningful. Allan said the approach the committee is taking completely leaves out conceptual uncertainty. Other uncertainty factors are at least partially addressed. He said that regarding field observations, the weights reflect the committee's confidence in the observations.

Willem said that in the approach the committee is taking, we are not considering how sure we are about the observations themselves. Next he said, the approach is a tool to figure out where to get better observations. Willem added that it will help us figure

out where to make more observations. Willem then asked why the Director wants to know about uncertainty. He said that maybe it is not the right question, and maybe the committee can help him.

Willem said that the uncertainty is a value below which we have no business making predictions, and at that point, it is more about noise. Greg Sullivan said one use is to make a trim line. Willem said then we really have to be careful with the numbers. Chuck Brockway reminded the committee that the purpose for the model is to provide an administrative tool. Chuck said that the Director asked us to calibrate and validate the model, perform uncertainty analyses, and compare the output with previous model output. Then Chuck said that he has concern if the Director makes the mistake again with respect to defining a minimum threshold below which there is no impact. Sean Vincent said the uncertainty analyses provide spatial information also.

Chuck Brockway said that he agrees uncertainty analyses should be done, but the committee needs to tell the Director what the information developed can and cannot do. Willem said we need to answer the right question; perhaps we should explore what the right question is. Chuck Brockway said we need to make sure what the Director said he wanted the committee to do is what we are doing. He said it is important to know how the model will be used after it is developed and adopted. Allan said it will be used for curtailment, planning, and transfers. Greg Sullivan asked how the predictive uncertainty of the model be factored into the use of the model.

Director Spackman joined the meeting and apologized for being late. He provided a series of comments and questions regarding the model:

- How much time should be spent on the uncertainty analyses and will the effort make a difference?
- We have changed from a reach analysis to a cell analysis so the conclusions should be better.
- There might be a change in the results from the previous model. If there are changes, how do the results compare? Should previous results be abandoned?
- Are we confident in the output of the model? If changes to the results of the previous model are made, hopefully we will not go back and forth between models so that there is business certainty on the ESPA.
- It is up to the committee to tell the Director if the right uncertainty analysis is being pursued.
- The uncertainty analysis may point to a certain model weakness that we might not have known.

Chuck Brockway said that the committee feels urgency since we are in a technical advisory role. He added that the committee wants the model to be defensible within limitations and for the intended administrative use. Regarding the trim line, Chuck said that whether there should be or not, the way the trim line was used in the past is not justified. Willem said that he does not have a problem with the trim line per se, rather he believes is should be related to a de minimus use rather than uncertainty.

Director Spackman said all of the people on the committee aren't there for technical satisfaction. He continued saying people are paid and bring baggage, and some will like the trim line, and others won't. Gary said that the Department values the opinions of the members regarding in what form the model should be adopted. He suggested that maybe a procedure or process should be set up to discuss the issues. Chuck Brockway said maybe a policy memo should be issued from the Department. The Director responded that maybe for the model but not for curtailment.

John Koreny said he has trouble regarding where we are at in the process. He said there are procedures to develop data and develop the conceptual model. John said that in other projects that John had worked on, the uncertainty was addressed in calibration. He added that when it's done, it's done. John said that he understands the need to address uncertainty, but the way it is being done is not part of standard practice. Greg Sullivan said that there are other cases where an estimate of predictive uncertainty was used in the application of the model. John Koreny said the uncertainty analysis being followed is a narrow procedure to get a number. He said the information obtained suggests where the model needs more calibration, but the uncertainty analysis needs to be limited.

Willem said that noted difference in Greg Sullivan's example is that we can agree on some minimal impact where we believe the model is unreliable, but that de minimus is not related to the uncertainty of the model. John Koreny said whether predictive uncertainty should be used to establish the trim line can't be resolved in this meeting. John suggested that maybe the committee should get back together soon to discuss this issue, and comments and suggestions should be put in writing.

Gary Spackman said that he does not want the committee to do anything that is unnecessary. Jim Brannon said there was good progress with the model and that it is incredible how much better it is. He said that he was scared that numbers will be used to reflect how good the model is. Roger Warner said some questions will be asked of ESPAM version 2.0 that will be similar to what was done before. He said the impact of pumping on streamflow has uncertainty. Bryce said that all members are paid here representing those with a stake in the outcome. Bryce said that the use of a trim line and its relationship to model uncertainty are not technical questions.

Roger Warner said that John Koreny discussed science, and Willem discussed what level of noise we can allow. Roger said that these concepts are difficult to explain to constituents – especially when depletions are difficult to measure, but the model says you are depleting.

Gary Spackman gave an example saying when I previously saw a flow of 7 cfs, but the new model says 70, how certain am I. Willem responded that in Colorado 1/10 of 1% of depletions are administered. He said he is not claiming precision, but this is what de minimus means. Gary said that he hoped that the process the committee is going through is helpful, if not, he said the committee should tell him. John Koreny

said his previous experience with models is that calibration is the place to address uncertainty and that the current procedure is not correct.

Willem asked if another White Paper would be appropriate and suggested that the committee provide the Director a discussion that is more informative. He said that all agree that uncertainty isn't everything, so the White Paper should indicate what the uncertainty analysis does not address. Willem said there is controversy with what you do with uncertainty. He added that the paper should discuss what uncertainty is and what it is not. Finally, Willem said the goal of the White Paper should be what we agree on and what we don't and what an appropriate application is. The committee agreed to develop a White Paper.

Item 10 - The committee agreed that the next meeting would be held on January 23rd, 2012.

DECISION POINT SUMMARY

The following was agreed upon:

1) IDWR agreed to setting up a subcommittee to discuss the method of Temporal Interpolation for Applying METRIC ET presented by Bryce Contor and to recommend an approach to the next version of ESPAM.

2) The committee completed the discussion and agreed that a GHB would be assigned to cells with springs that butt against the river, and for cells along the edge of the Hagerman Valley. Crystal and Thousand Springs flow would be assigned separate underflow targets as would the discharge from Blue Heart Spring. The underflow would be a separate target with less weight than the C target springs. The model reaches for distributing underflow would be Kimberly to Buhl, Buhl to Lower Salmon Falls, and Lower Salmon Falls to King Hill.

3) The committee agreed to develop comments and suggestions in writing regarding uncertainty and the use of a trim line for administration. The information will be compiled in a White Paper.

4) The committee agreed that the next meeting would be held on January 23rd, 2012.