**BEFORE THE**

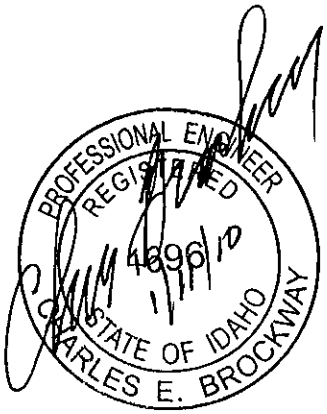
**IDAHO DEPARTMENT OF WATER RESOURCES**

| | | |
|---|---|---|
| IN THE MATTER OF DISTRIBUTION OF WATER TO WATER RIGHT NOS. 36-02356a, 36-07210 & 36-07247 | ) | **CM-MP-2009-002** |
| IN THE MATTER OF THE MITIGATION PLAN FILED BY A&B IRRIGATION DISTRICT | ) | |
| (Blue Lakes Delivery Call) | ) | |

**DIRECT TESTIMONY OF**
**CHARLES E. BROCKWAY, Ph.D., P.E.**

**SUBMITTED ON BEHALF OF:**

**A&B IRRIGATION DISTRICT**




**JANUARY 11, 2010**

1 **DIRECT TESTIMONY OF CHARLES E. BROCKWAY**

2 **Q. STATE YOUR NAME, BUSINESS ADDRESS AND POSITION.**

3 A. My name is Charles E. Brockway. I am the Senior Member of Brockway Engineering,
4 PLLC, located at 2016 North Washington Street, Suite 4, Twin Falls, Idaho 83301.

5 **Q. WHAT IS YOUR EDUCATION BACKGROUND AND WORK EXPERIENCE?**

6 A. I have a BS in Civil Engineering for the University of Idaho. I have an MS in Civil
7 Engineering from the California Institute of Technology. I have a Ph.D. in Water
8 Resources Engineering from Utah State University and did graduate work for both the
9 University of Denver and University of Colorado.
10 I have been involved with water resources studies and research in Idaho and the western
11 United States since 1964. I have been specifically involved with the Snake River Plain
12 and aquifers since 1965. My experiences include research and graduate student
13 instruction for 32 years with the University of Idaho in charge of water resources research
14 at the Kimberly Research and Extension Center. Research included development of
15 ground water models for various aquifers including the Eastern Snake Plain Aquifer
16 ("ESPA"), water resources planning, water quality research and management and
17 irrigation system evaluations. With the University of Idaho, I was the Associate Director
18 of the Idaho Water Resources Research Center and have been in full time private
19 consulting since 1997. Brockway Engineering PLLC specializes in ground water and
20 surface water evaluations, hydraulics and irrigation systems, river restoration and
21 protection and aquifer water quality management. Long term clients include various
22 canal companies and irrigation districts, aquaculture enterprises, dairies and private water
23 users.

1 **Q. HAVE YOU BEEN QUALIFIED AS AN EXPERT IN PROCEEDINGS BEFORE**
2 **IDWR?**
3 A. Yes. I have participated as an expert witness in numerous water right permit, transfer,
4 and delivery call proceedings before IDWR.
5 **Q. WHO ARE YOU TESTIFYING FOR IN THIS MATTER?**
6 A. I am testifying as an expert witness on behalf of the A&B Irrigation District ("A&B").
7 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?**
8 A. I am providing testimony regarding the adequacy of the proposed *A&B Irrigation District*
9 *Rule 43 Mitigation Plan* to provide mitigation for the A&B water rights subject to the
10 Blue Lakes Trout Company, Inc. delivery call.
11 **Q. HAVE YOU REVIEWED *A&B IRRIGATION DISTRICT'S RULE 43***
12 ***MITIGATION PLAN* THAT WAS FILED ON AUGUST 18, 2009?**
13 A. Yes. I reviewed and participated in the development of the A&B Mitigation Plan. I
14 prepared a memorandum on August 6, 2009, discussing the Mitigation Plan and whether,
15 by implementing that Mitigation Plan, A&B will be able to meet its mitigation
16 obligations to Blue Lakes Trout Company. That memo explained my review and analysis
17 of the A&B Mitigation Plan, including the results of ESPA model runs conducted by Dr.
18 Allan Wylie from the Idaho Department of Water Resources ("IDWR"). A copy of that
19 August 6th Memo was previously provided and is attached to my Direct Testimony as
20 Attachment A. By this reference, I will incorporate the August 6th Memo into my Direct
21 Testimony, as though fully stated herein.
22 **Q. DID YOU NEED TO ACTUALLY RUN THE ESPAM MODEL FOR YOUR**
23 **ANALYSIS? IF NOT, WHY?**

1 A. No. I am very familiar with the ESPAM model which Dr. Wylie utilized to evaluate the
2 impact of A&B pumping and the benefits of the proposed mitigation components. I serve
3 on the Eastern Snake Hydrologic Modeling Committee which serves as the advisory
4 committee to IDWR on the ESPA ground water model. I have discussed with Dr. Wylie
5 the model simulations which he performed in his evaluations. In my opinion, the model
6 input he utilized correctly depicts the impact of water use on A&B and the model was
7 utilized correctly. I therefore have no reason to duplicate the effort and run the model
8 personally.

9 **Q. HOW IS THE BENEFIT UNDER THE MITIGATION PLAN ESTIMATED?**

10 A. Analysis of the benefits attributed to the A&B Mitigation Plan considered the effects of
11 all mitigation activities undertaken by A&B on the reach gain to the Devils Washbowl to
12 Buhl reach, of which IDWR credits 20% to the Blue Lakes spring as mitigation. This
13 method is the same procedure used by IDWR to estimate the depletions to individual
14 springs caused by junior ground water pumping.

15 **Q. IS IT YOUR OPINION THAT THE AUGUST 18, 2009 MITIGATION PLAN**
16 **WILL PROVIDE SUFFICIENT WATER TO MEET A&B'S MITIGATION**
17 **OBLIGATIONS?**

18 A. Yes. Under the method used by IDWR to calculate the estimated depletion and benefits,
19 A&B's mitigation obligation is 0.26 cfs. Based on Dr. Wylie's evaluation of the benefits
20 to Blue Lakes under the Mitigation Plan, and adjusted by my conveyance loss calculation
21 as explained in detail below, A&B's mitigation activities will provide 0.38 cfs in
22 mitigation benefits to Blue Lakes.

**Q. ARE THERE OTHER METHODS TO ESTIMATE THE DEPLETION AND BENEFITS ON THE BLUE LAKES SPRING?**

A. Yes. The ESPAM model was calibrated directly to the historical discharge at to the Blue Lakes spring node. Therefore, the model can be used to predict the effects of pumping or mitigation actions directly to the spring rather than utilize a percentage of simulated Snake River reach gain

**Q. HAVE YOU UTILIZED ANY OTHER INFORMATION REGARDING A&B'S PROPOSED MITIGATION ACTIVITIES RELATIVE TO THIS METHOD?**

A. Yes. Dr. Wylie, at my request, analyzed the impacts of A&B pumping and the benefits of A&B's Mitigation Plan directly to the Blue Lakes Spring model node. This analysis did not require any additional model simulation runs since the individual node output was already calculated in the original simulations for the reach-gain analysis. Under this analysis, A&B's mitigation obligation is estimated to be 0.51 cfs, and the benefit from its mitigation actions is estimated to be 0.77 cfs (including my revision to estimated seepage or conveyance loss).

**Q. DO YOU HAVE AN OPINION ABOUT THIS ANALYSIS AS OPPOSED TO THE REACH-GAIN ANALYSIS USED BY IDWR?**

A. Yes, in my opinion. Since the ESPA ground water model is calibrated to the historical measure discharge of Blue Lakes spring, the use of the model to simulate the response of the Blue Lakes spring to A&B's mitigation efforts is more defensible than the use of a fixed percentage (i.e. 20%) of simulated Snake River reach gains.

**Q. HAVE YOU REVIEWED THIS SPRING NODE INFORMATION?**

1 A. Yes. I have reviewed and analyzed the information. I prepared a memorandum, dated
2 January 4, 2010, which is attached to my Direct Testimony as Attachment B, and which
3 is incorporated as though fully set forth herein.

4 **Q. DOES THE USE OF THE SPRING NODE INFORMATION CHANGE YOUR**
5 **OPINION ABOUT THE ABILITY OF A&B'S MITIGATION PLAN TO MEET**
6 **A&B'S MITIGATION OBLIGATIONS?**

7 A. No. In fact, as shown in the January 4th Memo, using the Spring Node information shows
8 that A&B's Mitigation Plan will be even more effective that realized under the original
9 reach gain analysis. The benefits of the A&B mitigation components, as simulated in the
10 individual spring node procedure are 0.82 cfs compared to the mitigation obligation of
11 0.51 cfs. I suggested a small revision of the seepage losses in the A&B 'A' canal as
12 shown in Attachment B which reduces the simulated total benefit from A&B mitigation
13 components to 0.82 cfs to 0.77 cfs.

14 **Q. WHY DID YOU REVISE THE CANAL SEEPAGE OR CONVEYANCE LOSS**
15 **CALCULATION USED BY IDWR?**

16 A. It is my understanding that Dr. Wylie assumed a 30% seepage or conveyance loss in the
17 canals used by A&B and that this number was derived in reference to conveyance loss in
18 the North Side Canal Company system. I am not aware that IDWR has performed any
19 actual conveyance loss studies on the A&B project. I previously performed an analysis
20 of the estimated loss in the A&B canal system for purposes of a report submitted in the
21 *Surface Water Coalition Delivery Call* matter and determined it is approximately 22%.
22 Accordingly, it is my opinion that using an estimated 22% conveyance loss is more

1 justifiable than 30% and therefore more appropriate to use when analyzing the benefits of
2 the A&B Mitigation Plan.

3 **Q. CAN YOU SUMMARIZE YOUR OPINIONS?**

4 A. It is my opinion that the components of the A&B Mitigation Plan adequately mitigate for
5 the estimated depletions to the Blue Lakes spring caused by the pumping under the junior
6 rights subject to the call. Although IDWR has used a reach-gain analysis to estimate the
7 impacts of pumping and the benefits of mitigation actions, use of the ESPAM Model
8 directly to the Blue Lakes spring is more justified. However, under either approach, as
9 explained above, A&B's actions fully mitigate for the pumping under the junior rights
10 subject to the Blue Lakes call.

11 **Q. IN YOUR OPINION, DOES THE A&B MITIGATION PLAN SATISFY THE**
12 **RULE 43 FACTORS TO BE CONSIDERED BY THE DIRECTOR?**

13 A. Yes. In my opinion A&B's conversion of the approximately 1,378 acres to a surface
14 water supply will prevent injury to Blue Lakes' senior surface water rights caused by
15 pumping under the junior rights subject to the call. Based upon the analysis provided in
16 the attachments to my testimony, along with the model simulations performed by Dr.
17 Wylie, it is my opinion that the plan meets the applicable criteria of Conjunctive
18 Management Rule 43.

# Attachment
# A

Review ofIDWR Analysis of A&B Depletions C.E. Brockway P.E. Brockway Engineering August 6, 2009

Allan Wylie of IDWR analyzed the impacts on the Snake River of ground water use by A&B Irrigation District due to pumping and irrigation on 2,063 expansion acres (pursuant to junior priority enlargement water rights) and the additions to the aquifer and Snake River due to the conversion of 1,378 acres from ground water irrigation to a surface water source through the A Canal system.

The analysis of depletions assumed a net consumptive use of 2.10 af/ac/year with a total depletion of 4,340 af/year. It was assumed that the net depletion was distributed uniformly throughout the 188 wells of the A&B system and the ESPAM model nodes within which the wells were located (i.e. approximately 11 acres per node). Since the 2,063 acres are spread throughout the district in varying amounts at various locations, this approach is reasonable. The ESPAM model was then used to simulate the steady state depletions within the 11 reaches of the Snake River from Ashton to Bancroft spring. The Devils Washbowl to Buhl reach simulated steady state depletion was calculated at 921 af/year or 1.3 cfs.

The ESPAM model was not run for this review by Brockway Engineering. However, the approach is reasonable and the output distribution and total steady state depletion matches the input depletion.

The analysis by IDWR of the impact of conversion of 1,378 acres from ground water irrigation to surface water irrigation from the A system assumed that the converted acres were located in 4 areas as depicted by the A&B Irrigation District (the location of the converted acres). These areas were then located in the proper ESPAM nodes and the model run at steady state. The net positive input per acre to the aquifer was determined by dividing the reported annual (2006) volume delivered to the conversion acres by A&B( 3,873 af) by the acres converted(1,378 ac) to get a value of 2.81 af/acre. This value includes the consumptive use forgone by not pumping from the aquifer and deep percolation of the additional 0.71 af/acre due to decreased application efficiencies occurring with surface irrigation.

This analysis shows a net positive impact on the Devil's Washbowl to Buhl reach of 1,055 acre feet/year and the steady state total gain is equal to the 3,873 gross delivery to the converted acres. The ESPAM model was not run by Brockway Engineering for this review. The assumptions are reasonable and the output distribution and total steady state depletion matches the input.

The analysis of the contribution from canal conveyance loss by IDWR assumed that the irrigation water for the conversion acres was delivered by 'the most direct route from Snake R to "B_lands_served_A from ABCanals" and assumed a 30% loss of the reported deliveries, purported to be the same as Northside Canal Company.

A better estimate of the conveyance loss can be achieved by using the Worstell method as outlined in the Hubble report. This analysis was used in the Surface Water Coalition Expert Report of September 26, 2007. Utilizing data from that report, Brockway Engineering PLLC estimated the losses in the Main A

canal and laterals used to deliver to the converted acres. Canal and lateral widths were digitized and the Worstell equation, utilizing the wetted area and seepage rate for the Portneuf silt loam soils, was used to calculate losses. This analysis showed that the total seepage loss in the canal system to the converted acres is about 22 percent of the system capacity. Therefore, an estimate of 22% loss in the reach is more justifiable than the 30% loss assumed by IDWR.

The **attached spreadsheet** with aerial photo shows the Brockway Engineering analysis and the IDWR analysis. Using the reduced 22% estimated loss to the converted acres results in an estimated positive impact in the Devil's Washbowl to Buhl reach of 250 acre feet per year compared to the IDWR estimate of 341 acre feet per year. Again, the ESPAM model was not run for the Brockway Engineering review but the depletion values are linear with input volumes so the Brockway Engineering estimates are multiples of the IDWR values (.22/.30=.733).

At the request of A&B Irrigation District(Memo from D. Temple, Aug 10, 2009) , IDWR (Alan Wylie) analyzed the benefits to Snake River Reaches from the implementation of 121 acres under the CREP program on the A&B District. These acres are separate from the CREP acres credited to IGWA. The analysis assumed that the 121 acres were located in Sec 25, 15, and 22 T8S R23E and Sec 5, 6, and 8 T8S R24E and the net reduction in aquifer depletion was 1.77 af/ac/year. This appears consistent with the assumption that a cover crop on the CREP acres would account for about 1/3 of an acre foot per year so that the full crop consumptive use could not be attributed to reduced depletion of the aquifer.

Wylie performed a simulation with the ESPAM model similar to the steady state analysis performed for the A&B conversion acres. Total reduced depletion input to the model was calculated as 121 acres x 1.77 af/ac/year or 214 af/year. The ESPAM steady state model shows a total of 214 af/year steady state output for all Snake River reaches. The ESPAM model calculated Devils Washbowl to Buhl reach steady state depletion reduction is 42 af/year. Brockway Engineering did not run the ESPAM model to confirm the IDWR output, but the results appear reasonable.

Combining the previous analysis of the conversion of 1378 acres of B lands which resulted in a beneficial impact on the Devils Washbowl to Buhl reach of 1055 af/ year with the 42 af/year attributable to the 121 A&B CREP acres results in a decrease in depletion of 1097 af/year.

# Attachment B

# Review of IDWR Analysis of A&B Depletions

C.E. Brockway P.E. Brockway Engineering

January 4, 2010

Dr. Allan Wylie of IDWR analyzed the impacts of mitigation components, as outlined in the proposed A&B mitigation plan for Blue Lakes spring, on the ESPA and Snake River Specifically, using the ESPAM model he analyzed the impacts due to pumping and irrigation on 2,063 expansion acres (pursuant to junior priority enlargement water rights) and the additions to the aquifer and Snake River due to the conversion of 1,378 acres from ground water irrigation to a surface water source through the A Canal system and the impacts due to the implementation of the removal of121 acres from irrigation under the CREP program. Dr Wylie, at the request of A&B, determined the impact of the above components of the proposed A&B mitigation plan on the Blue Lakes spring. Utilization of the ESPAM model to directly determine the simulated impact on the individual model node applicable to the Blue Lakes spring, rather than determining the impact on the spring as a percentage of simulated Snake River reach gain is justified. The ESPAM model was calibrated to measured historical spring discharge so that aquifer and spring properties were adjusted to best simulate the historical response of the Blue Lakes spring to land and water use on the aquifer for the calibration period (1980-2002). Therefore, the use of the model to simulate response of Blue Lakes spring to A&B water use changes is justified and is more defensible than the use of a fixed percentage (20%) of simulated Snake River reach gain. The results of the simulation of Blue Lakes spring node impact are described below:

The analysis of depletions assumed a net consumptive use of 2.10 af/ac/year with a total depletion of 4,340 af/year. It was assumed that the net depletion was distributed uniformly throughout the 188 wells of the A&B system and the ESPAM model nodes within which the wells were located (i.e. approximately 11 acres per node). Since the 2,063 acres are spread throughout the district in varying amounts at various locations, this approach is reasonable. The ESPAM model was then used to simulate the steady state depletions at the Blue Lakes spring node. The simulated steady state depletion due to A&B junior pumping was calculated at .51 cfs or 369 af/year. The ESPAM model was not run for this review by Brockway Engineering. However, the approach is reasonable and the output distribution and total steady state depletion matches the input depletion.

The analysis by IDWR of the impact of conversion of 1,378 acres from ground water irrigation to surface water irrigation from the A system assumed that the converted acres were located in 4 areas as depicted by the A&B Irrigation District (the location of the converted acres). These areas were then located in the proper ESPAM nodes and the model run at steady state. The net positive input per acre to the aquifer was determined by dividing the reported annual (2006) volume delivered to the conversion acres by A&B( 3,873 af) by the acres converted(1,378 ac) to get a value of 2.81 af/acre. This value includes the consumptive use forgone by not pumping from the aquifer and deep percolation of the additional 0.71 af/acre due to decreased application efficiencies occurring with surface irrigation.

This analysis shows a net positive impact on the Snake River at steady state with a total gain equal to the 3,873 gross delivery to the converted acres. The model shows a net impact of the converted acres of 0.60 cfs or 434 af/year on the Blue Lakes spring. The ESPAM model was not run by Brockway Engineering for this review. The assumptions are reasonable and the output distribution and total steady state depletion matches the input.

The analysis of the contribution from canal conveyance loss by IDWR assumed that the irrigation water for the conversion acres was delivered by 'the most direct route from Snake R to "B_lands_served_A from ABCanals" and assumed a 30% loss of the reported deliveries, purported to be the same as Northside Canal Company.

A better estimate of the conveyance loss can be achieved by using the Worstell method as outlined in the Hubble report. This analysis was used in the Surface Water Coalition Expert Report of September 26, 2007. Utilizing data from that report, Brockway Engineering PLLC estimated the losses in the Main A canal and laterals used to deliver to the converted acres. Canal and lateral widths were digitized and the Worstell equation, utilizing the wetted area and seepage rate for the Portneuf silt loam soils, was used to calculate losses. This analysis showed that the total seepage loss in the canal system to the converted acres is about 22 percent of the system capacity. Therefore, an estimate of 22% loss in the reach is more justifiable than the 30% loss assumed by IDWR.

The attached spreadsheet and aerial photo shows the location of mitigation components within the A&B project and revision of the transmission loss input. The attached table shows the results of the IDWR analysis and the revised Brockway Engineering analysis of the impact from junior pumping and the beneficial impact at the Blue Lakes spring of the A&B mitigation proposal. Using the reduced 22% estimated transmission loss to the converted acres results in an estimated positive impact on Blue Lakes spring of .147 cfs or 106 acre feet per year compared to the IDWR estimate of 145 acre feet per year. Again, the ESPAM model was not run for the Brockway Engineering review but the depletion values are linear with input volumes so the Brockway Engineering estimates are multiples of the IDWR values (.22/.30=.733).

At the request of A&B Irrigation District (Memo from D. Temple, Aug 10, 2009) , IDWR (Alan Wylie) analyzed the benefits to Snake River Reaches and the Blue Lakes spring from the implementation of 121 acres under the CREP program on the A&B District. These acres are separate from the CREP acres credited to IGWA. The analysis assumed that the 121 acres were located in Sec 25, 15, and 22 T8S R23E and Sec 5, 6, and 8 T8S R24E and the net reduction in aquifer depletion was 1.77 af/ac/year. This appears consistent with the assumption that a cover crop on the CREP acres would account for about 1/3 of an acre foot per year so that the full crop consumptive use could not be attributed to reduced depletion of the aquifer.

Dr. Wylie performed a simulation with the ESPAM model for the CREP acres similar to the steady state analysis performed for the A&B conversion acres. Total reduced depletion input to the model was calculated as 121 acres x 1.77 af/ac/year or 214af/year. The ESPAM steady state model shows a total of 214 af/year steady state output for all Snake River reaches. The ESPAM model calculated Blue Lakes

spring impact for a steady state depletion reduction is 0.023 cfs or 16.6 af/year. Brockway Engineering did not run the ESPAM model to confirm the IDWR output, but the results appear reasonable.

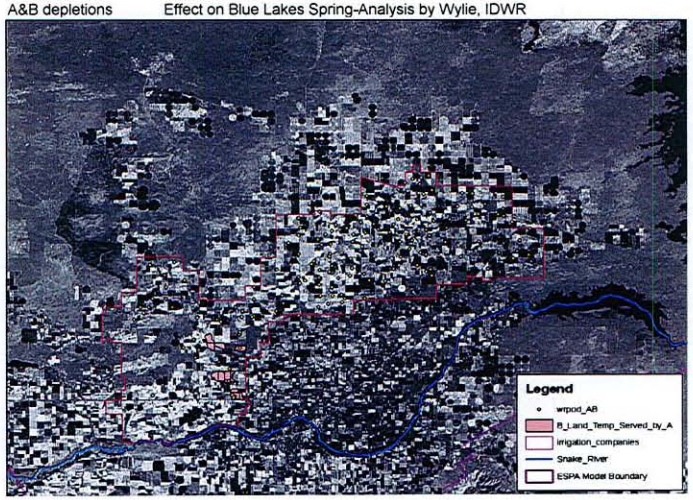
The modeled impact observed in the cell containing Blue Lakes Spring is shown in the following table:

| Mitigation Plan Component | Wylie ESPAM Discharge cfs | Wylie ESPAM Volume af/yr | Brockway Revised Discharge cfs | Brockway Revised Volume af/yr |
|---|---|---|---|---|
| Depletion Due to A&B junior pumping = | 0.51 cfs | 369 af/yr | 0.51 cfs | 369 af/yr |
| Mitigation | | | | |
| Due to A&B conversions = | 0.60 cfs | 434 af/yr | 0.60 cfs | 434 af/yr |
| Due to transmission loss = | 0.20 cfs * | 145af/yr | 0.147 cfs ** | 106 af/yr |
| Due to A&B CREP acres = | 0.023 cfs | 16.6 af/yr | 0.023 cfs | 16.6 af/yr |
| Total | 0.82 cfs | 595 af/yr | 0.77 cfs | 556 af/yr |
| | * Based on Wylie transmission loss | | **Based on Brockway transmission loss | |

The modeled impact from A&B Irrigation District junior pumping is 0.51 cfs or 369 af/yr and the beneficial impact from proposed A&B mitigation measures is 0.77 cfs or 556 af/yr.

The locations of the mitigation components on the A&B Project are shown on the accompanying aerial photos.

A&B depletions Effect on Blue Lakes Spring-Analysis by Wylie, IDWR




| irr_area | | Depletion | | ft/ac/yr |
|---|---|---|---|---|
| | m^2 | 517,624 | ft^3/d | 2.103751 |
| 2,063 | ac | 4,340 | ac-ft/y | |

| reach | cfs gain | ac-ft/y |
|---|---|---|
| Blue Lakes Spring | 0.51 | 359 |

**A&B depletions**

select usbor wells withn A&B - total = 188

select water rights 36-15127B, 36-15195B, 36-15196B, 36-15193B, 36-15194B

these rights are junior to blue lakes injured right (12/28/1973)

all water rights are associated with 188 usbor wells

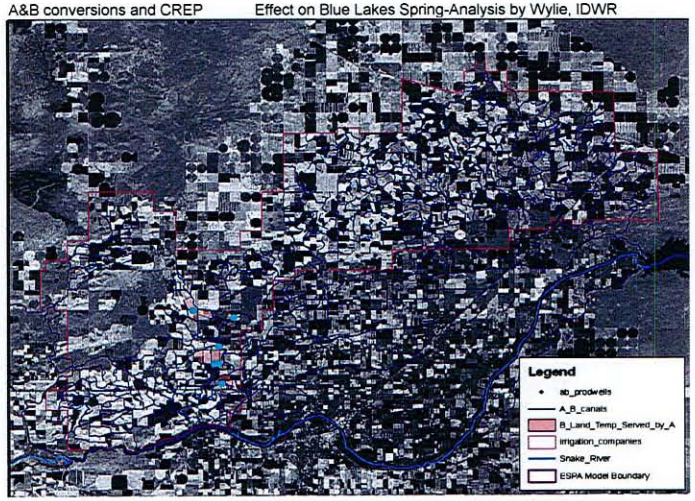
total junior acres = 2063.1

distribure junior ac evenly between 188 wells = 10.97 ac/well

extract net ET from net et raster

extract layer, row, col from model grid

A&B conversions and CREP  Effect on Blue Lakes Spring-Analysis by Wylie, IDWR




B_lands_served_A from 'Item Q from Directors request'
select model cells intercected by 'B_lands_served_A'
apportion 3870.27 ac-f (from A&B mitigation plan) by converted acres

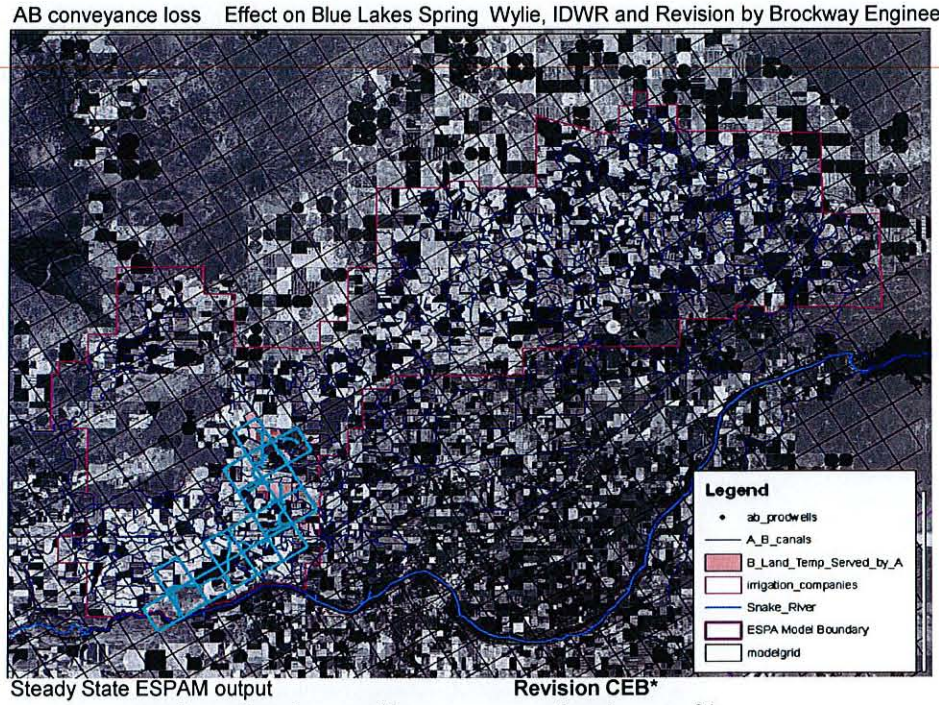
| | irr_area | | Benefit | | ft/ac/yr |
|---|---|---|---|---|---|
| Conversions | | m^2 | 461,888 | ft^3/d | 2.810934 |
| | 1,378 | ac | 3,873 | ac-ft/y | |

| | | | | |
|---|---|---|---|---|
| CREP | 121 | ac | 1.77 | ac-ft/y |

Sec 25, 15, and 22 T8S R23E and Sec 5, 6, and 8 T8S R24E

| | reach | cfs gain | ac-ft/y |
|---|---|---|---|
| Conversions | Blue Lakes Spring | 0.60 | 434 |
| CREP | Blue Lakes Srping | 0.023 | 16.6 |

AB conveyance loss  Effect on Blue Lakes Spring  Wylie, IDWR and Revision by Brockway Engineering




| Steady State ESPAM output | | | Revision CEB* | |
|---|---|---|---|---|
| reach | cfs gain | ac-ft/y | cfs gain | ac-ft/y |
| Blue Lakes Spring | 0.200 | 145 | 0.147 | 106 |

IDWR: select most direct route from Snake R to "B_lands_served_A' from AB_Canals
select model grid intersected by canals
assume 30% convayance loss (same as NSCCo)

Brockway, CE  Aug. 6, 2009

* Based on Worstell Method for determining conveyance:

loss :  B = 0.667*I*W
S = Seepage loss - ft/mile
I = Seepage rate - ft/day
W = Canal Water Surface width - ft

I :  based on Portneuf silt loam soil, Hubble report
Volume based on reported April - September operationdeliveries by A&B

Main Canal and Laterals to Conversions Acres (Groundwater B to Surface A)

All channals in Portneuf Silt Loam  Canal Capacity  270 cfs
Using Worstell Method  I=  0.5

| Canal | Length ft | miles | Width ft | Loss cfs/mile | Loss cfs |
|---|---|---|---|---|---|
| LATMain | 24830 | 4.70 | 32 | 10.67 | 50.19 |
| LATMMain | 3475 | 0.66 | 25 | 8.34 | 5.49 |
| LATG3.9 | 1523 | 0.29 | 14 | 4.67 | 1.35 |
| LATG | 1664 | 0.32 | 10 | 3.34 | 1.05 |
| | | | | sum | 58.07 |
| | | | | %of capaci | 0.22 |

Delivery to conversions  3873 acre feet/year
Conveyance Loss from conversion del.  833 acre feet/year  or 22% of delivery