IN THE DISTRICT COURT OF THE FOURTH JUDICIAL DISTRICT OF THE STATE OF IDAHO, IN AND FOR THE COUNTY OF ADA

SUN VALLEY COMPANY, a Wyoming corporation, Petitioner, vs. GARY SPACKMAN in his official capacity as the Director of the Idaho Department of Water Resources; and the IDAHO DEPARTMENT OF WATER RESOURCES, Respondents, and CITY OF KETCHUM, CITY OF FAIRFIELD, WATER DISTRICT 37-B GROUNDWATER GROUP, BIG WOOD & LITTLE WOOD WATER USERS ASSOCIATION, SOUTH VALLEY GROUND WATER DISTRICT, ANIMAL SHELTER OF WOOD RIVER VALLEY, DENNIS J. CARD and MAUREEN E. MCCANTY, EDWARD A LAWSON, FLYING HEART RANCH II SUBDIVISION OWNERS ASSOCIATION, INC., HELIOS DEVELOPMENT, LLC, SOUTHERN COMFORT HOMEOWNER'S ASSOCIATION, THE VILLAGE GREEN AT THE VALLEY CLUB HOMEOWNERS ASSOCIATION, INC., AIRPORT WEST BUSINESS PARK OWNERS ASSN INC., ANNE L. WINGATE TRUST, AQUARIUS SAW LLC, ASPEN HOLLOW HOMEOWNERS, DON R. and JUDY H. ATKINSON, BARRIE FAMILY PARTNERS, BELLEVUE FARMS LANDOWNERS ASSN, BLAINE COUNTY RECREATION DISTRICT, BLAINE COUNTY SCHOOL DISTRICT #61, HENRY and JANNE BURDICK, LYNN H. CAMPION, CLEAR CREEK LLC, CLIFFSIDE HOMEOWNERS ASSN INC, THE COMMUNITY SCHOOL INC, JAMES P. and JOAN CONGER, DANIEL T. MANOOGIAN REVOCABLE TRUST, DONNA F. TUTTLE TRUST, DAN S. FAIRMAN MD and MELYNDA KIM STANDLEE FAIRMAN, JAMES K. and SANDRA D. FIGGE, FLOWERS BENCH LLC, ELIZABETH K. GRAY, R. THOMAS GOODRICH and REBECCA LEA PATTON,	**Case No. CV-WA-2015-14500** **RESPONDENTS' BRIEF**

GREENHORN OWNERS ASSN INC, GRIFFIN RANCH HOMEOWNERS ASSN and GRIFFIN RANCH PUD SUBDIVISION HOMEOWNERS ASSN INC, GULCH TRUST, IDAHO RANCH LLC, THE JONES TRUST, LOUISA JANE H. JUDGE, RALPH R. LAPHAM, LAURA L. LUCERE, CHARLES L. MATTHIESEN, MID VALLEY WATER CO LLC, MARGO PECK, PIONEER RESIDENTIAL & RECREATIONAL PROPERTIES LLC, RALPH W. & KANDI L. GIRTON 1999 REVOCABLE TRUST, RED CLIFFS HOMEOWNERS ASSCIATION, F. ALFREDO REGO, RESTATED MC MAHAN 1986 REVOCABLE TRUST, RHYTHM RANCH HOMEOWNERS ASSN, RIVER ROCK RANCH LP, ROBERT ROHE, MARION R. and ROBERT M. ROSENTHAL, SAGE WILLOW LLC, SALIGAO LLC, KIRIL SOKOLOFF, STONEGATE HOMEOWNERS ASSN INC, SANDOR and TERI SZOMBATHY, THE BARKER LIVING TRUST, CAROL BURDZY THIELEN, TOBY B. LAMBERT LIVING TRUST, VERNOY IRREVOCABLE TRUST, CHARLES & COLLEEN WEAVER, THOMAS W. WEISEL, MATS AND SONYA WILANDER, MICHAEL E. WILLARD, LINDA D. WOODCOCK, STARLITE HOMEOWNERS ASSOCIATION, GOLDEN EAGLE RANCH HOMEOWNERS ASSN INC, TIMBERVIEW TERRACE HOEMOWNERS ASSN, and HEATHERLANDS HOMEOWNERS ASSOCIATION INC.,

Intervenors.

IN THE MATTER OF DISTRIBUTION OF WATER TO WATER RIGHTS HELD BY MEMBERS OF THE BIG WOOD & LITTLE WOOD WATER USERS ASSOCIATION DIVERTING FROM THE BIG WOOD AND LITTLE WOOD RIVERS

RESPONDENTS' BRIEF

Judicial Review from the Idaho Department of Water Resources

Honorable Eric J. Wildman, District Judge, Presiding

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I. STATEMENT OF THE CASE

A. NATURE OF THE CASE

This is a judicial review proceeding in which Sun Valley Company ("SVC") appeals an order issued by the Director ("Director") of the Idaho Department of Water Resources ("Department") denying SVC's motion to dismiss two conjunctive management water delivery call contested cases. The order appealed is the Director's *Order Denying Sun Valley Company's Motion to Dismiss* ("Sun Valley Order").

The issues raised in this appeal stem from two delivery calls (referred to herein as "the Big and Little Wood Delivery Calls") initiated by the Big Wood and Little Wood Water Users Association ("Association") pursuant to the Department's *Rules for Conjunctive Management of Surface and Ground Water Resources* ("CM Rules").[1] SVC primarily challenges the Director's determination in the Sun Valley Order, and subsequent *Order Denying Motion to Revise Interlocutory Order* ("Order Denying Motion to Revise"), that CM Rule 40 is applicable to the delivery calls, not CM Rule 30. SVC also challenges the Director's request for and utilization of staff memoranda in the contested case proceedings.

B. STATEMENT OF FACTS & PROCEDURAL BACKGROUND

On February 24, 2015, the Director received two conjunctive management water delivery call letters from the Association. The Association alleges its members' senior surface rights on the Big Wood and Little Wood Rivers "have suffered from premature curtailment of delivery of their surface water rights, along with the accompanying material injury." *BW CM-DC-2015-001*

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[1] The record on appeal includes filings in the Big Wood Delivery Call matter in a folder labeled BW CM-DC-2015-001, filings in the Little Wood Delivery Call matter in a folder labeled LW CM-DC-2015-002, and documents as a result of the Court's November 16, 2015, *Order Granting Motion to Augment* in a folder labeled Supp AR Lodged w-DC. Citations to the record herein are consistent with these labels.

at 1-5; *LW CM-DC-2015-002* at 1-5.[2] The Association also alleges that its members' senior surface water rights "are all located in Water District 37, and are hydrologically connected to ground water rights in the Wood River Valley aquifer system." *Id.* at 1; *Id.* at 1. The Association demands the Director "direct the Watermaster for Water District 37 to administer [the Association members'] surface water rights, and hydrologically connected to ground water rights within the district in accordance with the prior appropriation doctrine." *Id.* at 3; *Id.* at 3. The letters constitute delivery calls pursuant to CM Rule 10.04. *See* IDAPA 37.03.11.010.04 (defining a "Delivery Call" as "[a] request from the holder of a water right for administration of water rights under the prior appropriation doctrine.").

In response to the Association's letters, the Director initiated the Big and Little Wood Delivery Call contested case proceedings. On March 20, 2015, the Director sent letters to ground water users the Department identified as potentially affected by one or both of the delivery calls. *BW CM-DC-2015-001* at 12. The Department received over 100 notices of intent to participate in the delivery call proceedings, including a notice filed by SVC. *Id.* at 888.

The Director held a status conference on May 4, 2015. At that status conference, the Director stated he would submit a letter to the Association requesting submission of additional information about the Association members' diversion and use of water. *BW CM-DC-2015-001* at 179. On May 20, 2015, the Director sent a letter to the Association with an attached Information Request ("Information Request"). *Id.* at 179-82.

The Director held a pre-hearing conference on June 3, 2015. At the pre-hearing conference, the participants discussed information in possession of the Department and how it might be disseminated to the parties and participants. *BW CM-DC-2015-001* at 335. In

[2] A list of the Association member's senior surface water rights is attached to the letters as Exhibit A. *BW CM-DC-2015-001* at 4-5; *LW CM-DC-2015-002* at 4-5.

response, on June 12, 2015, the Director issued a *Request for Staff Memoranda* ("Request for Staff Memoranda") "to assist the Director and participants involved" in the delivery calls. *Id.* The Director requested two staff memoranda: one to present information about how water is delivered to the Association members' senior surface water rights and another to present hydrologic and hydrogeologic data and information in possession of the Department about "surface and ground water interactions in the Big and Little Wood River basins." *Id.* at 336. Staff memoranda were submitted to the Director in response to this request.[3]

On June 25, 2015, SVC filed its *Motion to Dismiss Contested Case Proceedings* ("Motion to Dismiss"). *BW CM-DC-2015-001* at 382-402. SVC argued the Big and Little Wood Delivery Calls should be dismissed because the Association failed "to file compliant petitions" under CM Rule 30, the Department's Rule of Procedure 230, and Idaho Code § 42-237b. *Id.* at 386-94. In the Sun Valley Order, the Director concluded that, because "[t]he Big and Little Wood Delivery Calls are against junior-priority ground water rights *in organized water districts*," CM Rule 40 is applicable to the delivery calls, not CM Rule 30. *Id.* at 890 (emphasis in original). The Director also concluded the Association's letters meet the pleading requirement set forth in CM Rule 40. *Id.* at 891. In addition, the Director rejected SVC's arguments that the delivery calls should be dismissed for failure to comply with requirements under the Department's Rule of Procedure 230 and Idaho Code § 42-237b. *Id.* at 889-92.

On July 1, 2015, SVC filed *Sun Valley Company's Motion to Modify/Withdraw "Request for Staff Memoranda" and May 20, 2015 "Request for Additional Information." BW CM-DC-2015-001* at 616-35. SVC asked the Director to withdraw the Information Request and Request for Staff Memoranda, asserting the Department's Rules of Procedure do not authorize the

[3] The August 28, 2015, *IDWR Staff Memo Re: Hydrology, Hydrogeology, and Hydrologic Data* appears in the record at *BW CM-DC-2015-001* at 1080-1104. The August 31, 2015, *IDWR Staff Memo Re: Surface Water Delivery Systems* appears in the record at *BW CM-DC-2015-001* at 1105-1342.

Department to prepare staff memoranda or gather information in advance of the hearing on the Big and Little Wood Delivery Calls and that such information gathering efforts violate SVC's due process rights. *Id.* at 620-29.

On July 22, 2015, the Director issued an *Order Denying Sun Valley Company's Motion to Modify/Withdraw* ("Staff Memoranda Order"). *Id.* at 899-908. The Director determined that the Department's Rules of Procedure authorize preparation of staff memoranda prior to hearing and do not preclude "the Department from gathering technical and factual information . . . and disseminating that information to the parties prior to hearing for evaluation and potential rebuttal." *Id.* at 901. The Director also rejected the argument that the Department's information gathering efforts violate SVC's due process rights because "[a]ll parties will have full and fair opportunity to examine and object to any information proposed for admission as evidence into the record at hearing" and staff employees responsible for memoranda "will be available for cross-examination at hearing." *Id.* at 902.

On August 6, 2015, SVC filed a *Motion for Review of Interlocutory Order* ("Rule 711 Motion") requesting the Director revise the Sun Valley Order to grant the Motion to Dismiss. *BW CM-DC-2015-001* at 963-77. SVC raised new arguments including that, before the Director can proceed with the Big and Little Wood Delivery Calls pursuant to CM Rule 40, CM Rule 20.06 requires the Director complete a fixed "two-step, sequential process" under CM Rule 30 to determine an area of common ground water supply ("ACGWS") and incorporate the water rights in that area into water districts. *Id.* at 970.

SVC filed a *Petition for Judicial Review* ("Petition") with the Court on August 19, 2015. The Petition states that SVC seeks judicial review of the Sun Valley Order "for the reasons set forth in the [Motion to Dismiss] and [Rule 711 Motion]." *BW CM-DC-2015-001* at 1042.

Thereafter, the Respondents, SVC, and certain other parties entered discussions regarding the propriety of the Petition given the Sun Valley Order was an interlocutory, not final, order of the Department. Following these discussions, a *Stipulation* was filed with the Court on September 18, 2015. Consistent with the *Stipulation*, on September 25, 2015, SVC and other parties filed a motion requesting the Director designate the Sun Valley Order as a final order pursuant to the Department's Rules of Procedure 710 and 750 ("Motion to Designate"). *Supp AR Lodged w-DC* at 72. The Director issued an order designating the Sun Valley Order as a final appealable order on October 15, 2015 ("Designation Order"). *Id.* at 71-74. The Director issued the Order Denying Motion to Revise on October 16, 2015. *Id.* at 84-88. SVC filed an *Amended Petition for Judicial Review* on October 26, 2015.

In the Order Denying Motion to Revise, the Director reaffirmed his determination in the Sun Valley Order that CM Rule 40 applies to the Big and Little Wood Delivery Calls, not CM Rule 30. *Supp AR Lodged w-DC* at 86. The Director also responded to SVC's new argument regarding CM Rule 20.06. Specifically, the Director determined that, consistent with CM Rule 20.06, "[the ACGWS] for the Big and Little Wood Delivery Calls is a factual question that can be answered using the framework of CM Rule 40 based upon information presented at hearing and applying the definition set forth in CM Rule 10.01." *Id.* at 85. The Director also determined the process advocated for by SVC "where water rights are put into water districts only after an area of common ground water is designated is not tenable" because "current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts." *Id.* The Director cited three sources to support this statement: the August 31, 2015, *IDWR Staff Memo Re: Surface Water Delivery Systems* ("Delivery Systems Memo"); the August 28, 2015, *IDWR Staff Memo Re: Hydrology, Hydrogeology, and Hydrologic Data*

("Hydro Memo"); and a September 17, 2013, *Preliminary Order* issued by the Department related to Water District 37 ("Preliminary Order").[4] *Id.*

On October 28, 2015, the Respondents timely filed a *Motion to Augment the Record* ("Motion to Augment") with several documents including the Order Denying Motion to Revise. In response, SVC objected to the Director's citation to staff memoranda. *See Joint Response to Motion to Augment the Record* at 5. The Court granted the Motion to Augment on November 16, 2015, as well as a request by SVC for additional time to further amend its petition for judicial review. *Order Granting Motion to Augment* at 7.

SVC filed a *Second Amended Petition for Judicial Review* ("Second Petition) on December 3, 2015, seeking to expand the Court's review beyond issues addressed in the Sun Valley Order and the Order Denying Motion to Revise. The Second Petition states that SVC seeks judicial review of site visits conducted in preparation of the Delivery Systems Memo, "the Director's Request for Staff Memoranda, the Sun Valley Order, the Staff Memoranda Order and the Order Denying Motion to Revise." *Second Petition* at 10.

[4] The Preliminary Order was issued *In the Matter of the Proposed Combination of Water District Nos. 37, 37A, 37C, and 37M and the Inclusion of Both Surface Water and Ground Water Rights in the Combined Water District; and in the Matter of Abolishing the Upper Wood Rivers Water Measurement District* and is located in the record at *BW CM-DC-2015-001* at 464-80.

II. ISSUES ON APPEAL

Respondents' formulation of the issues presented is as follows:

1) Whether the Director acted consistent with the Department's administrative rules and Idaho law in denying SVC's Motion to Dismiss.

2) Whether the notice procedures utilized in the Big and Little Wood Delivery Calls prejudiced SVC's substantial rights.

3) Whether the Court has jurisdiction to review the Request for Staff Memoranda, Staff Memoranda Order, or preparation of the Delivery Systems Memo.

4) Whether staff memoranda were requested and prepared consistent with the Department's administrative rules and Idaho law or violated SVC's substantial rights.

5) Whether the Director properly responded to new arguments raised by SVC in the Rule 711 Motion by issuing the Order Denying Motion to Revise.

6) Whether SVC is entitled to costs and attorney fees on appeal.

III. STANDARD OF REVIEW

Judicial review of a final decision of the Department is governed by the Idaho Administrative Procedure Act ("IDAPA"), chapter 52, title 67, Idaho Code. I.C. § 42-1701A(4). Under IDAPA, the court reviews an appeal from an agency decision based upon the record created before the agency. Idaho Code § 67-5277; *Dovel v. Dobson*, 122 Idaho 59, 61, 831 P.2d 527, 529 (1992). The court shall affirm the agency decision unless it finds the agency's findings, inferences, conclusions, or decisions are: (a) in violation of constitutional or statutory provisions; (b) in excess of the statutory authority of the agency; (c) made upon unlawful procedure; (d) not supported by substantial evidence on the record as a whole; or (e) arbitrary, capricious, or an abuse of discretion. Idaho Code § 67-5279(3); *Barron v. Idaho Dept. of Water Resources*, 135 Idaho 414, 417, 18 P.3d 219, 222 (2001). The party challenging the agency decision must show that the agency erred in a manner specified in Idaho Code § 67-5279(3), and that a substantial right of the petitioner has been prejudiced. Idaho Code § 67-5279(4); *Barron*, 135 Idaho at 417, 18 P.3d at 222. "Where conflicting evidence is presented that is supported by substantial and competent evidence, the findings of the [agency] must be sustained on appeal regardless of whether this Court may have reached a different conclusion." *Tupper v. State Farm Ins.*, 131 Idaho 724, 727, 963 P.2d 1161, 1164 (1998). If the agency action is not affirmed, it shall be set aside, in whole or in part, and remanded for further proceedings as necessary. *Idaho Power Co. v. Idaho Dep't of Water Res.*, 151 Idaho 266, 272, 255 P.3d 1152, 1158 (2011).

IV. ARGUMENT

A. THE DIRECTOR ACTED CONSISTENT WITH THE DEPARTMENT'S ADMINISTRATIVE RULES AND IDAHO LAW IN DENYING SVC'S MOTION TO DISMISS.

1. The Director correctly determined that CM Rule 40 applies to the Big and Little Wood Delivery Calls, not CM Rule 30.

The Director's decision that CM Rule 40 applies to the Big and Little Wood Delivery Calls, not CM Rule 30, is consistent with the language of the CM Rules. When the Director is faced with a delivery call by the holders of senior-priority surface water rights against the holders of junior-priority ground water rights, the CM Rules provide two avenues for responding, CM Rule 30 or CM Rule 40. *See* IDAPA 37.03.11.030 & IDAPA 37.03.11.040. CM Rule 30 lays out the administrative process for when such a delivery call is made against junior-priority ground water rights "within areas of the state *not* in organized water districts." IDAPA 37.03.11.030 (emphasis added).[5] When this occurs, a new water district can be created or an existing water district can be modified to allow for administration of the water rights pursuant to the prior appropriation doctrine. IDAPA 37.03.11.030.03-04. In short, CM Rule 30 outlines a pathway to ensure administration can take place if the water rights subject to the delivery call are not currently in a water district. In contrast, CM Rule 40 outlines a pathway for when the delivery call is made against junior-priority water rights that are "*in* an organized water district." IDAPA 37.03.11.040 (emphasis added).

In the Sun Valley Order the Director determined that, because "[t]he Big and Little Wood Delivery Calls are against junior-priority ground water rights *in organized water districts*," CM Rule 40 is applicable to the delivery calls, not CM Rule 30. *BW CM-DC-2015-001* at 890

[5] CM Rule 30 also lays out the process for when such a delivery call is made against junior-priority ground water rights within water districts where ground water regulation has not been included in the functions of such districts or within areas that have not been designated ground water management areas. IDAPA 37.03.11.030. Neither circumstance is present in the Big and Little Wood Delivery Calls.

(emphasis in original). Accordingly, the Director concluded that SVC's arguments regarding the failure of the Association's delivery call letters to comply with CM Rule 30's pleading requirements were "not a basis to dismiss the Big and Little Wood Delivery Calls." *Id.* The Director also concluded the Association's delivery call letters meet the pleading requirement set forth in CM Rule 40 in that the calling party alleges "'that by reason of diversion of water by the holders of one (1) or more junior-priority ground water rights (respondents) from an area having a common ground water supply in an organized water district the petitioner is suffering material injury. . . .' IDAPA 37.03.11.040.01." *Id.* at 891. Because CM Rule 30 does not apply to the Big and Little Wood Delivery Calls and the Association's letters meet the pleading requirements of CM Rule 40, the Director did not err by denying SVC's Motion to Dismiss.

i. The language of applicable CM Rules confirms that CM Rule 40 applies to the Big and Little Wood Delivery Calls.

As discussed above, SVC raised a new argument in the Rule 711 Motion that CM Rule 20.06 mandates the Director designate an ACGWS and incorporate water rights within that area into water districts utilizing CM Rule 30 before the Director has "jurisdiction" to proceed with the delivery calls pursuant to CM Rule 40. *See BW CM-DC-2015-001* at 970. CM Rule 20.06 states: "These rules provide the basis for the designation of areas of the state that have a common ground water supply and the procedures that will be followed in incorporating the water rights within such areas into existing water districts. . . ." IDAPA 37.03.11.020.07. As the Director explained in the Order Denying Motion to Revise, "[t]his statement simply explains the CM Rules 'provide the basis' for the designation of an [ACGWS]." *Supp AR Lodged w-DC* at 85. CM Rule 10.01 defines an "Area Having a Common Ground Water Supply" as:

> A ground water source within which the diversion and use of ground water or changes in ground water recharge affect the flow of water in a surface water source or within which the diversion and use of water by a holder of a ground

> water right affects the ground water supply available to the holders of other ground water rights. (Section 42-237a.g., Idaho Code)

IDAPA 37.03.11.010.01. Consistent with CM Rule 20.06, the Director concluded that "[t]he [ACGWS] for the Big and Little Wood Delivery Calls is a factual question that can be answered using the framework of CM Rule 40 based upon information presented at hearing and applying the definition set forth in CM Rule 10.01." *Supp AR Lodged w-DC* at 85. The Director also concluded that the process advocated for by SVC "where water rights are put into water districts only after an area of common ground water is designated is not tenable" because "current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts." *Id.* at 86. Accordingly, the Director rejected SVC's argument regarding CM Rule 20.06 and re-affirmed his determination that CM Rule 40 applies to the delivery calls, not CM Rule 30. *Id.*

SVC now argues the "plain, unambiguous terms" of CM Rule 20.07 describe the "determinative factors" as to whether CM Rule 30 or CM Rule 40 applies to the Big and Little Wood Delivery Calls. *Petitioner's Brief* at 30. Specifically, SVC argues the test for deciding which rule applies is whether an "ACGWS has been determined and then has been incorporated into an existing or new water district, not whether a given junior water right falls within the geographic boundaries of an existing water district." *Id.* In support of this argument, SVC cites CM Rule 20.07's statement that "Rule 30 provides procedures for responding to delivery calls within areas having a common ground water supply that have not been incorporated into an existing or new water district." *Id.* SVC asserts the clause "that have not been incorporated into an existing or new water district" modifies "areas having a common ground water supply," not a "particular set of ground water right holders, as the Director concluded." *Id.*

SVC does not cite to where the Director reached this conclusion. Presumably, SVC is referring to the Director's conclusion in the Order Denying Motion to Revise that CM Rule 20.06 does not require the Director determine an ACGWS and incorporate the water rights in that area into water districts before the Director can proceed with the Big and Little Wood Delivery Calls pursuant to CM Rule 40. *See Supp AR Lodged w-DC* at 86. SVC overlooks that the language of CM Rule 20.06 *does* focus on incorporating water rights into water districts, not incorporating an ACGWS into water districts. IDAPA 37.03.011.020.06 ("These rules provide the basis for the designation of areas of the state that have a common ground water supply and the procedures that will be followed *in incorporating the water rights* within such areas into existing water districts. . . .") (emphasis added)). SVC even cites the language of CM Rule 20.06 to support the contention that "[p]lainly, an ACGWS must be 'designated' and 'incorporated' in accordance with formal rule-based procedures." *Petitioner's Brief* at 35. This contention is contrary to the plain language of CM Rule 20.06.

SVC urges the Court to view the language of CM Rule 20.07 in a vacuum. But CM Rule 20.07 should be construed with other applicable sections of the CM Rules to determine the intent of the rules. *See In re Idaho Dep't of Water Res. Amended Final Order Creating Water Dist. No. 170*, 148 Idaho 200, 211, 220 P.3d 318, 329 (2009) ("Language of a particular section need not be viewed in a vacuum. And all sections of applicable statutes must be construed together so as to determine the legislature's intent." (citations omitted)). The Court should not only examine the "literal words of the statute, but also the reasonableness of proposed constructions." *Id.* at 210, 220 P.3d at 328. Further, "[c]onstructions that would lead to absurd or unreasonably harsh results are disfavored." *Id.* (citation omitted). "[E]ffect must be given to all the words of the statute, if possible, so that none will be void, superfluous, or redundant." *Hillside Landscape*

Const., Inc. v. City of Lewiston, 151 Idaho 749, 753, 264 P.3d 388, 392 (2011). These principles apply to the Court's review of administrative rules. *See Mason v. Donnelly Club*, 135 Idaho 581, 583, 21 P.3d 903, 905 (2001).

The Court should reject SVC's argument that, per the "plain, unambiguous terms" of CM Rule 20.07, the test for deciding whether CM Rule 30 or 40 applies is whether an "ACGWS has been determined" and then "incorporated" into a water district. This interpretation is inconsistent with the language of the CM Rules, leads to an absurd result that reads language out of the rules, and runs afoul of the Director's mandatory duty to timely distribute water in water districts in accordance with the prior appropriation doctrine.

CM Rule 20.07 states, in relevant part:

> **07. Sequence of Actions for Responding to Delivery Calls**. Rule 30 provides procedures for responding to delivery calls within areas having a common ground water supply that have not been incorporated into an existing or new water district or designated a ground water management area. Rule 40 provides procedures for responding to delivery calls within water districts where areas having a common ground water supply have been incorporated into the district or a new district has been created.

IDAPA 37.03.11.020.07. SVC argues that, because the sentence in CM Rule 20.07 referencing CM Rule 40 also refers to "areas having a common ground water supply," CM Rule 40 cannot apply to the Big and Little Wood Delivery Calls before an ACGWS is "determined" and "incorporated" into a water district. *Petitioner's Brief* at 36. SVC asserts "[t]he existence of an ACGWS is clearly the touchstone." *Id.* at 35.

SVC's argument is contrary to the plain language of CM Rule 20.07 because the rule does not refer to an already "determined" ACGWS. SVC's argument also breaks down because the sentences in CM Rule 20.07 referencing *both* CM Rule 30 and CM Rule 40 utilize identical language: "areas having a common ground water supply." Equal application of SVC's interpretation of CM Rule 20.07's reference to "areas having a common ground water supply" with respect to the sentence referencing CM Rule 30 would mean that CM Rule 30 only applies if an ACGWS has already been determined. This interpretation leads to an absurd result because the CM Rules clearly contemplate the Director may determine an ACGWS *within* the context of a CM Rule 30 proceeding. *See* IDAPA 37.03.11.030.07.c; IDAPA 37.03.11.031.01-05. If SVC's interpretation were accepted, the Director's ability to determine an ACGWS within the context of a CM Rule 30 delivery call would be read out of the CM Rules. In addition, the CM Rules recognize the Director's authority to incorporate an ACGWS into an organized water district by order following consideration of a contested case. *See* IDAPA 37.03.11.030.07.d. Consistent with overall structure of the CM Rules, the Director can incorporate an ACGWS into organized water districts upon determination of that ACGWS within the context of a CM Rule 40 proceeding. The language of the CM Rules demonstrates that the test for deciding whether CM Rule 30 or 40 applies to the Big and Little Wood Delivery Calls is not whether an "ACGWS has been determined" and then "incorporated" into a water district.

Further, a timely response is required when a delivery call is made. *Am. Falls Reservoir Dist. No. 2 v. Idaho Dep't of Water Res.*, 143 Idaho 862, 874, 154 P.3d 433, 445 (2007) ("AFRD#2"). A construction of the CM Rules that would require the Director designate an ACGWS and incorporate that ACGWS into water districts before proceeding with the Big and Little Wood Delivery Calls pursuant to CM Rule 40 would result in lengthy delay and run afoul of the Director's mandatory duty to timely distribute water in water districts in accordance with the prior appropriation doctrine. Idaho Code § 42-602; *see In re SRBA*, 157 Idaho 385, 393, 336 P.3d 792, 800 (2014); *see also Musser v. Higginson*, 125 Idaho 392, 395, 871 P.2d 809, 812 (1994).

In sum, SVC's interpretation of the CM Rules is inconsistent with the language of the rules, leads to an absurd result that reads language out of the rules, and runs afoul of the Director's duty to timely distribute water in water districts in accordance with the prior appropriation doctrine. Thus, the Court should reject SVC's interpretation that the CM Rules mandate the existence of an already-determined and incorporated ACGWS before the Director can proceed with the Big and Little Wood Delivery Calls pursuant to CM Rule 40.

The Court should instead affirm the Director's determination that the language of the CM Rules demonstrates the test for deciding whether CM Rule 30 or 40 applies is whether delivery calls are against junior ground water rights within water districts. CM Rule 20.07 explicitly states that "Rule 40 provides procedures for responding to delivery calls *within water districts*." IDAPA 37.03.11.020.07 (emphasis added). CM Rule 20.07 makes no similar reference with respect to a CM Rule 30 delivery call. Further, SVC argues the Director cannot rely on the plain language of the headings of CM Rule 30 or 40 because the language of the rules "is clear." *Petitioner's Brief* at 32-32. However, to the extent SVC's arguments suggest the language of the CM Rules create some question as to what test the Director should utilize to decide whether CM Rule 30 or CM Rule 40 applies, the headings of the rules may be consulted to ascertain the intent of the rules. *See Walker v. Nationwide Fin. Corp. of Idaho*, 102 Idaho 266, 268, 629 P.2d 662, 664 (1981). The heading of CM Rule 30 states, in relevant part, that the rule governs delivery calls "against the holders of junior-priority ground water rights within areas of the state *not in organized water districts*." IDAPA 37.03.11.030 (emphasis added). The heading of CM Rule 40 states, in relevant part, that the rule governs delivery calls "against the holders of junior-priority ground water rights from areas having a common ground water supply *in an organized water district*." IDAPA 37.03.11.040 (emphasis added). These headings confirm the test for deciding whether CM Rule 30 or CM Rule 40 applies is whether delivery calls are against junior ground water rights within water districts. Therefore, the Director correctly determined that, because "[t]he Big and Little Wood Delivery Calls are against junior-priority ground water rights *in organized water districts*," CM Rule 40 is applicable to the delivery calls, not CM Rule 30. *BW CM-DC-2015-001* at 890 (emphasis in original).

The Director's interpretation of the CM Rules is entitled to deference. The Court "applies a four-pronged test to determine the appropriate level of deference to the agency interpretation." *Duncan v. State Bd. of Accountancy*, 149 Idaho 1, 3, 232 P.3d 322, 324 (2010). Specifically, the Court "must determine whether: (1) the agency is responsible for administration of the rule in issue; (2) the agency's construction is reasonable; (3) the language of the rule does not expressly treat the matter at issue; and (4) any of the rationales underlying the rule of agency deference are present." *Id.* "There are five rationales underlying the rule of deference: (1) that a practical interpretation of the rule exists; (2) the presumption of legislative acquiescence; (3) reliance on the agency's expertise in interpretation of the rule; (4) the rationale of repose; and (5) the requirement of contemporaneous agency interpretation." *Id.*

Here, the four-pronged test set forth in *Duncan* is met. The Director is responsible for administration of the CM Rules and his construction of the rules at issue is reasonable. To the extent SVC's arguments suggest the language of the CM Rules create some question as to what test should be utilized to decide whether CM Rule 30 or CM Rule 40 applies to the Big and Little Wood Delivery Calls, the language of the CM Rules does not expressly treat the matter at issue. The rationales underlying the rule of deference are present including that the Director's interpretation of the CM Rules is practical and based on the Department's expertise in interpretation of the rules. Thus, the Director's interpretation that the language of the CM Rules demonstrates the test for deciding whether CM Rule 30 or 40 applies to the Big and Little Wood Delivery Calls is whether the delivery calls are against junior ground water rights within water districts is entitled to deference and should be affirmed.

ii. Because CM Rule 30 does not apply, the Association's failure to comply with pleading requirements of CM Rule 30 does not warrant dismissal of the Big and Little Wood Delivery Calls.

SVC argues the Big and Little Wood Delivery Calls should be dismissed for failure to comply with the pleading requirements of CM Rule 30. *Petitioner's Brief* at 23-27. As discussed above, the Director correctly concluded that "CM Rule 30 applies only where a delivery call is filed by the holders of senior-priority surface or ground water rights against "holders of junior priority ground water rights within areas of the state *not in organized water districts*." *BW CM-DC-2015-001* at 890 (emphasis in original). Because the Big and Little Wood Delivery Calls are against junior ground water rights in organized water districts, "the applicable rule is CM Rule 40 that addresses delivery calls against junior-priority ground water users "in an organized water district." *Id.* Accordingly, failure of the Association's delivery call letters to set forth all information required by CM Rule 30 is not a basis for dismissal of the Big and Little Wood Delivery Calls.

2. Rule of Procedure 230 does not require dismissal of the Big and Little Wood Delivery Calls.

SVC argues the Big and Little Wood Delivery Calls should be dismissed because the Association's letters do not meet "the pleading requirements" of the Department's Rule of Procedure 230. *Petitioner's Brief* at 21, 23, 39. The Director properly rejected this argument in the Sun Valley Order.

Rule of Procedure 230 lists general requirements of petitions, including that they should "[f]ully state facts upon which they are based" and "[s]tate the name of the person petitioned against (the respondent), if any." IDAPA 37.01.01.230.02 (a) &(d). It is well recognized that a specific rule controls over a more general rule when there is conflict between the two. *See Ausman v. State*, 124 Idaho 839, 842, 864 P.2d 1126, 1129 (1993). Thus, the specific pleading requirements set forth in the CM Rules govern the requirements of petitions for delivery calls under the CM Rules, not the general pleading requirements of Rule of Procedure 230. As discussed above, CM Rule 40 applies to the Big and Little Wood Delivery Calls. Accordingly, the Director correctly determined that the appropriate question is whether the Association's delivery call letters meet the specific pleading requirement of CM Rule 40, not the more general requirements of petitions under Rule of Procedure 230. *See BW CM-DC-2015-001* at 890-91.

Even if Rule of Procedure 230's pleadings requirements were applicable to petitions to initiate CM Rule 40 delivery calls, Rule of Procedure 52 instructs that "this chapter will be liberally construed to secure just, speedy and economical determination of all issues presented to the agency. Unless prohibited by statute, the agency may permit deviation from these rules when it finds that compliance with them is impracticable, unnecessary or not in the public interest." IDAPA 37.01.01.052. The Director concluded that compliance with Rule 230's requirement to state the name of each respondent "is unnecessary" because "the water rights at issue in the Big and Little Wood Delivery Calls" are in water districts and "have been defined through partial decrees entered in the Snake River Basin Adjudication." *BW CM-DC-2015-001* at 892. The watermaster in the water districts "already possesses the names and water right information of junior-priority ground water users that may be subject to a delivery call by senior users" within the districts. *Id.* Therefore, the Director rejected SVC's argument that the delivery calls should be dismissed for "failure to list in the delivery call letters the name of each junior-priority ground water user petitioned against." *Id.* The Director acted within his authority in concluding that Rule of Procedure 230 does not require dismissal of the Big and Little Wood Delivery Calls.

3. Idaho Code § 42-237b does not require dismissal of the Big and Little Wood Delivery Calls.

SVC argues the Big and Little Wood Delivery Calls should be dismissed because the Association's letters do not meet the "pleading requirements" of Idaho Code § 42-237b. *Petitioner's Brief* at 42-44. The Director properly rejected this argument in the Sun Valley Order.

Idaho Code § 42-237b states, in relevant part, that, "[w]henever any person owning or claiming the right to the use of any surface or ground water right believes that the use of such right is being adversely affected by one or more user[s] of ground water rights of later priority" that person "*may* make a written statement under oath of such claim to the [Director]." (emphasis added). The statement under oath must contain certain information including a "description of the respondent's water rights so far as is known to the claimant." I.C. § 42-237b. If the Director determines the statement is sufficient, the Director "shall issue a notice setting the mater for hearing *before a local ground water board. . . .*" *Id.* (emphasis added). SVC argues that use of the word "whenever" in the first sentence of Idaho Code § 42-237b means the Association's letters had to contain a "written statement under oath" setting forth information required by Idaho Code § 42-237b. *Petitioner's Brief* at 44. This argument is contrary to the plain language of Idaho Code § 42-237b.

The plain language of Idaho Code § 42-237b demonstrates that the Association is not required to follow the process set forth in the statute to seek redress for injury to their senior water rights. The statute only describes one possible pathway for a person owning a senior surface or ground water right who believes the right is being injured to seek redress. Idaho Code

§ 42-237b (explaining a claimant "*may* make a written statement under oath" (emphasis added)). The pathway under Idaho Code § 42-237b leads to a hearing before a local ground water board. The Association does not seek a determination by the Director that will lead to a hearing before a local ground water board. Instead, the Association demands the Director instruct "the Watermaster for Water District No. 37 to administer Petitioners' surface water rights, and hydrologically connected to ground water rights within the district in accordance with the prior appropriation doctrine." *BW CM-DC-2015-001* at 3; *LW CM-DC-2015-002* at 3. The Association's letters constitute delivery calls pursuant to CM Rule 10.04. *See* IDAPA 37.03.11.010.04. A delivery call under the CM Rules is an alternate pathway for a person owning a senior surface or ground water right who believes the right is being injured to seek redress. Therefore, the Director properly concluded that "the specific pleading requirements set forth in Idaho Code § 42-237b do not apply and are not a basis to dismiss the Big and Little Wood Delivery Calls." *BW CM-DC-2015-001* at 890.

B. SVC'S SUBSTANTIAL RIGHTS HAVE NOT BEEN PREJUDICED BY NOTICE PROCEDURES UTILIZED IN THE UNDERLYING DELIVERY CALLS.

SVC argues that the notice procedures utilized by the Department in the Big and Little Wood Delivery Calls have deprived "Sun Valley of adequate notice, and procedural due process," and "operated to prejudice the substantial rights of Sun Valley." *Petitioner's Brief* at 24-25, 39 n. 8, 41. SVC asserts that it does not know if the Association is "actually alleging that Sun Valley is causing material injury to any of their respective water rights" and "a ground water user is entitled to know ***why*** Petitioners seek to curtail its ground water use." *Id.* at 25 (emphasis in original). SVC also asserts that, by identifying holders of junior-priority ground water rights that may be affected by the delivery calls, the Director has drawn "prejudicial conclusions about potential causation and hydrological connection." *Id.* at 24-25.

SVC's argument that it does not know whether the Association members are "alleging that Sun Valley is causing material injury to any of their respective water rights" or why the Association seeks to curtail SVC's ground water use lacks any factual basis. As explained above, the Association's letters state that its members' water rights on the Big Wood and Little Wood Rivers "have suffered from premature curtailment of delivery of their surface water rights, along with the accompanying material injury." *BW CM-DC-2015-001* at 1-5; *LW CM-DC-2015-002* at 1-5. The Association alleges that its members' rights "are all located in Water District 37, and are hydrologically connected to ground water rights in the Wood River Valley aquifer system." *Id.* at 1; *Id.* at 1. The Association demands that the Director "direct the Watermaster for Water District 37 to administer [the Association members'] surface water rights, and hydrologically connected to ground water rights within the district in accordance with the prior appropriation doctrine." *Id.* at 3; *Id.* at 3. SVC admits it owns water rights "within the geographic boundaries of Water District 37" that are "implicated by the Association's water delivery calls." *Petitioner's Brief* at 4-5. SVC's suggestion that it does not know whether or why the Association seeks to curtail its ground water use is not credible.

In addition, SVC's argument that notice procedures utilized in the Big and Little Wood Delivery Calls have deprived it of procedural due process lacks any factual or legal basis. Procedural due process requires that "there must be some process to ensure that the individual is not arbitrarily deprived of his rights in violation of the state or federal constitutions." *Aberdeen-Springfield Canal Co. v. Peiper*, 133 Idaho 82, 91, 982 P.2d 917, 926 (1999) (internal quotations and citations omitted). "This requirement is met when the defendant is provided with notice and an opportunity to be heard." *Id.* "The opportunity to be heard must occur at a meaningful time and in a meaningful manner in order to satisfy the due process requirement." *Id.* "Due process is not a concept to be applied rigidly in every matter." *Id.* Rather, it is a flexible concept calling for such procedural protections as are warranted by the particular situation." *Id.*

SVC was provided notice of the Big and Little Wood Delivery Calls and invited to participate in proceedings related to the calls in the Director's March 20, 2015, letter. In response, SVC filed a *Notice of Intent to Participate*. *Id.* at 45-48. SVC has taken active advantage of opportunities to be heard and participate in the Big and Little Wood Delivery Calls. SVC attended the status conference and pre-hearing conference and filed numerous motions in both contested cases seeking action by the Director. Thus, SVC has not been deprived of procedural due process by notice procedures utilized in the Big and Little Wood Delivery Calls.

Finally, the Director's notice letters sent to ground water users did not cause the Director to draw any prejudicial conclusions. As the Director explained in the Sun Valley Order, "the Department has not drawn any conclusions 'about potential causation and hydrological connection'" and "[t]hose determinations are for the Director upon a fully developed record and evidence admitted at hearing." *BW CM-DC-2015-001* at 892.

In sum, SVC has failed to demonstrate any prejudice to a substantial right by notice procedures utilized in the Big and Little Wood Delivery Calls. Thus, SVC is not entitled to any relief. *Cowan v. Bd. of Comm'rs of Fremont Cty.*, 143 Idaho 501, 513, 148 P.3d 1247, 1259 (2006).

C. THE COURT LACKS JURISDICTION TO REVIEW CHALLENGES TO THE REQUEST FOR STAFF MEMORANDA, STAFF MEMORANDA ORDER, AND PREPARATION OF THE DELIVERY SYSTEMS MEMO.

While SVC states that it seeks judicial review of the Request for Staff Memoranda, the Staff Memoranda Order, and preparation of the Delivery Systems Memo, SVC also admits the

Court only has jurisdiction to review the Sun Valley Order "because it is a final order in a contested case. *See* Idaho Code § 67-5270(3); IDAPA 37.01.01.740." *Second Petition* at 10-11.

The Sun Valley Order is a final appealable order only because the Director designated it a final order pursuant to the Department's Rules of Procedure 710 and 750. *Supp AR Lodged w-DC* at 71-74. Rule 710 allows the agency to "by order decide some of the issue presented in a proceeding and provide in that order that its decision on those issues is final and subject to review by reconsideration or appeal." IDAPA 37.01.01.710. In the Designation Order, the Director declared his decision in the Sun Valley Order as final. *Supp AR Lodged w-DC* at 73. The Director has not issued any order designating his decisions in the Request for Staff Memoranda or the Staff Memoranda Order as final and subject to review on appeal. As such, those orders are interlocutory orders. IDAPA 37.01.01.710. Therefore, the Court lacks jurisdiction to consider the subject matter of the Request for Staff Memoranda and the Staff Memoranda Order. *Laughy v. Idaho Dep't of Transp.*, 149 Idaho 867, 876, 243 P.3d 1055, 1064 (2010). Site visits conducted in response to the Request for Staff Memoranda also fall outside the appropriate scope of the Court's review for the same reason. The only agency action that is the proper subject of the Court's review is the Director's decision in the Sun Valley Order, as re-affirmed in the Order Denying Motion to Revise, to proceed with the Big and Little Wood Delivery Calls pursuant to CM Rule 40 rather than CM Rule 30. *See BW CM-DC-2015-001* at 890-92; *See Supp AR Lodged w-DC* at 84-87. Therefore, the Court should not consider SVC's arguments regarding the Director's Request for Staff Memoranda, the Staff Memoranda Order, or preparation of the Delivery Systems Memo.

D. STAFF MEMORANDA WERE REQUESTED AND PREPARED CONSISTENT WITH THE DEPARTMENT'S ADMINISTRATIVE RULES AND IDAHO LAW AND DO NOT PREJUDICE SVC'S SUBSTANTIAL RIGHTS.

Even if the Court considers SVC's arguments regarding the Director's Request for Staff Memoranda, the Staff Memoranda Order, and site visits conducted in response to the Request for Staff Memoranda, the arguments must be rejected. Staff memoranda were requested and prepared consistent with the Department's administrative rules and Idaho law and do not violate SVC's substantial rights. Because SVC cannot demonstrate any prejudice to a substantial right by the request for or preparation of staff memoranda, SVC is not entitled to any relief. *Cowan*, 143 Idaho at 513, 148 P.3d at 1259.

1. The Department's Rules of Procedure authorize the Director to request, and staff to prepare, memoranda prior to hearing.

SVC argues the Director's Request for Staff Memoranda is not authorized by the Department's Rules of Procedure because Department staff cannot prepare staff memoranda or gather information in advance of the hearing on the Big and Little Wood Delivery Calls. Specifically, citing to Rules of Procedure 600 and 602, SVC argues "[t]he proper role, if any, of the Department staff in this proceeding, if any, is, upon the Director's request, to evaluate the evidence that has been gathered, compiled, organized, and presented ***by the parties—both Petitioners and Respondents—at a hearing*** and properly admitted, as evidence, into the hearing record by the Director." *Petitioner's Brief* at 50 (emphasis in original).

SVC's argument ignores the plain language of the Department's Rules of Procedure. The plain language of Rule 602 expressly authorizes the Director to notify the parties *before* hearing that official notice will be taken of staff memoranda. IDAPA 37.01.01.602. This plain language clearly contemplates that the Director may request, and Department staff may prepare, memoranda prior to hearing. Rule 602's requirement that employees responsible for staff memoranda be available for cross-examination at hearing also presupposes staff memoranda may be requested and prepared prior to hearing. Further, while Rule 600 states that "[t]he agency's experience, technical competence and specialized knowledge may be use in evaluation of evidence," nothing in Rule 600 precludes the Department from gathering technical and factual information that *may become evidence* admitted into the record at hearing and disseminating that information to the parties prior to hearing for evaluation and potential rebuttal. Contrary to SVC's argument, the Department's Rules of Procedure do not limit the Department's role in delivery call proceedings to evaluating evidence provided by the parties at hearing.

2. The Director can take official notice of the staff memoranda consistent with the Department's Rule of Procedure 602.

SVC argues the Director cannot take official notice of the staff memoranda pursuant to Rule of Procedure 602 because they do "not consist of 'generally recognized technical or scientific facts within the agency's specialized knowledge." *Petitioner's Brief* at 57, 63. A review of the Delivery Systems Memo and the Hydro Memo reveals the staff memoranda contain generally recognized technical or scientific facts within the Department's specialized knowledge. *BW CM-DC-2015-001* at 1080-1104 (describing hydrologic/ hydrogeologic data and publications in possession of the Department regarding surface and ground water interactions in the Big and Little Wood River basins, describing a conceptual description of interaction between groundwater and surface water, identifying diversion records for junior ground water pumping available to the Department, and identifying methods and data available for analyzing consumptive use associated with junior ground water pumping); *Id.* at 1105-1342 (describing the calling parties' water rights and sources, the delivery systems and accounting of delivery, the delivery and water application works for the Association Members' water rights, and information contained in water delivery records). The information set forth in the Delivery

Systems Memo and Hydro Memo is the type of information the Director may take official notice of consistent with Rule of Procedure 602. SVC's argument must be rejected.

3. The Request for Staff Memoranda prior to hearing is consistent with Idaho law and prior delivery calls.

SVC argues the Director's Request for Staff Memoranda prior to hearing shifts the burden of showing material injury from the senior water users to the Department. *Petitioner's Brief* at 48. This argument must be rejected because the Request for Staff Memoranda is consistent with Idaho law and requests in prior delivery call matters.

The Director has a "clear legal duty" to administer water rights according to the prior appropriation doctrine. *Musser*, 125 Idaho at 395, 871 P.2d at 812. The Director is required to provide a timely response to a delivery call. *Am. Falls Reservoir Dist. No. 2*, 143 Idaho at 874, 154 P.3d at 445. As the Idaho Supreme Court stated in AFRD#2, the swiftness of the response to the delivery call is not the only important factor for the Director to consider in a delivery call. It is also critical "the Director have the necessary pertinent information" to make a decision. *Id.* Conjunctive administration requires knowledge by the Department "of the relative priorities of the ground and surface water rights, how the various ground and surface water sources are interconnected, and how, when, where and to what extent the diversion and use of water from one source impacts the water flows in that source and other sources." *A & B Irrigation Dist. v. Idaho Conservation League*, 131 Idaho 411, 422, 958 P.2d 568, 579 (1997).

Here, the Director requested staff memoranda prior to hearing to present information about how water is delivered to the Association members' senior surface water rights and about hydrologic and hydrogeologic data, recognizing that time is of the essence in a delivery call and that Water District 37 has a complex water delivery system. This complexity is illustrated by the presentation of Tim Luke at the May 4, 2015, status conference. *BW CM-DC-2015-001* at 123-

147. The presentation describes there are eighty calling water rights at issue in the Big and Little Wood Delivery Calls with thirty-nine separate owners; multiple diversions, injection points, and re-diversions; and overlapping sources, overlapping service areas, combined use conditions, and a unique exchange condition. *Id.* For example, one water right is diverted from a canal with other river rights and storage, injected into a slough ten miles away, injected into the Little Wood River another ten miles away, re-diverted from the Little Wood River about a quarter mile downstream at four points of re-diversion, subject to a 27% conveyance loss, with a priority cut different than other Big Wood Rights, and combined with two other Little Wood River rights plus water from AFRD2 as per the water right condition. *Id.* at 139. The Delivery Systems Memo simply describes the Association members' water rights and sources, the delivery systems and accounting of delivery, water application works, and information contained in water delivery records. *BW CM-DC-2015-001* at 1105-1342. Given the need for a timely response and recognizing the complexity of water distribution issues, it is appropriate for the Director to request staff memoranda prior to hearing to help provide facts and information related to a delivery call.

In addition, the process for determining material injury is not as fixed or rigid as suggested by SVC. *See In Matter of Distribution of Water to Various Water Rights Held By or For Ben. of A & B Irrigation Dist.*, 155 Idaho at 648, 315 P.3d at 836 ("The Director may employ a baseline methodology as a starting point for considering material injury.") The request for staff memoranda prior to hearing is a regular practice in delivery call proceedings. *See Rangen v. IDWR*, Case No. CV-2014-1338 (Fifth Jud. Dist.), Exhibit Nos. 1129 & 3203; *see also A&B Irrigation District v. IDWR,* Case No. 2009-647 (Fifth Jud. Dist.), Exhibit No. 121.[6] The

[6] Copies of Exhibit Nos. 1129 & 3203 filed in the Rangen case and Exhibit No. 121 filed in the A&B case are attached hereto as Addendum A, B, and C. The Respondents move the Court to take judicial notice of the exhibits

information is prepared and distributed for the benefit of all parties to hearing. Moreover, it is within the authority of the Director to request water right information from the senior water users in advance of a delivery call hearing. *Am. Falls Reservoir Dist. No. 2,* 143 Idaho at 878, 154 P.3d at 449 (2007) (concluding the Director's pre-hearing request for information related to "post-adjudication factors" that are "relevant to the determination of how much water is actually needed" is appropriate and not a re-adjudication of the senior water right.) While information provided in the staff memoranda may be helpful to one or all parties, the staff memoranda do not change the substantive burdens of the parties as SVC suggests. *See Petitioner's Brief* at 48. Those burdens are fixed. *Am. Falls Reservoir Dist. No.* 2, 143 Idaho at 874, 154 P.3d at 445 (The evidentiary burdens "have been developed over the years and are to be read into the CM Rules."). The Request for Staff Memoranda is consistent with Idaho law and requests in prior delivery call matters and does not shift the burdens of the parties in the Big and Little Wood Delivery Calls proceedings.

4. The Request for Staff Memoranda and Department's information gathering efforts do not violate SVC's due process rights.

SVC repeatedly argues that the Request for Staff Memoranda and the Department's information gathering efforts violate SVC's "due process" rights. *Petitioner's Brief* at 45, 47-58. SVC asserts the Department's information gathering efforts may cause staff to develop "bias or, at a minimum, the appearance of a bias in favor of the information collected from the Petitioners" that may influence its "eventual 'evaluation of evidence' in accordance with Rule 600." *Id.* at 50-51. SVC also asserts "this one-sided evaluative process was highly prejudicial,"

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pursuant to IRE 201(d). If a party moves the Court to "take judicial notice of records, exhibits or transcripts from the court file in the same <u>or a separate case</u>, the party shall identify the specific documents or items for which the judicial notice is requested or shall proffer to the court and serve on all the parties copies of such documents or items. A court shall take judicial notice if requested by a party and supplied with the necessary information." IRE 201(d) emphasis added. "Judicial notice may be taken at any stage of the proceeding." IRE 201(f).

that preparation of the staff memoranda "constitutes the offering and taking of evidence outside the scope of the formal contested case hearing," and that SVC has been deprived of "having a full and fair opportunity to observe and pose legitimate evidentiary objections to the information gathered by Department staff." *Id.* at 52, 54-55.

As the Director explained in the Staff Memoranda Order, "Department efforts to collect and disseminate information about the [Association members'] diversion and use of water and hydrologic and hydrogeologic data to the parties for evaluation and potential rebuttal prior to hearing do not prejudice, but rather assist, all the parties." *BW CM-DC-2015-001* at 902. The Director alone "is responsible for admitting evidence at hearing and deciding what weight to give that evidence in his determination of the ultimate issues to be decided in the Big and Little Wood Delivery Calls." *Id.* SVC and all parties "will have full and fair opportunity to examine and object to any information proposed for admission as evidence into the record at hearing." *Id.* Consistent with Rule 602, "[i]f the Director notifies the parties that official notice will be taken of staff memoranda, responsible staff employees will be available for cross-examination at hearing." *Id.* The Request for Staff Memoranda and the Department's information gathering efforts prior to hearing are consistent with the Department's Rules of Procedure and do not violate SVC's due process rights.[7]

[7] SVC misleadingly asserts that, "pursuant to the Request for Staff Memoranda, the Department staff proceeded to discuss, analyze and evaluate 'responses and submittal of additional information by the Petitioners to 'assist' the Director 'in determining whether the holders of senior water rights are suffering material injury and using water efficiently and without waste as required by the Department's Conjunctive Management Rules." *Petitioner's Brief* at 54. SVC also asserts the staff memoranda contain "legal conclusions, legal commentary, or legal opinions." *Id.* at 58-59 n. 14. The Director's Request for Staff Memoranda did not ask Department staff to "discuss, analyze and evaluate 'responses and submittal of additional information by the Petitioners to 'assist' the Director 'in determining whether the holders of senior water rights are suffering material injury and using water efficiently and without waste." It was the Director's Information Request sent to the Association that asked for "responses and submittal of additional information that will assist [the Director] in determining whether the holders of senior water rights are suffering material injury and using water efficiently and without waste." *BW CM-DC-2015-001* at 179. In addition, the Director's Request for Staff Memoranda "does not ask Department staff to opine regarding factors set forth in CM Rule 42 that are '[f]actors the *Director* may consider in determining whether the holders of water rights are suffering material injury and using water efficiently and without waste.'" *Id.* at 871 (emphasis in original). The

5. Site visits associated with preparation of the Delivery Systems Memo did not violate SVC's due process rights.

SVC argues that site visits conducted in preparation of the Delivery Systems Memo "violated SVC's due process rights." *Petitioner's Brief* at 58. This argument must be rejected because, as discussed above, the Department's administrative rules and Idaho law authorize the Director to request that Department staff collect information and prepare staff memoranda prior to hearing to disseminate to the parties for evaluation and potential rebuttal.

In addition, Idaho case law cited by SVC is distinguishable. Specifically, SVC cites *Comer v. Cty. of Twin Falls*, 130 Idaho 433, 434, 942 P.2d 557, 558 (1997) to support its argument that any "[p]roperty viewing in an administrative proceeding is analogous to a viewing in trial, which requires notice to all parties prior to a viewing." *Id.* at 59. Similarly, SVC cites *Eacret v. Bonner Cty.*, 139 Idaho 780, 787, 86 P.3d 494, 501 (2004) to support its argument that "Idaho case law demands that 'any view of a parcel of property in question must be preceded by notice and the opportunity to be present to the parties in order to satisfy procedural due process concerns." *Id.* at 60. SVC also cites the Court's statement in *Idaho Historic Pres. Council, Inc. v. City Council of City of Boise*, 134 Idaho 651, 654, 8 P.3d 646, 649 (2000) that, "when a governing body deviates from the public record, it essentially conducts a second fact-gathering session without proper notice, a clear violation of due process." *Id.* at 61.

The cases of *Comer*, *Eacret*, and *Idaho Historic Pres. Council, Inc.*, are distinguishable from the circumstance at issue in the Big and Little Wood Delivery Calls. Specifically, *Comer* and *Eacret* involved appellate proceedings to a county board of commissioners from the decision of a county planning and zoning commission. *See Comer*, 130 Idaho at 434, 942 P.2d at 558; *see*

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staff memoranda do not contain "legal conclusions, legal commentary, or legal opinions." The staff memoranda contain technical and scientific information within the Department's specialized knowledge. *See BW CM-DC-2015-001* at 1080-1104; *BW CM-DC-2015-001* at 1105-1342.

Eacret, 139 Idaho at 782, 86 P.3d at 496. The case of *Idaho Historic Pres. Council, Inc,* involved an appellate proceeding in which the reviewing body did not confine it decision to the record of the agency from which the appeal was taken. *See Idaho Historic Pres. Council, Inc.*, 134 Idaho at 654, 8 P.3d at 649. The Big and Little Wood Delivery Calls are before the Director and do not involve review by an appellate body following a public hearing. This is an important distinction because the Court's due process concerns in *Comer, Eacret,* and *Idaho Historic Pres. Council, Inc.*, relate to failure of the reviewing bodies sitting in their appellate capacities to confine themselves to the records on appeal. *See Comer*, 130 Idaho at 439, 942 P.2d at 563; *see Eacret v. Bonner Cty.*, 139 Idaho at 787, 86 P.3d at 501. The holdings of *Comer, Eacret,* and *Idaho Historic Pres. Council, Inc.,* are simply not implicated in this case.

The case of *Evans v. Bd. of Comm'rs of Cassia Cty. Idaho*, 137 Idaho 428, 433, 50 P.3d 443, 448 (2002), is relevant to the circumstances at issue in the Big and Little Wood Delivery Calls. The Court in *Evans* dealt with a decision issued by a board of county commissioners sitting as the original deciding body after the board visited the proposed use site without notice to or presence of the interested parties. The Court found "that whatever knowledge the Board may have gained from visiting the property was not necessary to form the basis of its decision, as the hearing yielded substantially the same evidence as could have been garnered during the visit." *Id.* The Court also found that "interested persons were provided a fair opportunity to present and rebut evidence at the hearing." *Id.* Thus, the Court concluded "the appellants cannot show that a substantial right of theirs has been prejudiced by the Board's visit to the cite." *Id.*

There has been no hearing on the Big and Little Wood Delivery Calls. The Delivery Systems Memo notifies the parties that site visits occurred during preparation of the memo and sets forth facts derived from the visits. The Director has made no determinations tied to the site visits and only cited the Delivery Systems Memo in the Order Denying Motion to Revise to demonstrate the Association members' water rights are in Water District 37. *Supp AR Lodged w-DC* at 86. SVC's allegations regarding participation by the Director, legal staff, and Department staff in site visits are simply that—allegations based on an undeveloped record. *See Petitioner's Brief* at 58-59.[8] As the Director has repeatedly stated, all parties "will have full and fair opportunity to examine and object to any information proposed for admission as evidence into the record at hearing." *BW CM-DC-2015-001* at 902. Consistent with Rule 602, the Director will notify "the parties that official notice will be taken of staff memoranda" and "responsible staff employees will be available for cross-examination at hearing." *Id.*; *see also BW CM-DC-2015-001* at 337 ("The Director will require attendance of staff participating in writing staff memoranda for examination at any hearing set in this matter pursuant to IDAPA 37.01.01.201 and 602."). The concerns of the Court in *Comer, Eacret*, and *Idaho Historic Pres. Council, Inc,* are not at issue in the Big and Little Wood Delivery Calls. Similar to the circumstance in *Evans*, SVC cannot show its due process rights have been violated by site visits conducted in preparation of the Delivery Systems Memo because all parties will have a fair opportunity to present concerns regarding the Delivery Systems Memo at hearing.

E. THE DIRECTOR PROPERLY RESPONDED TO NEW ARGUMENTS RAISED IN THE RULE 711 MOTION BY ISSUING THE ORDER DENYING MOTION TO REVISE.

As discussed above, SVC raised new arguments in the Rule 711 Motion including that, before the Director can proceed with the Big and Little Wood Delivery Calls pursuant to CM Rule 40, CM Rule 20.06 requires the Director must determine an ACGWS and incorporate the

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[8] SVC overlooks that, consistent with IDAPA 04.11.01.001, the Department has affirmatively declined "in whole to adopt the contested case portion of the 'Idaho Rules of Administrative Procedure of the Attorney General,' cited as IDAPA 04.11.01.100 through .04.11.01.799." IDAPA 37.01.01.050. SVC's reliance upon IDAPA 04.11.01.423.01 to support its allegations related to preparation of the Delivery Systems Memo is misplaced.

water rights in that area into water districts under CM Rule 30. *BW CM-DC-2015-001* at 970. In response, the Director determined that the process advocated for by SVC "where water rights are put into water districts only after an area of common ground water is designated is not tenable" because "current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts." *Supp AR Lodged w-DC* at 86. The Director cited three sources to support this determination: the Delivery Systems Memo, the Hydro Memo, and the Preliminary Order. SVC argues the Director erred by citing the staff memoranda.

1. The Court should affirm the Director's determination that current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts.

Citing to Idaho Code § 67-5251, SVC argues the Director cannot cite to the staff memoranda in the Order Denying Motion to Revise because "he did not notify Sun Valley of the specific facts or material to be noticed." *Petitioner's Brief* at 63. SVC concludes the Director's "findings" based on staff memoranda are, "not based upon substantial, competent evidence in the record and, accordingly, must be overturned." *Id.* at 65.

The Director had an obligation to respond to SVC's Rule 711 Motion that raised new arguments as to why the Big and Little Wood Delivery Calls should be dismissed. Any order issued by the Director responding to a motion to dismiss must be in writing and supported by substantial evidence "in the record of the contested case and on matters officially noticed in that proceeding." Idaho Code §§ 67-5248 & 67-5279. The only reason there is any question as to the propriety of the Director's citation to staff memoranda in the Order Denying Motion to Revise is because the Director has indicated he will take official notice of the memoranda in the underlying delivery call proceedings and Idaho Code 67-5251 states that "[p]arties must be afforded a timely and meaningful opportunity to contest and rebut the facts or material so noticed." SVC argues the Director had to provide it "a timely and meaningful opportunity to contest and rebut" the staff memoranda before citing the memoranda in the Order Denying Motion to Revise. *Petitioner's Brief* at 63.

The Director only cited the staff memoranda for one purpose: to explain why the process advocated for by SVC in the Rule 711 Motion makes no practical sense because "current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts." *Supp AR Lodged w-DC* at 86. Because this determination is supported by substantial evidence in the contested case records apart from the staff memoranda and does not result in prejudice to SVC's substantial rights, the determination must be affirmed.

The Director cited the Delivery Systems Memo only to demonstrate the Association members' senior surface water rights are in Water District 37. *Id.* The Association's letters confirm this by stating the members' senior surface water rights "are all located in Water District 37." *BW CM-DC-2015-001* at 1; *LW CM-DC-2015-002* at 1. The Preliminary Order confirms this by stating "Water District No. 37 shall include ground water and all streams tributary to the Big Wood River and Little Wood River" excepting Camas Creek and other named tributaries. *BW CM-DC-2015-001* at 477; *see id.* at 479.

The Director only cited the Hydro Memo to show that current information demonstrates the junior ground water rights at issue in the Big and Little Wood Delivery Calls are diverted from the Wood River Valley aquifer system and the Camas Prairie aquifer system and, therefore, in Water Districts 37 and 37B. The Preliminary Order supports this determination by citing statements in the 1991 order creating the Big Wood River Ground Water Management Area that "[t]he surface and ground waters of the Big Wood River drainage are interconnected. Diversion of ground water from wells can deplete the surface water flow in streams and rivers." *BW CM-*

DC-2015-001 at 466. The Preliminary Order also states "that the Camas drainage aquifer system is characteristically different from the Upper Wood River Valley aquifer system but the aquifer systems are hydraulically connected to each other and the Big Wood River." *Id.* at 473. Again, the Preliminary Order provides that "Water District No. 37 shall include ground water and all streams tributary to the Big Wood River and Little Wood River" excepting Camas Creek and other named tributaries. *Id.* at 477. The Preliminary Order creates Water District No. 37B "to include all surface water and ground water rights in the Camas Creek drainage in Basin 37." *Id.*

The only statement in the Order Denying Motion to Revise related to the junior water rights at issue that cites to the Hydro Memo but is not directly supported by the Preliminary Order is that "[g]round water use in the upper Little Wood River valley above Silver Creek does not appear to affect the calling surface water rights." *BW CM-DC-2015-001* at 86 n.2. The Director made this statement for clarification because there are some junior ground water rights in the upper Little Wood River valley above Silver Creek in water districts where ground water regulation is not included in the function of the districts. However, as the Hydro Memo concludes, "[b]ecause surface water supply shortages in the Little Wood River are not expected to occur during peak runoff, groundwater use in the upper Little Wood River valley does not appear to be relevant to the Little Wood Water Users Association delivery call." *Id.* at 1093. The Hydro Memo based this finding upon 1922 watermaster reports for Water Districts 7 and 11; a 2010 U.S. Bureau of Reclamation *Draft Environmental Assessment for the Little Wood River Irrigation District Pressurized Pipeline Irrigation Delivery System*; the 1952 *Evaluation of Streamflow Records in Big Wood River Basin, Idaho* in U.S. Geological Survey Circular; and a 2005 Idaho Department of Environmental Quality report *Little Wood River Subbasin Assessment and TMDL*. *Id.* The 1922 watermaster reports for Water District 7 & 11 are contained in the record in the folder entitled *Supplemental Files to JSukow Staff Memo*. The 2010 U.S. Bureau of Reclamation report, 1952 U.S. Geological Survey Circular publication, and 2005 Idaho Department of Environmental Quality report are electronically linked in the Hydro Memo. *BW CM-DC-2015-001* at 1099-1102.

The Director can rely upon watermaster reports and reports and publications of other government agencies in issuing a pre-hearing order responding to a motion to dismiss contested case proceedings. Thus, instead of citing the Hydro Memo itself, the Director could have cited the above-described documents identified in the Hydro Memo to support the statement that "[g]round water use in the upper Little Wood River valley above Silver Creek does not appear to affect the calling surface water rights." It makes little sense for the Court to remand this matter to the Director because of his citation to staff memoranda when the Director could have individually reached the same determination—that current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are in water districts—based upon the Association's letters, the Preliminary Order, and reports and publications cited in the Hydro Memo. Such remand would result in a waste of the parties' time and resources.

Further, SVC's substantial rights have not been prejudiced by the Director's citation to staff memoranda for the sole purpose of showing that current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are in water districts. The purpose of the notice requirement associated with taking official notice of specific facts or material in an administrative proceeding is to afford parties "an opportunity to contest and rebut the facts or material officially noticed," including that "responsible staff employees or agents shall be made available for cross-examination if any party timely requests their availability." Idaho Code § 67-5251; IDAPA 37.01.01.602. As the Director has repeatedly stated, "[a]ll parties will have full and fair opportunity to examine and object to any information proposed for admission as evidence into the record at hearing" and that if "official notice will be taken of staff memoranda, responsible staff employees will be available for cross-examination at hearing." *BW CM-DC-2015-001* at 902. Because the alleged procedural error does not affect a substantial right of SVC and is, therefore, harmless, the error must be disregarded. I.R.C.P. 61; *Bolger,* 137 Idaho at 797, 53 P.3d at 1211.

2. The Director made no findings of fact concerning the ACGWS.

SVC argues the Director made "findings of fact" in the Order Denying Motion to Revise that "speak to one of the issues at the very core of the case—the ACGWS." *Petitioner's Brief* at 64. However, SVC also acknowledges the Director's repeated recognition in the Order Denying Motion to Revise that the ACGWS "is a factual question that can be answered using the framework of CM Rule 40 based upon information presented at hearing and applying the definition set forth in CM Rule 10.01." *Supp AR Lodged w-DC* at 85-86. Again, the Director cited the staff memoranda for one purpose only: to explain why the process advocated for by SVC in the Rule 711 Motion makes no practical sense because "current information demonstrates the water rights at issue in the Big and Little Wood Delivery Calls are already in water districts." *Id.* at 86. The Director was careful to use language such as "current information demonstrates" in recognition that "[a]ll parties will have full and fair opportunity to examine and object to any information proposed for admission as evidence into the record at hearing" and that if "official notice will be taken of staff memoranda, responsible staff employees will be available for cross-examination at hearing." *BW CM-DC-2015-001* at 902. The Director's statements in the Order Denying Motion to Revise do not constitute findings of fact regarding the ACGWS. Instead, the Director narrowly and properly responded to new arguments raised by SVC in the

Rule 711 Motion by utilizing current information in possession of the Department and identified in the contested case records.

F. SVC IS NOT ENTITLED TO COSTS OR ATTORNEY FEES.

SVC argues it is entitled to costs and attorney fees "pursuant to Idaho Code Section 12-107, as well as Section 12-117(1)." *Petitioner's Brief* at 67. SVC cannot recover costs on appeal pursuant to Idaho Code § 12-107 because the section "does not apply to the state, particularly when the state is a party in its governmental capacity." *Chicago, M. & St. P. Ry. Co. v. Pub. Utilities Comm'n of Idaho*, 47 Idaho 346, 275 P. 780, 781 (1929) (citations omitted); *Chastain's, Inc. v. State Tax Comm'n*, 72 Idaho 344, 350, 241 P.2d 167, 170 (1952). In addition, SVC cannot recover costs or attorney fees pursuant to Idaho Code § 12-117(1). That section provides that "the court shall award the prevailing party reasonably attorney's fees, witness fees and other reasonable expenses, if it finds that the nonprevailing party acted without a reasonable basis in fact or law." Idaho Code § 12-117(1). Here, the Director acted within his authority under the Department's administrative rules and Idaho law in responding to the Big and Little Wood Delivery Calls and to SVC's Motion to Dismiss and Rule 711 Motion. SVC has suffered no prejudice to a substantial right. The Court should deny SVC's request for costs and attorney fees.

V. CONCLUSION

The Director acted consistent the Department's administrative rules and Idaho law in denying SVC's Motion to Dismiss. Notice procedures utilized in the Big and Little Wood Delivery Calls do not prejudice SVC's substantial rights. The Court lacks jurisdiction to review challenges to the Request for Staff Memoranda, Staff Memoranda Order, and preparation of the Delivery Systems Memo. Even if considered, the staff memoranda were requested and prepared in response to the Big and Little Wood Delivery Calls consistent with the Department's administrative rules and Idaho law and do not prejudice SVC's substantial rights. The Director properly responded to new arguments raised by SVC in the Rule 711 Motion by issuing the Order Denying Motion to Revise. SVC is not entitled to costs and attorney fees on appeal. The Respondents respectfully request the Court affirm the Director's Sun Valley Order.

RESPECTFULLY SUBMITTED this 4th day of February 2016.

LAWRENCE G. WASDEN
Attorney General

CLIVE J. STRONG
Deputy Attorney General
CHIEF, NATURAL RESOURCES DIVISION

GARRICK L. BAXTER
EMMI L. BLADES
Deputy Attorneys General
Idaho Department of Water Resources

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 4th day of February 2016, I caused a true and correct copy of the foregoing document to be filed with the Court and served on the following parties by the indicated methods:

Original to: SRBA DISTRICT COURT 253 3RD AVE NORTH PO BOX 2707 TWIN FALLS ID 83303-2707 Facsimile: (208) 736-2121	( ) U.S. Mail, Postage Prepaid (x) Hand Delivery ( ) Facsimile ( ) E-mail
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Emmi L. Blades
Deputy Attorney General

ADDENDUM A

MEMORANDUM

December 15, 2003

TO: Karl Dreher

FROM: Cindy Yenter

CC: Brian Patton, Jennifer Berkey, Tim Luke

RE: Water Right Review and Sufficiency of Measuring Devices, Rangen Aquaculture

Water Rights Review

Rangen, Inc. holds three water rights for fish propagation use at the hatchery and research facility on Billingsley Creek. They are as follows:

36-15501	7/01/1957	1.46 cfs
36-2551	7/13/1962	48.54 cfs (includes 0.1 cfs for domestic use)
36-7694	4/12/1977	26.00 cfs
Total authorized diversion		76.00 cfs

Additionally, Rangen, Inc. holds two earlier water rights for irrigation and domestic uses:

36-134B	10/09/1884	0.09 cfs	
36-135A	4/01/1908	0.05 cfs	
Total authorized diversion		0.14 cfs	7 acres

According to historical flow data which Rangen submitted, flows at the head of Billingsley Creek have not been available to fully satisfy the most junior fish propagation right, 36-7694, since October 1972[1], a period predating the priority of the right. In fact, it is unclear whether diversion and beneficial use have ever actually occurred under right no. 36-7694. Reported average monthly flows during the development period of the water right permit, April 1977 through 1979, never exceeded 50 cfs, the amount of the two earlier rights. The licensing examination from 1979 appears to base the recommendation for an additional 26 cfs diversion rate, on average estimated spring flows of 76 cfs which occurred in October 1972, *five years prior to the filing of the permit.* Even though there may have been some historical basis for the issuance of this license, there is no actual beneficial use documented.

The last year in which flows may have been available to satisfy right no. 36-2551 was during October 1987, when average available flows at the head of Billingsley Creek were estimated to

[1] See Rangen's table entitled "Head of Billingsley Creek at Curren Tunnel". Per Jennifer Berkey's 12-04-03 Memo, these figures reflect total available flows from the source, rather than actual hatchery diversions.

EXHIBIT
1129
CM-DC-2011-004

DEPOSITION EXHIBIT
213 3/12/13
J. Sukow

be above 50 cfs[2]. However, a breakdown of submitted data indicates that Rangen had only diverted a maximum of about 42 cfs to hatchery raceways during that same month[3]. It is not clear where the balance of the flows were used. A portion may have been diverted for late-season irrigation under the Musser and Candy rights (at the tunnel pipelines), although an average of 10 cfs was measured over the creek weir during that month. This may indicate a significant bypass of flows around the hatchery.

The largest beneficial-use diversion indicated in post-1981 data occurred during November 1983, when nearly 48 cfs was measured at the large raceways. Prior to 1981, submitted data cannot be parsed to individual measurements, but the estimated total flows in Billingsley Creek exceeded 50 cfs during November in every year from 1966 to 1976, indicating that flows were available at least part of those years, to satisfy right nos. 36-15501 and 36-2551.

Because of a lack of documentation to support historical use of right no. 36-7694, any indication of injury at Rangen should be limited to the documented reduction of available flows to satisfy right no. 36-2551.

Sufficiency of Measuring Devices

1. 6" PVC Pipeline from Curren Tunnel

This pipeline has no measuring device. It may be used to divert an unspecified portion of the Rangen fish propagation rights to the hatch house and research lab, and is the sole conveyance for domestic water to the lab, shop, office, and manager's house, as well as irrigation water for 3 to 5 acres of landscaping. Instantaneous flow through the hatch house incubation and rearing tanks may be estimated by determining the number of tanks in operation and applying pre-determined flows per unit, as shown on the attached worksheet. The unit flows were calculated by previous Rangen facility managers, using timed fill tests. All hatch house flows are returned to the Billingsley Creek channel, above the diversion to the lower raceways, and are measured again at the raceways.

Diversions for domestic and irrigation uses are not measured. The hatch house worksheet uses a constant 20 gpm for domestic (including irrigation) uses. This is likely on the high side for winter diversions, and too low for summer when irrigation is occuring. Authorized diversion rate for these uses is 0.14 cfs, from right nos. 36-134B and 36-135A, plus 0.1 cfs as a non-additive element of right no. 36-2551. This is a comparatively small portion of Rangen's total diversions, nevertheless, it is the only consumptive portion.

In July 2001, Tim Luke conducted a measurement certification on the 6" pipeline using a polysonic meter. Concurrently, the hatchery manager estimated flow through the pipeline using the worksheet. On that date, indicated pipeline flow was 18% higher than the standard meter.

In March 2002, I conducted the same test, again working with the hatchery manager. On that date, indicated pipeline flow was 9% lower than the standard meter.

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[2]See Rangen's table entitled "Head of Billingsley Creek at Curren Tunnel".
[3] See tables attached to Jennifer Berkey's 12-11-03 memo. Measurements taken in the Large Raceways are most representative of total hatchery diversions.

There seems to be a great deal of variability in pipeline estimations. Because the majority of the flow returns to the creek to be reused and re-measured, this is probably not of great concern. However, the magnitude of diversions to domestic and irrigation uses is still unknown.

2. Rangen Hatchery Raceways

Raceway flows are measured by Rangen personnel over dam boards in the two lowest blocks of raceways ("large" raceways and "CTR" raceways - see facility diagram submitted by Rangen). The CTR raceways are situated downstream from the large raceways. Each block of raceways contains three sets of check dams; heads are collected at the uppermost set of checks in each block. A measurement is also taken over a check dam in the Billingsley Creek channel.

At the time of our visit, Mr. Wayne Courtney (Rangen Inc) indicated that measurements are taken weekly in both the large and the CTR raceways, and the two results averaged for a final flow. Presently, all flows from the large raceways are being sent to the CTR raceways, so these measurements should cross-check.

On the day of our investigation, Brian Patton and I took measurements at both the large and CTR raceways. Width of the individual raceway openings, and thus crest length, varied slightly from raceway to raceway. Most checks were not entirely level. We took crest width measurements at each opening, and, using a standard hand-held 3-foot staff gage, took the average of three head readings across each check. Applying the Francis formula for rectangular suppressed weirs, Brian Patton calculated a flow of 18.49 cfs in the large raceways and 18.21 cfs in the CTR raceways. These measurements are representative of the total diverted flow through the facility. We also measured 0.48 cfs over the dam in the creek, using the same techniques. This measurement is representative of the unappropriated flows which bypass all or part of the facility.

Aside from Mr. Courtney, there were no hatchery workers present during our investigation to confirm either the measurement points or the measurement methods used by Rangen staff. I made a call to the hatchery on Friday, December 12, and spoke with Lonnie Tate, who confirmed that all measurements are made at the first set of checks in each block. Mr. Tate indicated that heads were read at the middle of the crest, with a 2" wide metal ruler rather than a standard staff gage. Measurements taken by hatchery personnel on November 24, the day before our visit, indicated flows of 16.6 cfs in the large raceways and 15.9 cfs in the CTR raceways. These flows are as related to me by Mr. Tate, and are not documented. They are 10% to 12% lower than the flows we measured the next day. The chances of actual inflows changing 2 cfs over a 24-hour period is possible but not probable. Mr. Tate confirmed that no operational changes were made within the hatchery during that period. Mr. Tate also confirms that Rangen is still using some form of averaging between the large and CTR raceways and the creek dam flow, to derive flows for reporting purposes.

Brian Patton applied the Francis formula individually to each set of data we collected, but Rangen uses weir discharge tables calculated with fixed 44 inch (for large raceway) or 58 inch (for CTR raceway) openings. In the large raceway measurement section, crest lengths ranged from 43.44 to 44.04 inches. In the CTR block, crest lengths ranged from 58.32 inches to 58.8 inches. To test the sufficiency of the fixed-length discharge tables, I applied our head measurements to the Rangen tables, and calculated total flows of at 18.55 cfs for the large raceways and 18.03 for CTR raceways, a difference of less than 1% in each case, from the flows derived from the sum of independant equations.

The 10% difference found in total flow measurements taken by Rangen and by DWR is not greater than the range of accuracy expected for open-channel measurements under these conditions, and therefore Rangen also passes the sufficiency test with respect to measurement methodology. My experience has been that measurements taken at flat-crested dam boards are generally less accurate than those taken at sharp-crested weirs, and that flat-crested dam measurements return indications of flow which are typically 5-10% lower than actual flow, when checked against other methods of measurement. Because I have not had the opportunity to check flows at this particular facility against a more standard method of measurement, I can only compare one set of measurements against the other.

The most likely cause of the discrepancy between the DWR measurement and the Rangen measurement is a data collection error due to the hatchery staff's use of a narrow metal ruler to measure head. The best measurement location for head readings is upstream from the crest, past the point of crest drawdown. When this is not possible, proper technique for using a hand-held staff gage directly on the crest is to turn the surface of the gage into the flow slightly, to overcome the drawdown and simulate a true head reading. Without actually observing the hatchery staff's measurement techniques, I suspect that the head readings taken by them are probably more indicative of crest drawdown rather than true head over the dam. This would result in a slightly lower head reading and a lower total flow.

It seems reasonable to conclude that, while Rangen's measuring techniques for the hatchery raceways may not be absolutely correct, they are fairly consistent, and are resulting in reported measurements which are no more than about 10% lower than actual flows. However, the reported measurements continue to be measurements of available flow, which usually includes at least some bypass flow, and not actual diverted flow.

Attachment A
Rangen Worksheet for Estimating Hatch House Use

IDWR record		Hatchery/Lab water use		
Date Location	# possible	# in use	GPM/unit	Total GPM
Hatchery 1-6	6	0		
Hatchery 7-12	6	6	22	132
Greenhouse A-D	4	4	9.56	38.2
Greenhouse 1-20	20	20	9.56	191.2
Greenhouse 1H-3H	3		19.86	
Barrels 1-36	36		2.00	
Greenhouse E,F	2		9.56	
Swamp Cooler	1		2.00	
Cleanroom 1-34	34		0.50	
Isolation tanks 1-18	18		2.00	
Domestic	1	20	20.00	20
Total GPM				381.4
CFS				.85

Handwritten notes beside the table:

6 (calibrated by timed fill by previous mgr)

(Hatchery 1-12:) hatchery tanks w/ calibrated inlets & standpipes, incl. table & variable flows

(Greenhouse A-D through Greenhouse E,F:) hatchery barrels w/ flow restrictors, always run full open, calibrated volumetrically (timed fill) by Caroline

(Swamp Cooler:) est.

(Isolation tanks 1-18:) timed fill calibration? ~~[illegible]~~

(Domestic:) est.

to- Cindy y.... / Dept. Water Resources
From – Lonny – Rangen. [redacted]

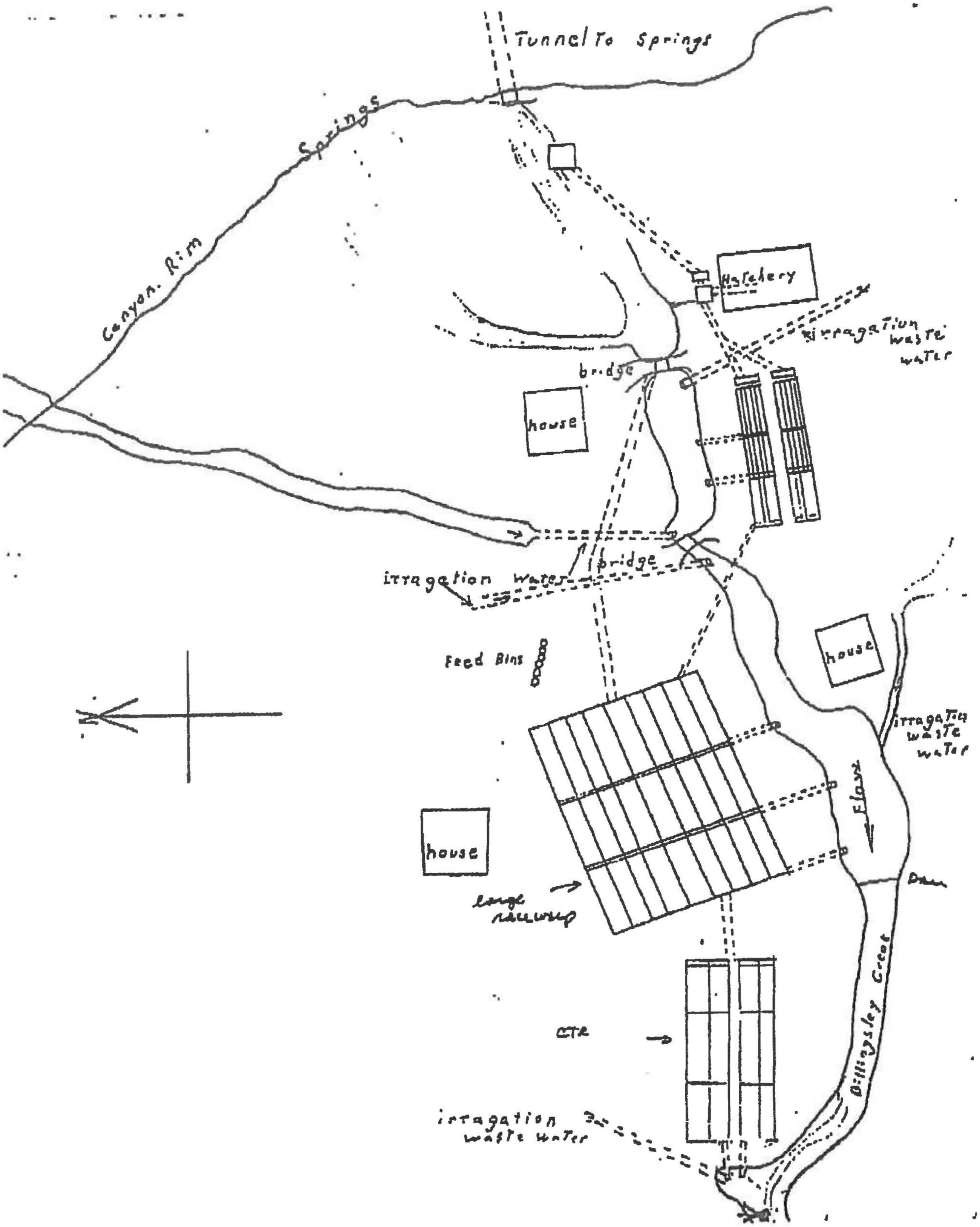
736-3067

INCHES		LG RW	CTR	SM	DAM
1	0	0.25	0.33	0.23	0.28
1	1/8	0.30	0.40	0.27	0.33
1	1/4	0.35	0.47	0.31	0.39
1	3/8	0.41	0.54	0.36	0.45
1	1/2	0.47	0.61	0.41	0.51
1	5/8	0.52	0.69	0.47	0.57
1	3/4	0.58	0.77	0.52	0.64
1	7/8	0.65	0.86	0.56	0.71
2	0	0.72	0.95	0.64	0.78
2	1/8	0.78	1.04	0.70	0.86
2	1/4	0.93	1.22	0.82	1.01
2	3/8	1.00	1.32	0.89	1.09
2	1/2	1.08	1.42	0.96	1.18
2	5/8	1.16	1.53	1.03	1.26
2	3/4	1.24	1.63	1.10	1.35
2	7/8	1.32	1.74	1.17	1.44
3	0	1.40	1.85	1.24	1.53
3	1/8	1.48	1.96	1.32	1.62
3	1/4	1.57	2.07	1.40	1.72
3	3/8	1.66	2.19	1.47	1.81
3	1/2	1.75	2.31	1.55	1.91
3	5/8	1.84	2.43	1.63	2.01
3	3/4	1.93	2.55	1.72	2.11
3	7/8	2.12	2.80	1.89	2.32
4	0	2.22	2.93	1.97	2.43
4	1/8	2.32	3.06	2.06	2.53
4	1/4	2.42	3.19	2.15	2.64
4	3/8	2.52	3.33	2.24	2.75
4	1/2	2.62	3.46	2.33	2.87
4	5/8	2.73	3.60	2.42	2.98
4	3/4	2.83	3.74	2.52	3.10
4	7/8	2.94	3.88	2.61	3.21
5	0	3.05	4.02	2.71	3.33
5	1/8	3.16	4.17	2.80	3.45
5	1/4	3.27	4.31	2.90	3.57
5	3/8	3.38	4.46	3.00	3.69
5	1/2	3.49	4.61	3.10	3.82
5	5/8	3.61	4.76	3.20	3.94
5	3/4	3.72	4.92	3.31	4.07
5	7/8	3.84	5.07	3.41	4.20
6	0	3.96	5.23	3.52	4.33
6	1/8	4.08	5.38	3.62	4.46
6	1/4	4.20	5.54	3.73	4.59
6	3/8	4.32	5.70	3.84	4.72
6	1/2	4.44	5.86	3.95	4.86
6	5/8	4.57	6.03	4.06	4.99
6	3/4	4.69	6.19	4.17	5.13
6	7/8	4.82	6.36	4.28	5.27

** table adjusted for measurement over 2" boards

		LGRW	CTR	DAM
7	0	4.95	6.53	5.41
7	1/8	5.08	6.70	5.55
7	1/4	5.21	6.87	5.69
7	3/8	5.34	7.04	5.83
7	1/2	5.47	7.22	5.98
7	5/8	5.60	7.39	6.12
7	3/4	5.73	7.57	6.27
7	7/8	5.87	7.75	6.41
8	0	6.01	7.92	6.56
8	1/8	6.14	8.11	6.71
8	1/4	6.28	8.29	6.86
8	3/8	6.42	8.47	7.02
8	1/2	6.56	8.66	7.17
8	5/8	6.70	8.84	7.32
8	3/4	6.84	9.03	7.48
8	7/8	6.99	9.22	7.63
9	0	7.13	9.41	7.79
9	1/8	7.27	9.60	7.95
9	1/4	7.42	9.79	8.11
9	3/8	7.57	9.99	8.27
9	1/2	7.72	10.18	8.43
9	5/8	7.86	10.38	8.59
9	3/4	8.01	10.5[illegible]	8.76
9	7/8	8.16	10.77	8.92
10	0	8.32	10.97	9.09
10	1/8	8.47	11.18	9.26
10	1/4	8.62	11.38	9.42
10	3/8	8.78	11.58	9.59
10	1/2	8.93	11.79	9.76
10	5/8	9.09	11.99	9.93
10	3/4	9.25	12.20	10.10
10	7/8	9.40	12.41	10.28
11	0	9.56	12.62	10.45
11	1/8	9.72	12.83	10.63
11	1/4	9.88	13.04	10.80
11	3/8	10.04	13.26	10.98
11	1/2	10.21	13.47	11.16
11	5/8	10.37	13.69	11.33
11	3/4	10.53	13.90	11.51
11	7/8	10.70	14.12	11.69
12	0	10.87	14.34	11.87

Rangens Research Hatchery
Hagerman Ida.



11-25-03 Cindy Yenter Brian Patton J Dee May
Wayne Courtney Frank Erwin
(Doug Ramsey – hatchery lead)

- config of diversion works
- sufficiency of meas devices
- Amount of water diverted now
- any undiverted flows? How much
- alternate sources

11-25-03 Rangen Tour

- Irr pipes L to R Candy – Musser – Morris
- White pipes from RH Box → middle box (Crandel mure)
- White pipes from middle box → ~~lower~~ upper raceways + spill to creek
- Dir @ bridge → lower raceways + outflow from upper
- numerous seeps, all captured
- How much irrigation use on hatchery grounds?
- everything below bridge not retreivable?
  - minor seep @ headgate 1 gpm
  - 40-50 gpm over checks
  - 2 anti-freeze pipes from dom. systems (house & shop 1-2 gpm

- Upper raceways 2 of 8
- lower " 4 of 10 A Block
  2 of 4 B Block
  (1 used as settling pond) – pond is pumped, does not spill
  all discharges to creek channel.

11-25-03 Rangen (con't)

- Uncaptured flows in ck meas @ check next to Lower Block B (CTR)

May sent a packet to Karl containing a system diagram and historical diversion data.

I asked that discharge tables being used for dam board measurements be sent to Brian for review

Need to assess how much irrigation, and what right it is authorized under.

At Rangen's measuring point in upper bank in lower raceways

Large Raceway

2nd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	3.65	0.34	2.41
Right Middle	3.65	0.34	2.41
Left Middle	3.62	0.3	1.98
Left	3.67	0.34	2.42

Q (cfs) from Rangen tables
2.42
2.42
2.01
2.42

3rd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	3.67	0.3	2.01
Right Middle	3.66	0.36	2.63
Left Middle	3.66	0.34	2.42
Left	3.66	0.32	2.21
		TOTAL	18.49

2.01 (avg width = 43.86")
2.64
2.42
2.21
18.55 ≈ 1%

At d/s end of upper bank in Lower raceways

2nd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	3.66	0.3	2.00
Right Middle	3.65	0.32	2.20
Left Middle	3.63	0.28	1.79
Left	3.71	0.28	1.83

3rd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	3.65	0.28	1.80
Right Middle	3.66	0.3	2.00
Left Middle	3.68	0.3	2.01
Left	3.55	0.36	2.55
		TOTAL	16.19

At lower bank of lower raceways

CTR Raceway

2nd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	4.9	0.34	3.23
Middle	4.87	0.36	3.50
Left	4.86	0.32	2.93

Q from Range table
3.19
3.47
2.91

3rd Raceway from right

	W (ft)	H (ft)	Q (cfs)
Right	4.88	0.32	2.94
Middle	4.89	0.3	2.68
Left	4.86	0.32	2.93
		TOTAL	18.21

avg width = 58.52"
2.91
2.64
2.91
18.03 < 1%

At wier in stream near d/s of facility

W (ft)	H (ft)	Q (cfs)
3.5	0.12	0.48

12-11-03 phone call

Lonnie - Don measures

@ 1st check in Log

@ 1st check in CTR (capacity ~ 30 cfs)

@ creek weir

Meas on 24th 16.6 Log

15.9 CTR

1.62 creek

ADDENDUM B

HYDROGEOLOGIC ANALYSIS OF THE A AND B IRRIGATION DISTRICT AREA

Prepared for the

Idaho Department of Water Resources
Boise, Idaho

January 2008

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INTRODUCTION

Water management on the Snake Plain Aquifer by the Idaho Department of Water Resources (IDWR) is dependent in large part on understanding the hydrogeologic characteristics of the aquifer. The purpose of this report is to analyze the hydrogeology of a segment of the aquifer north of Rupert in the south-central portion of the aquifer. The focus of the study is the North Side Pumping Division (A&B Irrigation District), which is a portion of the U.S. Bureau of Reclamation (USBR) Minidoka Project. Irrigation water is supplied to Unit A via a pump in the Snake River. Ground water is the source for irrigation for Unit B. The general location of the production wells is shown on Figure 1.

The objectives of this report are as follows: 1) develop a hydrogeologic conceptual model of in the general vicinity of the A&B Irrigation District with an emphasis on the presence of low hydraulic conductivity sedimentary strata interbedded with the basalt of the aquifer, 2) analyze the significance of hydrogeologic conceptual model with respect to the ability of the A&B Irrigation District wells to obtain water from the aquifer, and 3) evaluate the impacts on A&B Irrigation District production wells from declining ground-water levels in the aquifer. The report is based on a review of published reports, unpublished information from a range of sources and discussions with individuals with knowledge of the area (citations provided in the text). The unpublished information provided by the A&B Irrigation District in December 2007 and posted on the FTP portion of the IDWR website is a particularly important source.

OVERVIEW OF THE AREA

The general description of the Minidoka Project that is presented below was taken from the USBR website (www.usbr.gov/dataweb/html/minidoka.html) on November 14, 2007.

> "Minidoka Project lands extend discontinuously from the town of Ashton, in eastern Idaho along the Snake River, about 300 miles downstream to the town of Bliss in south-central Idaho.... The project works consist of Minidoka Dam and Powerplant and Lake Walcott, Jackson Lake Dam and Jackson Lake, American Falls Dam and Reservoir, Island Park Dam and Reservoir, Grassy Lake Dam and Grassy Lake, two diversion dams, canals, laterals, drains and some 177 water supply wells" (page 1).
>
> "Water is diverted from the north side of Lake Walcott into the North Side Canal, a gravity canal and lateral system serving 72,000 acres of land called the Gravity division, in the vicinity of Rupert, Idaho. The 8-mile main canal has an initial capacity of 1,700 cubic feet per second" (page 2).
>
> The North Side Pumping division consists of some 77,000 acres of irrigable public land that have been withdrawn from entry, of which some 62,000 acres (Unit B) are irrigated by pumping ground water from deep wells, and 15,000 acres (Unit A) by pumping from the Snake River.... Water for Unit A is pumped from the Snake River by a pumping plant located about 8 miles west of Burley. The plant capacity is 270 cubic feet per second and the dynamic head is 168 feet. The pumping plant delivers water to a 4.4-mile long unlined canal that has the

same capacity. Seven groups of deep wells, totaling 177 wells from 12 to 24 inches in diameter, initially supplied water for Unit B. The average discharge of these wells was about 6.4 cubic feet per second. Currently, 174 wells are being used" (page 4).

A general description of the ground-water supply for the North Side Pumping Division is presented in the Planning Report and Draft Environmental Statement for the North Side Pumping Division Extension (U.S. Bureau of Reclamation, 1986, pages 6-12 to 6-14).

> "The Snake Plain aquifer lies beneath the project area and is one of the largest and most prolific aquifers in the Nation....In the North Side Pumping Division area, the Snake Plain aquifer consists of a thick series of basalt flows in the northern part of the project area (mainly Unit B) and basalt flows interbedded with large amounts of fine-grained lake sediments in the southern part. Deep well water yields range from a high of several thousand gallons per minute in the predominantly basalt aquifer to the north to lows of a few hundred gallons per minute in the less permeable sediment-basalt aquifer to the south. One such area is near Extension Area 4 where several low yields wells are found.
>
> The Geological Survey estimates total storage in the aquifer to be about 250 million acre-feet....In an average year, about 8 million acre-feet of water enter and leave the Snake Plain aquifer. Inflow to the system includes about 3 million acre-feet of natural recharge (precipitation and stream losses) and approximately 5 million acre-feet from irrigation seepage. Outflow or depletion is made up of spring discharge from the aquifer of about 6.6 million acre-feet and pumping depletion of about 1.4 million acre-feet annually. Annual discharge by pumping from the aquifer presently does not begin to approach annual recharge.
>
> Changes in recharge and withdrawal rates within the Snake Plain aquifer affect water levels beneath the North Side Pumping Division. The three major influences which cause water levels to change in the aquifer are (1) climatic trends, (2) irrigation diversions, and (3) ground-water pumping.
>
> The most significant influence which affects the water table is long-term climatic change – prolonged wet or dry cycles.... The second major influence on water table levels is changes in the quantity of irrigation diversions onto the plain.... Beginning in 1961, large quantities of water previously diverted each winter for domestic use and stock watering were greatly reduced or stopped. The reduction in diversions in canals below American Falls during winter amounted to over 100,000 acre-feet annually, most of which would have recharged the aquifer.
>
> The third major influence on aquifer water table levels is withdrawals of ground water for irrigation. Use of ground water from the Snake Plain aquifer has reached major proportions. Based on 1979 estimates, total ground-water pumpage from the aquifer is about 2.3 million acre-feet annually. With about 40 percent of this pumpage percolating downward and returning to the aquifer, net pumpage is estimated to be about 1.4 million acre-feet per year.

Ground-water pumping is the major aquifer discharge in the North Side Pumping Division area, with over 200,000 acre-feet pumped each year with Unit B of the division. A total of 177 deep wells serve the 62,000 acres irrigated within Unit B. Additional ground-water pumping of an estimated 400,000 acre-feet occurs in the general area adjacent to the division....

Snake Plain aquifer ground-water levels generally peaked in the mid-1950's as a result of a moderately wet sequence of years and maximum amounts of surface-water irrigation diversions onto the Snake River Plain which caused abundant ground-water recharge. Ground-water levels then declined during a period of dry years and increased ground-water pumping. Water levels reached new lows in the mid-1960's.

Levels then rose for about a decade because of above average precipitation. A second general ground-water decline began in the mid-1970's because of significant reductions in surface-water diversions onto the Snake river Plain. The water level decline accelerated because of a series of dry years, and water levels reached record lows in 1982. Increased precipitation beginning in late 1981 has stabilized water levels, and some recovery has occurred. In general, the recovery of ground-water levels has continued through 1985.

Studies show that this pattern of Snake Plain aquifer water level behavior occurred both in areas with major amounts of ground-water pumping and in areas with no pumping. Although large quantities of ground water are pumped from the aquifer, they are relatively minor when compared to total aquifer discharge and recharge quantities....

There has been an estimated net 10- to 15-foot decline in the water table elevation beneath the North Side Pumping Division since the project was constructed. These amounts of ground-water level decline have been of some concern to the local area. They are very minor, however, when compared to many other aquifers used for irrigation, including local aquifers south of the Snake River and in other areas of the Northwest where water level declines have in some cases far exceeded 100 feet.

At this time, the Snake Plain aquifer shows only minor evidence of stress in response to major ground-water withdrawals. There are areas of minor decline (such as beneath the North Side Pumping Division) which in part can be attributed to ground-water pumpage. The reduction in total discharge at Thousand Springs may also in part be attributed to ground-water pumping. However, there are no significant changes in the aquifer which would indicate that the system is being overtaxed."

HYDROGEOLOGIC SETTING

Regional Geologic Setting

The A&B Irrigation District is located in a transition zone where the subsurface consists of mostly basalt to the north and northwest and mostly sediment to the south and southeast. Figure 2a is a geologic map of the area taken from Whitehead (1992). Geologic units shown on the map are described in Figures 2b and 2c. The basalt shown north of the A&B Irrigation District well field is identified as Quaternary basalt (Qb or Qtb). Sediments in the area are mapped as wind blown deposits (Qw) and older alluvium (Qts). The general relationship between basalt and sediment is shown on two figures taken from Whitehead (1992). Figure 3 shows the thickness of Quaternary basalt whereas Figure 4 shows the thickness of sedimentary rocks. The two figures show the transition from a basalt-dominated subsurface in the center of the Snake Plain to a sedimentary-dominated subsurface south of the A&B Irrigation District well field.

Local Geologic Setting

Sterns and others (1938), Nace (1948) and Crosthwaite and Scott (1956) describe the subsurface geology of the general Minidoka Project area. The dominant units are Quaternary basalt and sedimentary units. Nace (1948, p. 13) provides the following description of the sequence of geologic events in the creation of the subsurface sequence.

> "Early in the sequence of events the Sand Springs basalt was extruded from sources between Kiamam and Hazelton ... spreading westward and southwestward, spilling into the old Snake River Canyon and partially filling it from the northwest part of T7S R13E for a distance of about 50 miles upstream, to the area south of Hazelton and Eden. Filling of the river channel effectively dammed the Snake River and the impounded waters spread widely over what is now called the Minidoka Project in Cassia and Minidoka Counties. In the Sterns report this body of water is called Lake Burley, and in it the Burley lake beds accumulated to a maximum thickness of 90 to 150 feet. The areal distribution of these beds approximately coincides with the area of the Minidoka Project in Cassia and Minidoka Counties. At the boundaries of the lake the shore phases of the accumulating sediments overlapped or abutted on the surrounding lavas and other rocks. Northward and westward from Burley, Rupert, and Acequia, the Burley lake beds thin and disappear against the basaltic rock masses of the unknown thickness. Probably the older sediments beneath the Burley lake beds behave similarly. The lake remnant was then drained as the Snake River entrenched a new outlet through the basalt barrier on the west. As this entrenchment progressed upstream through the lake beds, the lake floor remained as a slightly elevated terrace adjacent to the river. Quaternary alluvium, loess, and residual soil were deposited as a mantle over the Burley lake beds and surrounding lava flows."

Crosthwaite and Scott (1956, pages 7 and 9) describe the Burley lake beds and Snake River Basalt as follows.

> "The ancient lake in which the Burley lake beds were deposited covered the area of the Gravity Division but apparently did not extend into the Pumping Division. ... The Burley lake beds ... .consist of about 450 feet of compacted to unconsolidated clay and silt, and small amounts of sand and fine gravel. Several basalt layers are intercalated in the lake beds 150 to 225 feet below the land surface and at the base of the formation. The sand, gravel and basalt are permeable and yield moderate amounts of ground water to domestic, municipal and industrial wells. The clay and silt beds are very low in permeability and are the base on which shallow ground water is perched in overlying alluvium. At

depth these impermeable beds confine artesian water in associated permeable sediments. "

"The Snake River basalt underlies all of the Minidoka area and most of the Snake River Plain. At most places in the area of proposed ground-water development the basalt is overlain by 2 to 50 feet or more of windblown deposits, but small outcrops are common.... In Minidoka County and most other parts of the Snake River Plain the Snake River basalt is the principal water-bearing formation, and it yields water copiously to wells. Intertongued sedimentary beds are saturated below the water table but yield little or no water to wells.... The Snake River basalt consists of many individual flow sheets, 10 to 75 feet thick, which originated at numerous volcanic vents scattered over the Snake River Plain.... A few sedimentary beds are intercalated in the basalt. The total thickness of the basalt is not known. In southern Minidoka County wells 500 deep end in basalt."

The U.S. Bureau of Reclamation (1985a, page 19) describes the hydrogeology of the area as follows.

"The aquifer, as previously discussed, is made up of sediment and basalt....The basalt is made up of a series of thin flow sheets, from a few feet to several tens of feet thick. Where the flow sheets are deposited one upon another to form a relatively thick sequence, and where the basalt is highly fractured and/or contains numerous rubble or cinder zones, the water yield is large, up to several thousand gallons per minute. Where the flow sheets are made up of dense, and massive basalt and/or is covered, penetrated, or innerbedded with fine sediment, the water yield is small to moderate. One such area is in the southwest part of Unit B located mostly in T9S/R22E where several low yielding wells are found. Here the aquifer is comprises of basalt innerbedded with substantial amounts of fine sediment. Some of the basalt in the upper part of the aquifer also contains fine sediment that reduces the permeability. The deeper basalt is relatively free of sediment, but must be thick, massive, and dense with a low permeability because water yield remains low despite more than 100 feet of exposed basalt aquifer in some wells."

Analysis of Well Logs

Records are available for a large number of wells in the general vicinity of the A&B Irrigation District. The two primary sources were used for analyze information on area wells: 1) the website for the IDWR and 2) the FTP posting of A&B Irrigation District information on the website of the IDWR. Idaho well driller reports on the IDWR website are filed by legal description (township, range and section) and include geologic information, well completion information and in some cases well yield information. The IDWR website also includes records of wells provide by the USBR. Information on these wells is similar to that provided on Idaho well driller reports except that well completion information (casing and screened intervals) is often missing but surveyed well information is often available. A legal description is provided in addition to a well number created for project wells. For example, project well 20A922 is located in section 20 of township 9 south and range 22 east. The focus of the well log analysis was on wells constructed as part of the Northside Pumping Division of the Minidoka Project.

The geologic descriptions for the project wells (identified as USBR or A&B Irrigation District) often are more detailed than for the private wells.

Hydrogeologic information on the project wells is summarized in Tables 1 and 2. The table is a compilation of information from the IDWR well log files and the A&B Irrigation District files available on the FTP portion of the IDWR website. An attempt was made to eliminate duplications in listing of project wells. This task was difficult because multiple logs are available for the wells that have been cleaned out or deepened. In some cases, information is given for deepening of a well for which the original log could not be found.

Explanations of the columns on Table 1 are given below.

- The well location is given in terms of township, range and section number. The location within the section is given as quarter section and then quarter-quarter section with the notation of A, B, C and D for the northeast, northwest, southwest and southeast quarters. Thus, well 7S 23E 34DC is located in the southwest quarter of the southeast quarter of section 34 in township 7 south and range 23 east.
- The owner is listed either as the U.S. Bureau of Reclamation (USBR) or the A&B Irrigation District (A&B).
- The next columns provide information on the well depth, land surface elevation and static depth to water at the time the well was drilled. Blanks in the table show that specific information either was not on the log or in some cases was not readable. A number of the wells have been deepened since they were originally drilled. The depth given in Table 1 is the greatest depth based on the source documents. Surveyed land surface elevations are given to tenths or hundredths of a foot on the individual USBR logs. Comparison of the 1950's surveyed elevations with topographic maps and an A&B Irrigation District summary table from the FTP site revealed an approximate 50-foot datum correction was needed. All of the surveyed elevations from the USBR logs were corrected by subtracting 50 feet. Approximate elevations (rounded to nearest foot) were given for a few wells. No elevation information is available for some of the wells.
- The geologic information of most significance is the presence of fine-grained sedimentary interbeds within the Quaternary basalt below the water table. Sedimentary interbeds were so classified if descriptive terms such as clay or clay and sand were provided on the logs. Professional judgment was used to differentiate between weathering along a basalt flow contact zone (sometimes noted as yellow clay and basalt) and the presence of unconsolidated sediments deposited between basalt placement events. Logically, the aquifer is less productive in those areas where fine-grained sediments make up much of the saturated thickness as compared to areas where the interval below the water table almost all Quaternary basalt. The geologic information on Table 1 is presented in terms of the depth intervals of identified sedimentary interbeds penetrated by the well below the water table at the time of well construction. Wells for which no geologic information is given (such as well 7S 23E 34CD) penetrated only basalt below the water level. Some of the wells in the southern portion of the project

area have as many as four sedimentary interbeds identified below the water table at the time of drilling.

Table 2 presents information on the sedimentary interbeds in terms of elevation above sea level rather than depth below land surface. Interbed elevation data are presented only for those wells where land-surface elevation data are available and sedimentary interbeds were penetrated below the water level. Information presented in Table 2 allows analysis of the lateral continuity of sedimentary interbeds within the saturated subsurface. The elevations of the bottom of wells are also given in Table 2. Many of the wells do not penetrate interbeds identified using information from deeper wells.

Information from Tables 1 and 2 can be used to document the presence or absence of sedimentary interbeds within the sequence of basalt flows penetrated by the project wells. The following is a description of the subsurface geology in various portions of the project area based on an analysis of data on Tables 1 and 2.

- Neither of the two project wells in section 34 of T7S R23E penetrate sedimentary interbeds to a bottom-hole elevation of about 3,965 feet.
- A number of project wells located in sections 30 to 33 of T7S R24E penetrate a clay interbed that is 6 to 12-feet thick generally in the elevation intervals of 3930 to 3,950 feet in sections 30 and 31 and between 3,970and 4,020 feet in sections 32 and 33. A well in section 32 penetrates about 80 feet into the basalt that underlies the interbed.
- A well in section 27 of T7S R25E penetrates a 28-foot sedimentary interbed in the depth range of 4,055 to 4,083 feet.
- The remaining wells in T7S R24E and T7S R25E do not penetrate an identified sedimentary interbed to the depths drilled.
- One of the six project wells constructed in T8S R21E penetrates a sedimentary interbed greater than six feet in thickness. The bottom 13 feet of a 420-foot well in section 24 was identified as clay (elevation interval of 3,779 to 3,792 feet). No other project wells are in this section. A 587-foot well in section 26 did not penetrate sediments in the same depth interval.
- The majority of the wells in the northern half of T8S R23E do not penetrate a sedimentary interbed to the drilled depths. The bottom elevation of the deepest well is about 3,960 feet.
- Wells in section 23, 24 and 25 of T8S R23E intercept thin (less than 10 feet thick) sedimentary interbed, mostly in the depth range of about 3,990 to 4,020 feet. The deepest well in section 24 penetrates about 77 feet of basalt below the sedimentary interbed.
- Two wells (one in section 27 and one in section 28 of T8S R23E) penetrate a slightly thicker (about 20 feet) interbed in the elevation range of 3,940 to 3,960 feet). The deeper of the two wells penetrates basalt to a depth of about 70 feet below the bottom of the interbed.

- One well in section 34 and four wells in section 35 ofT8S R23E penetrate an interbed. The variation in the thickness (4 to 27 feet) and elevation (4,034 to 4,069 feet) of the unit make it questionable whether there is a single sedimentary layer or several laterally discontinuous layers. One of the wells in section 35 penetrated about 80 feet of basalt below the potential interbed.
- Most of the wells in the northern half of T8S R24E do not penetrate a sedimentary interbed to the drilled depths.
- Two wells in section 20 ofT8S R24E penetrate multiple sedimentary layers below an elevation of about 3,990 feet. About 60 percent of the drilled section below this elevation is composed of sediment with basalt making up the remainder. Two wells are of similar depth are present in section 21 of T8S R24E. One well has two interbeds approximately in the same elevation range as the section 20 wells. The geologic log for the second section 21 well does not show the presence of sedimentary interbeds.
- The project well in section 33 of T8S R24E penetrates a seven-foot thick interbed in the elevation range of 3,966 to 3,973 feet. The well was drilled about five feet into basalt below the interbed.
- Three of the four project wells in section 3 of T8S R25E penetrate two sedimentary interbeds. The higher interbed ranges in thickness from 5 to 8 feet and in elevation from 4,012 to 4,040 feet. The lower interbed ranges in thickness from 3 to 8 feet and in elevation from 3,954 to 3,973 feet. The deepest of the wells penetrates about 40 feet of basalt below the interbed.
- The only two of the remaining project wells in T8S R25E penetrate sedimentary interbeds below the water table. Both of these zones are thin.
- Deeper wells have been drilled in the southwestern portion of the A&B Irrigation District area (T9S R21E). A 700-foot well in section 3 penetrates two sedimentary interbeds below the water table (depth ranges of 447 to 460 feet and 435 to 545 feet – elevation ranges of 3,738 to 3,751 feet and 3,653 to 3,633 feet). About 155 feet of basalt was penetrated below the lower interbed. A 587-foot deep well in section 1 penetrates sediments in the elevation intervals of 3,693 to 3,698 feet and 3,653 to 3,678 feet.
- Wells in sections 9 and 10 of T9S R22E penetrate multiple sedimentary interbeds. About 50 percent of the saturated thickness (water level elevation minus the bottom hole elevation) is composed of sediment in a well in section 9. About 38 percent of the saturated thickness of a well in section 10 is composed of sediment. The depths of these two wells are 415 and 429 feet.
- The 494-foot well in section 11 of T9S R22E penetrated a single interbed about 180 feet thick at the bottom of the well in the elevation range of 3,668 to 3,847 feet. The geologic log shows blue clay for the entire thickness.
- The 700-foot well in section 20 of T9S R22E penetrates a 54-foot thick interbed in the elevation range of 3,783 to 3,837 feet with sand underlain by clay. Thin

sedimentary interbeds (<15 feet) were also penetrated both higher and lower in the well.

- A 1,000-foot well in section 22 of T9S R22E penetrates a 199-foot thick interbed in the elevation range of 3,703 to 3,902 feet and a 55-foot interbed in the elevation range of 3,521 to 3,576 feet with several additional thin sedimentary units.
- Several wells in section 33 of T9S R22E show sediments in the general elevation interval of about 3,870 to 3,920 feet.
- A 340-foot well in section 3 of T9S R23E penetrated three interbeds greater than 20-feet thick (elevation ranges of 3,974 to 4,002 feet, 3875 to 3897 feet and 3,843 to 3865 feet). About 45 percent of the geologic section between the elevations of 3,843 to 4,002 feet is composed of sediment.
- The 646-foot well in section 2 of T10S R21E has only two thin sedimentary interbeds in the geologic section below the water table (elevation ranges of 3,928 to 3,940 feet and 3,591 to 3,597 feet). The remainder of the material penetrated is basalt.

The geologic data from wells supports the general geologic description presented by Crosthwaite and Scott (1956). The percentage of sedimentary interbeds in the subsurface below the water table increases to the south with thicker and more laterally extensive clay units. The number and thickness of clay units interbedded with the basalt below the water table in the northern portion of the project area are small.

Aquifer Characteristics

The Quaternary basalt near the center of the Snake Plain generally is considered to host a single, unconfined aquifer. Water producing zones within the Quaternary basalt occur at flow contacts which are present at depth intervals of about 15 to 20 feet. The average hydraulic conductivity of the basalt is extremely high. The inter-fingering of Quaternary basalt flows with fine-grained sedimentary in the general vicinity of the A&B Irrigation District creates a subsurface environment composed of multiple aquifers and confining units (aquitards).

The A&B Irrigation District is located the south-central portion of the Snake River Plain aquifer. Contours of Fall 2001 water-level elevation data from Cosgrove and others (2006) for this portion of the aquifer are shown on Figure 5. There is a considerable distance between the 4,050 and 4,100-foot contours on the map in the general vicinity of the A&B Irrigation District, indicating a low hydraulic gradient. Also, the 4,100-foot contour appears to follow along the Snake River in the vicinity of below and midway through Lake Walcott.

Cosgrove and others (2006, pages 14 and 16) describe the general water budget for the Snake Plain aquifer and the corresponding temporal changes in ground-water levels and aquifer discharge.

> "The Snake River Plain aquifer is recharged by irrigation percolation; canal stream and river losses; subsurface flow from tributary valleys; and precipitation directly on the plain. The aquifer discharges to the Snake River, springs along the

Snake River and to ground-water pumping, primarily for irrigation...Historically, aquifer water levels and corresponding discharges to the Snake River rose significantly at the onset of surface water irrigation... Aquifer water levels peaked around 1950 and have been declining since that time. The declines are attributed to the onset of ground-water irrigation, more efficient surface water irrigation practices such as conversion to sprinkler irrigation and canal lining, and the recent seven years of drought."

Water-level data are available from observation wells operated by the U.S. Geological Survey located across the Snake Plain aquifer. Figure 6 shows the locations of three observation wells located near the A&B Irrigation District. The hydrographs for the three observation wells, presented in Figures 7, 8 and 9, show an overall downward water-level trend with highs and lows reflecting changing climatic conditions. The long-term rate of water-level decline is about 0.5 to 0.6 feet per year.

DESCRIPTION OF PROJECT PRODUCTION WELLS

Production Well Information

The majority of the project production wells were constructed by the USBR in the 1950's with some wells deepened and a few additional wells drilled later with ownership noted as the A&B Irrigation District. The U.S. Bureau of Reclamation (1985, page 28) describes the construction of the wells as follows.

"Since construction of the pumping division in the 1950's, well construction methods have changed, especially construction specifications written by Reclamation planners. The original 177 project production wells were drilled by drilling contractors using cable drills, and were completed using the usual completion methods at that time. Drilling was continued below the water table until the drill cuttings were "lost", which was apparently an indication of good yield. Construction completion usually consisted of installing surface casing with the balance of the well left "open hole". When caving conditions were encountered during the drilling, a casing liner was installed, generally just through the caving interval. The liner would be perforated when the caving interval was located within the "good" aquifer section of the well. After the well was completed, a pump test was run to determine the yield. If the yield was insufficient, the well would be deepened in hopes of encountering additional water.

These methods were workable, but generally did not allow for much lowering of the pump if the water level declined. The project was begun about the water level peak period and was completed during a water level decline period. More than one-half of the wells had less than 100 feet of saturated well bore; therefore, as the water levels declined, drawdown increased, the thickness of the saturated well bore thinned, and yield decreased. Deepening of many of the wells was undertaken before the project was completed. About one-half of the wells have been deepened to date (1984) and about one-half of the wells still have less than 100 feet of exposed aquifer" (page 28).

The same report provides guidance with respect to how new project wells should be drilled.

> "Well construction should consist of drilling a hole of adequate diameter to the minimal total depth. The total depth can vary somewhat depending upon where the drill site is selected in each tract. The total depth is determined by selecting a depth where the pump can be placed allowing the pumped water level to remain at least 5 feet above the pump bowls after subtracting out drawdown from pumping and natural fluctuations of the water table. Below the pump intake, a pump chamber is drilled about 50 feet into the aquifer. The pump chamber is essentially that portion of the well where the pump is placed and must be deep enough to allow room to lower the pump in case of persistent water level declines.... The portion of the well deeper than 50 feet below the pump intake may be reduced in diameter. The reduction should decrease drilling costs and will not materially reduce the intake potential... Casing must be placed in the upper portions of the well to seal out caving zones in the sediment and prevent aquifer pollution form surface waters. The balance of the well can be left open hole, however, for maximum pump protection, casing should be installed throughout the pump chamber" (U.S. Bureau of Reclamation, 1985, page 32).

Information on the A&B Irrigation District production wells is presented in Table 3. The table was taken from FTP files located on the IDWR website. The columns on Table 3 are described below.

- The first two columns provide the USBR well identification number and the township range number as described previously.
- The well diameter at the deepest point in the third column is assumed to represent casing diameter if casing is present or open-hole diameter is no casing is present.
- The third through sixth columns present information on well productivity at the time of construction. The yield rate in cfs (cubic feet per second) is presented along with drawdown (assumed to be at the end of the test). The specific capacity is the pumping rate divided by drawdown with the units of gpm/ft.
- The seventh column provides ground elevation corrected from the original USBR elevations by 49.7 feet.
- The eighth and ninth columns provide the depth to water at the time of drilling and the ground-water elevation at the time of drilled using the corrected land-surface elevation.
- The tenth and eleventh columns provide the initial well depth and the date the well was drilled.
- The twelfth through seventieth columns present information on depths and years individual wells were deepened. Some of the wells have not been deepened while other wells have been deepened as many as three times.
- The eighteenth column provides the most recent well depth.
- The nineteenth column provides to depth to the top of the pump bowl in 1964.

- The twentieth and twenty-first columns present lowest water-level in 2007 and depth to top of pump bowl in 2007. The lowest water-level is represents pumping conditions for most wells.
- The remaining columns provide information on well history including identification of those wells that have been deepened or replaced.

Information presented in Table 3 is reasonably complete for 178 wells. Limited data are presented for nine additional wells. The analysis presented in this section is limited to the 178 wells for which data are reasonably complete. Summary statistics relative to the production wells when they were first drilled are presented below.

- The production wells are, in general, highly productive. The pumped yields during the tests ranged from 1.5 to 10.5 cfs with an average yield of 5.4 cfs (about 2,400 gpm). The reported specific capacity (discharge divided by drawdown) values ranged from 42 gpm/ft to 20,445 gpm/ft with an average of 1,912 gpm/ft.
- The high yields were achieved with only a small portion of the aquifer penetrated by most of the wells. The difference between the bottom of the well and the depth to water is the saturated thickness of the aquifer penetrated by each well. The saturated thickness values range from 27 feet to 403 feet with an average saturated thickness of 91 feet and a median saturated thickness of 72 feet. These numbers include those wells that have been deepened.
- One hundred and nine of the 178 production wells have been deepened at least one time since they were initially constructed. The average depth increase was 58 feet with 12 wells greater than 100 feet and 2 wells greater than 200 feet. Twenty-two wells were deepened a second time with three wells deepened a third time.
- The difference between the lowest water level in 2007 and the top of the pump bowl provide a measure of the available drawdown for each well. This value ranges from 55.1 feet to minus 6.6 feet. Sixteen of the 131 wells for which data are available had pumping water levels below the top of the pump bowls. An additional 36 wells had pumping water levels within 10 feet of the top of the pump bowls.

Water Production Characteristics

Information on the quantity of water pumped from each production well during the period of 1995 through 2007 was provided by A&B Irrigation District and posted on the FTP portion of the IDWR website. Table 4 includes a small portion of the pumping information as an example of the information provided and the format. Pumped amounts (in acre feet) are given per well for combined two month periods for each year (i.e. April-May of 1995). Totals for each well for each year (April through October) are provided. The information provided does not allow identification of the following: 1) instantaneous pumping rates for each well and any changes in the pumping rate with time; 2) pumping periods (hours per day and/or days per month) and how the pumping patterns have changed with time.

The pumping data were analyzed in several ways. The first approach was to calculate the total amount pumped per year from all of the wells to see if there was a temporal pattern for the time period of 1995 through 2007. The average was about 178,000 acre-feet per year with a low value of about 151,000 acre-feet per year in 2005 and a high value of about 207,000 acre-feet per year in 2000 (Figure 10). No pattern was evident that could be correlated to operational problems associated with water-level decline.

An average withdrawal rate for the 13-year time period was calculated for each well (Table 5). The table also summarizes the years during 1995 through 2007 when each well was pumped. A large percentage of the water withdrawal for the A&B Irrigation District is in townships T8S R23E, T8S R24E and T8S R25E. More than two-thirds of the total pumping for the project is derived from wells in these three townships.

The temporal patterns of pumping from selected individual wells were evaluated to assess whether yields are correlated to declining ground-water levels, particularly wells where pumping water levels are at or below the top of the pump bowls. Figure 10 presents annual pumping amounts from nine wells spread though the project area. Also shown on the legend is the height of the pumping water level above the top of the pump bowls in each well in fall 2007. The temporal pattern of annual pumping amounts from wells where the water level was at or below the top of the pump bowls in 2007 is similar to wells where the pumping water level was considerably higher. This may have been accomplished by pumping the wells at lower discharge rates but for longer periods of time. Information on pumping times for individual wells is not included in the files provided for the IDWR FTP website.

Discharge data for individual wells is included in 2007 Annual Pump Report for the A&B Irrigation District which was posted on the FTP portion of the IDWR website. High and low discharge rates are given for five years (2003-2007) with Idaho miner's inch as the discharge unit. One Idaho miner's inch is approximately equal to 9 gpm. The discharge data were compiled and an average discharge rate per well for each township was calculated. These results are presented in Table 6 and plotted on Figures 11A, 11B and 11C. The number of wells per township varies from T8S/R23E with 50 to T10S/R21E with 1 well. The most discernable downward trend in well production is for the three wells in T9SR21E, shown on Figure 11C. The average well yield for most of the townships changed very little over the five-year period.

DISCUSSION OF RESULTS

The historic response within the A&B Irrigation District to water-level declines has been to lower and change pumps within wells and deepen wells as needed. Part of the need for these actions stems from construction of most of the wells in the 1950's when aquifer water levels were at historic highs. A number of the original production wells were constructed less than 50 feet deeper than the water table at the time of drilling.

Four topics are addressed in the discussion of results: 1) hydrogeologic impacts on well production from continued water-level decline; 2) well operational alternatives to deal with continued water-level decline; 3) hydrogeologic limitations on well deepening; and 4) summary of A and B Irrigation District activities.

Hydrogeologic Impacts on Well Production from Continuing Water-Level Decline

Wells constructed in basalt within the Snake Plain Aquifer obtain water from one or more flow contact zones that are penetrated below the water table. The original USBR well logs do not include identification of water producing zones. The last geologic entry on the depth log for many of the wells includes the notation of "lost cuttings". Other wells were terminated when clay was penetrated. Aquifer tests were run on many of the wells with information shown on the well log. The yield and drawdown numbers given represent the sum of water derived from the unique number of flow contact zones penetrated

Water-level decline does not appreciably decrease the transmissivity of the zone penetrated by a given well until the water level drops below one of the flow contact zones that supply water to the well. The effective transmissivity of the aquifer at that well decreases abruptly at that time. This "stair-step" decrease in transmissivity in a basalt aquifer is much different than occurs in an aquifer where the hydraulic conductivity is uniform over depth (such as a thick sand zone). A step decrease in transmissivity results in greater drawdown and reduced well yield. The impacts associated with decreased transmissivity are unique to each well.

Water-level decline decreases the available drawdown (distance from the static water level to the pump setting) in a well. This is not a critical factor if the available drawdown is 100 feet, the water-level decline is 0.5 feet/year and the drawdown at the design pumping rate is 10 feet. However, this becomes a major problem when the maximum available drawdown (lowest possible pump setting) is 20 feet under the same water level and drawdown conditions. The impacts associated with reduced available drawdown are unique to each well.

Water-level decline causes a decreased pumping rate by increasing the total dynamic head against which the pump operates. The relationship between water-level decline and decreased pumping rate is dependent on the head-discharge rating curve for the given pump installed in the well.

Well Operational Alternatives to Deal with Continued Water-Level Decline

The primary approaches for dealing with continued water-level decline are to lower and change pumps, decrease pumping rates and finally deepen wells. Lowering the pump increases the available drawdown and allows well operation at nearly the design pumping rate. Decreased pumping rates results in less drawdown and allows continued operation of the pump. The pump and motor are changed when the total dynamic head has increased to the extent that the desired pumping rate cannot be achieved or the overall efficiency of the pump has decreased to an unacceptable level.

Wells typically are deepened to increase transmissivity and thus yield and also increase the available drawdown by allowing the pump to be set deeper below land surface. Well deepening can be a relatively simple operation if the well is stable (caving conditions are not encountered) and the strings of casing are not involved. Well deepening may not be possible in some circumstances because of casing configurations, well alignment or penetration of unstable formational material. In this case a replacement well may need to be drilled.

The unique construction of each of the project wells controls the ease and success of lowering pumps and deepening wells. Data on the casing configuration for each project well has not been located; thus, a well by well evaluation of problems associated lowering pumps and deepening wells is not possible. It is likely that decisions made in the construction history of individual project wells make lowering pumps and/or deepening wells not possible.

Depth Limitations to the Aquifer

Successful deepening of wells depends on water producing zones (dominantly flow-contact zones in Quaternary basalt) being present in the aquifer in the depth interval below the bottom of the existing well. The dominant hydrogeologic question is whether water-producing zones in the basalt are present in the depth interval (say 100 feet) below the bottom of each existing wells for which deepening is considered. An associated question pertains to determination of the effective bottom of the aquifer within different parts of the project area.

The first step in the analysis of well deepening potential is to examine the subsurface stratigraphy. Water producing zones are not present in most of the sedimentary interbeds because they are composed dominantly of clay. Thus, the presence of a clay interbed that extends hundreds of feet below the present depth of a well makes the probability of successful well deepening very low. Conversely, the presence of basalt (absence of clay interbeds) in the depth interval below the bottom of a well means that there is a reasonable chance that well deepening can be successful.

Geologic information from drilled wells provides information on the presence or absence of sedimentary interbeds (mostly composed of clay) in the sequence of basalt flows. As described previously in the "Analysis of Wells" portion of this report, sedimentary interbeds below the water table are thin and do not appear to be laterally continuous in the northern portion of the project area. In contrast, clay interbeds below the water table are thicker and are penetrated in more wells in the southern portion of the district. Thick clay units that are probably the Burley Lake Beds are present in the southern portion of the district. The potential for successful well deepening is high in the northern portion of the project and relatively low in the southern portion of the project area.

Knowledge of the subsurface geology is available to a greater depth for the southern portion of the district than the northern portion. The four project production wells that have been drilled to depths greater than 600 feet (656, 700, 700 and 1,000 feet) are all located in the southern portion of the project area (9S/21E, 9S/22E and 10S/21E). The 1,000-foot well in section 22 of T9S R22E penetrates a 199-foot thick interbed in the elevation range of 3,703 to 3,902 feet and a 55-foot interbed in the elevation range of 3,521 to 3,576 feet with several additional thin sedimentary units. Only four project production wells have been drilled deeper than 500 feet (510, 510, 516 and 587 feet) in the three townships that include more than two-thirds of the ground-water production in the northern portion of the project (8S/R23E, 8S/24E and 8S/25E). The deepest of these, a 587-foot well in section 26 of T8S R21E, did not penetrate a sedimentary interbed below the water table.

The second step in the analysis of well deepening potential is to ascertain whether water yielding zones in the basalt become more or less frequent with depth and whether they individually yield more or less water. This type of information is needed but has not been located for either within the A&B Irrigation District files or more generally within the literature dealing with the Snake Plain aquifer. The section of the U.S. Bureau of Reclamation (1985a) quoted previously in this report indicates that the basalt penetrated at depth in the southern portion of the project (T9S R22E) has fewer producing zones than the shallow basalt. This type of information is needed for the northern portion of the project area.

Summary of A&B Irrigation District Activities

Previous sections of the report ("Production Well Information" and "Water Production Information") provide summary comments on actions taken by A&B Irrigation District to respond to declining water levels. More than half of the production wells have been deepened. Summary statistics on changes in pumps and motors are not available from the FTP site. Notations on the records for individual wells show that pumps and motors have been changed at a number of wells. Notations on the district map provided on the FTP site indicate that 7 wells have been abandoned and 5 wells replaced. Water-level and pump setting information indicate that 16 of the 131 wells for which data are available had pumping water levels below the top of the pump bowls in 2007; an additional 36 wells had pumping water levels within 10 feet of the top of the pump bowls.

In contrast with the above information, data presented in the "Water Production Characteristics" section of the report indicate that nearly the same group of wells has been used to supply water for the district for the last 12 years. No decrease in the total amount pumped per year from all of the wells was evident that could be correlated to operational problems associated with water-level decline. The average well yield per township has not varied in the last five years for much of the area.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

General aquifer conditions such as water-level elevation and the temporal rate of water-level decline are regional in nature within the service area of the A&B Irrigation District and thus are predictable from well to well. However, each existing A&B production well is unique with respect to well construction characteristics and hydrogeologic conditions (such as water producing zones and water yielding characteristics) penetrated by the well. The specific steps necessary to maintain water production in an environment of long-term water-level decline are thus unique to each production well.

In general, the percentage of sedimentary interbeds in the subsurface below the water table is greater in the southern portion of the project area with thicker and more laterally extensive clay units. The number and thickness of clay units interbedded with the basalt below the water table in the northern portion of the project area are small. The hydrogeologic environment generally correlates with the centers of ground-water pumping for the district. The majority of the ground-water production by the A&B

Irrigation District occurs in northern portion of the project area with about two-thirds in townships T8S R23E, T8S R24E and T8S R25E.

The A&B Irrigation District has responded to issues raises by declining ground-water levels by lowering and replacing pumps and deepening selected project wells. Part of the need for these actions stems from construction of most of the wells in the 1950's when aquifer water levels were at historic highs.

The hydrogeologic environment makes the probability of success in well deepening greater in the northern portion of the project area than in the southern portion of the project area. The primary factor is the greater presence of sedimentary (mostly clay) units interbedded with the basalt in the southern portion of the project area.

Detailed information on the depth frequency and water yielding characteristics of water producing zones has not been compiled for A&B Irrigation District production wells. Compilation of this information, if it exists, is needed is help in development of a more quantitative predictive tool for the costs and effectiveness of well deepening efforts in different portions of the project area.

Recommendations

To the extent possible, additional information should be sought from the A&B Irrigation District relative to each of their production wells. The following is a list of the type of information that is needed.

- Information is needed relative to specific water producing zones and estimated yield amounts of these zones for each production well. This information is needed for the original drilled depth and any succeeding well deepening efforts.
- Additional temporal data on pumping rates are needed for each production well. Well-yield information has been provided to date is in the format of acre feet per two-month period from 1995 through 2007 or in the form of high and low pumping rates for the period of 2003 through 2007. This data base does not allow assessment of changed operational practices relative to pumping rate and pumping period from each well.

Construction of one or more test wells would greatly improve knowledge of the yield characteristics of the Snake Plain Aquifer with dept, particularly h in the northern portion of the A&B Irrigation District. This program should include identification of stratigraphic units and determination of yield characteristics of water producing zones.

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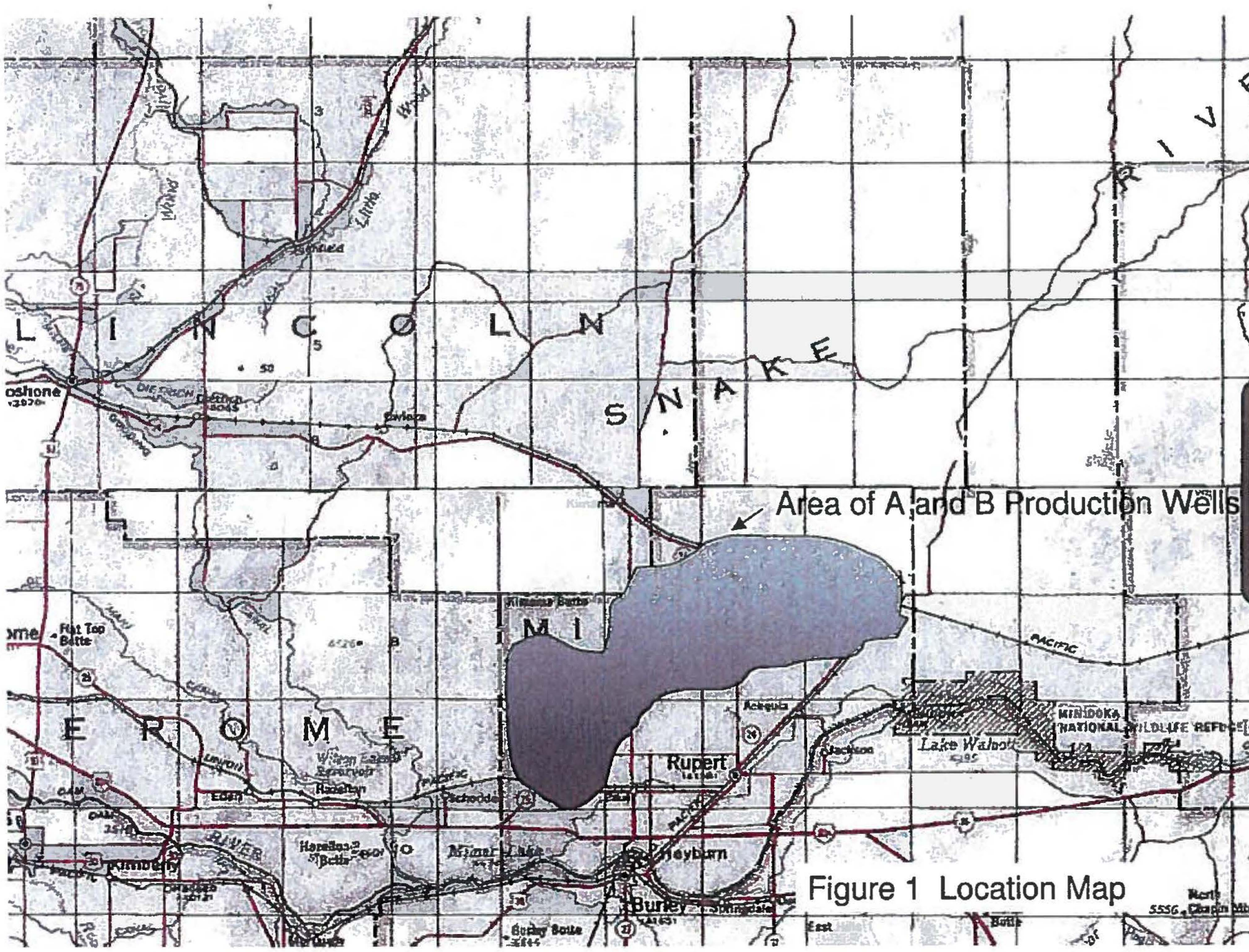


Figure 1 Location Map

EXHIBIT 121A

A&B 1093

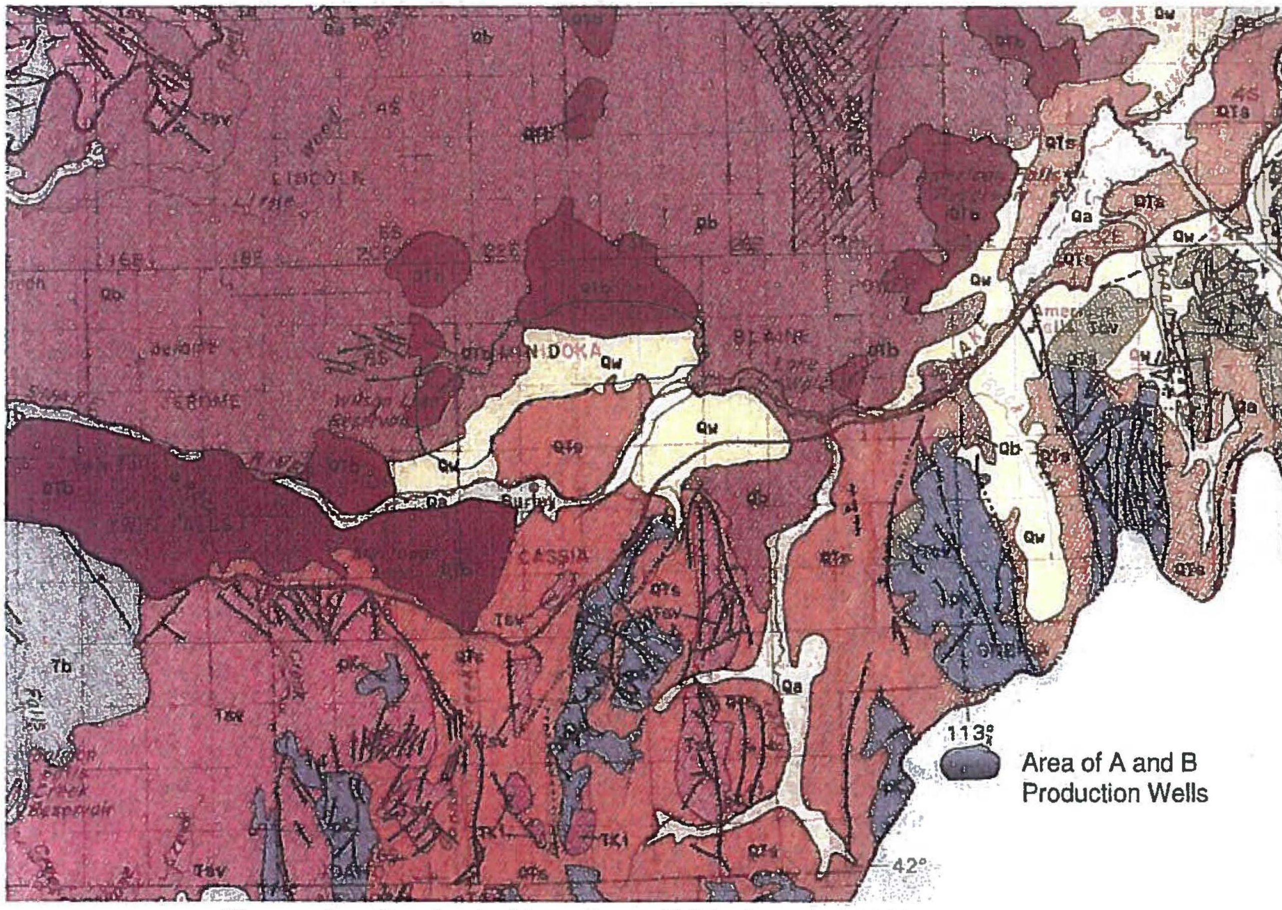


Figure 2a Geologic Map (from Whitehead, 1992)

A&B 1094

EXHIBIT 1218

EXPLANATION AND DESCRIPTION OF MAP UNITS

System	Series	Rock unit and map symbol	Physical characteristics and areal distribution	Water-yielding characteristics	Known thickness (ft)
QUATERNARY	Holocene	Alluvium (Qa)	Chiefly flood-plain deposits. May contain some glacial deposits and colluvium in the uplands. Clay, silt, sand, gravel, and boulders, unconsolidated to well compacted, unstratified to well stratified. Alluvium floors the tributary valleys and flood plains of the main streams and forms fans at mouths of some valleys.	Hydraulic conductivity variable, moderately high in coarse grained deposits. Sandy and gravelly alluvium yields moderate to large quantities of water to wells. Transmissivity ranges from about 16,000 to more than 160,000 ft²/d (Nace and others, 1957, p. 55). Specific capacities commonly range from 20 to 100 (gal/min)/ft. An important aquifer.	<250 (?)
		Windblown deposits (Qw)	Chiefly windblown deposits, include some lake and glacial-flood deposits; mantle much of the lowland areas. Include active sand dunes in places, generally in northern Owyhee County and in northern part of eastern plain.	Generally above the water table	<100 (?)
	Holocene–Pleistocene	Younger basalt ([illegible])	Olivine basalt, dense to vesicular, aphanitic to porphyritic; irregular to columnar jointing; thickness of individual flows variable, but averages about 20-25 ft (Mundorff and others, 1964, p. 143). Includes beds of basaltic cinders, rubbly basalt, and interflow sedimentary rocks. Chiefly basalt of the Snake River Group. Crops out in much of Snake River Plain; mantled in many places with alluvium, terrace gravel, and windblown deposits.	Hydraulic conductivity variable but extremely high in places; formational conductivity high because of jointing and rubbly contacts between numerous flows; rock conductivity low. Unit constitutes the Snake River Plain aquifer east of King Hill (Mundorff and others, 1964, p. 8). Specific capacities of 500-1,000 (gal/min)/ft are common. Transmissivity determined from aquifer tests ranges from about 100,000 to more than 1,000,000 ft²/d in much of the Snake River Plain (Mundorff and others, 1964, p. 159; Nace and others, 1957, p. 55)	>4,000 Includes QTb below
	Pleistocene	Younger silicic volcanic rocks (Qsv)	Rhyolitic ash-flow tuff; occurs as thick flows and blankets of welded tuff with associated fine- to coarse-grained ash and pumice beds. Include rocks of upper part of the Yellowstone Group and Plateau Rhyolite. Mantle much of Yellowstone Plateau in northeastern part of basin.	Hydraulic conductivity generally unknown but may be high as indicated by rapid percolation of surface runoff (Whitehead, 1978, p. 10). Tightly welded in places. Specific capacities range from 2 to 60 (gal/min)/ft. An important aquifer locally.	>3,000
QUATERNARY AND TERTIARY	Pleistocene, Pliocene, and Miocene	Basalt (QTb)	Olivine basalt similar to Qb above. Included as part of the Snake River Plain aquifer. Tentatively assigned to upper part of Idaho Group. Exposures generally have well-developed soil cover.	Hydraulic conductivity slightly lower than Qb above. It decreases with increasing age.	Included with Qb above
		Older alluvium (QTs)	Subaerial and lake deposits of clay, silt, sand, and gravel. Compacted to poorly consolidated; poorly to well stratified; beds somewhat lenticular and intertongued; contains beds of ash and interpolated basalt. Widespread tuffaceous sedimentary rocks and tuff in western part of basin. Includes upper part of Idaho Group and Payette and Salt Lake Formations. In places, underlies the older basalt (Tb).	Hydraulic conductivity highly variable; generally contains water under confined conditions; yields to wells range from a few gallons per minute from clayey beds to several hundred gallons per minute from sand and gravel. Specific capacities range from 5 to 60 (gal/min)/ft. In places, an important aquifer.	>5,500

Figure 2b Geologic Units (from Whitehead, 1992)

EXPLANATION AND DESCRIPTION OF MAP UNITS

Era / Epoch	Rock unit and map symbol	Physical characteristics and areal distribution	Water-yielding characteristics	Known thickness (ft)
TERTIARY — Pliocene and Miocene	Older basalt (Tbo)	Flood type basalt, dense, columnar jointing in many places; folded and faulted (except for the Banbury Basalt), may include some rhyolitic and andesitic rocks; some flows of vesicular olivine basalt (Banbury), interbedded locally with minor amounts of stream and lake deposits. Includes Columbia River Basalt Group or equivalent (Miocene) and the Banbury Basalt of the Idaho Group (Miocene).	Hydraulic conductivity variable, may be high in places. Locally yields small to moderate amounts of water to wells from fractures and faults; some interbedded zones of sand and silt yield good supplies of water under confined or unconfined conditions. Specific capacities range from 3 to 900 (gal/min)/ft. An important aquifer.	>7,000 (The Banbury Basalt is generally <1,000. The older basalt may be >7,000 in the western plain)
TERTIARY — Pliocene to Oligocene	Older silicic volcanic rocks (Tsv)	Rhyolitic, latitic, and andesitic rocks, massive and dense; jointing ranges from platy to columnar; occur as thick flows and blankets of welded tuff with associated fine- to coarse grained ash and pumice beds (commonly reworked by flowing water) and as clay, silt, sand, and gravel; locally folded, tilted, and faulted. Include Idavada Volcanics.	Hydraulic conductivity highly variable. Joints and fault zones in flows and welded tuff and interstices in coarse grained ash, sand, and gravel yield small to moderate, and rarely large, amounts of water to wells. Commonly contain thermal water under confined conditions. Specific capacities range from 1 to >2,000 (gal/min)/ft and are generally <400 (gal/min)/ft. An important aquifer.	>3,000
TERTIARY — Eocene and Paleocene	Volcanic rocks, undifferentiated ([illegible])	Extrusive rocks range in composition from rhyolite to basalt. Include welded tuff, pyroclastic, tuffaceous, and other clastic and sedimentary rocks. Chiefly Challis Volcanics; mainly crop out in mountains and foothills north of the eastern plain, may include some intrusive rocks.	Hydraulic conductivity generally low. Little information available on yields to wells. May be an important aquifer locally for domestic and stock use.	>5,000
TERTIARY AND CRETACEOUS	Sedimentary rocks, undifferentiated (TKs)	Undifferentiated shale, siltstone, sandstone, and freshwater limestone of Tertiary and Cretaceous age. Younger rocks composed chiefly of breccia, conglomerate, and sandstone. Exposed in eastern part of basin. May include a few small outcrops of Jurassic age.	Hydraulic conductivity generally low. Little information available on yields to wells; weathered zones and fractures may yield moderate quantities of water to wells; large yields may be obtained in places. May be an important aquifer locally.	>10,000
TERTIARY AND CRETACEOUS	Intrusive rocks (TKi)	Chiefly granitic rocks of the Idaho batholith, include older and younger crystalline rocks; crop out in a few places south of Snake River in Idaho and northern Nevada.	Hydraulic conductivity generally low. Faults, fractures, and weathered zones may yield small quantities of water to wells. Not an important aquifer.	Unknown
PRE-CRETACEOUS	Pre-Cretaceous rocks, undifferentiated ([illegible])	Well-indurated sedimentary and metamorphic rocks that have been folded, faulted, and intruded by igneous rocks. Crop out in mountainous areas. Include extrusive rocks of Permian and Triassic age in western part of basin. May include Cretaceous or younger sedimentary rocks.	Hydraulic conductivity low. Faults, fractures, and weathered zones may yield small quantities of water to wells. Little information available on yields to wells. Not an important aquifer.	>12,000

Figure 2c Geologic Units (from Whitehead, 1992)

A&B 1096

EXHIBIT 1210

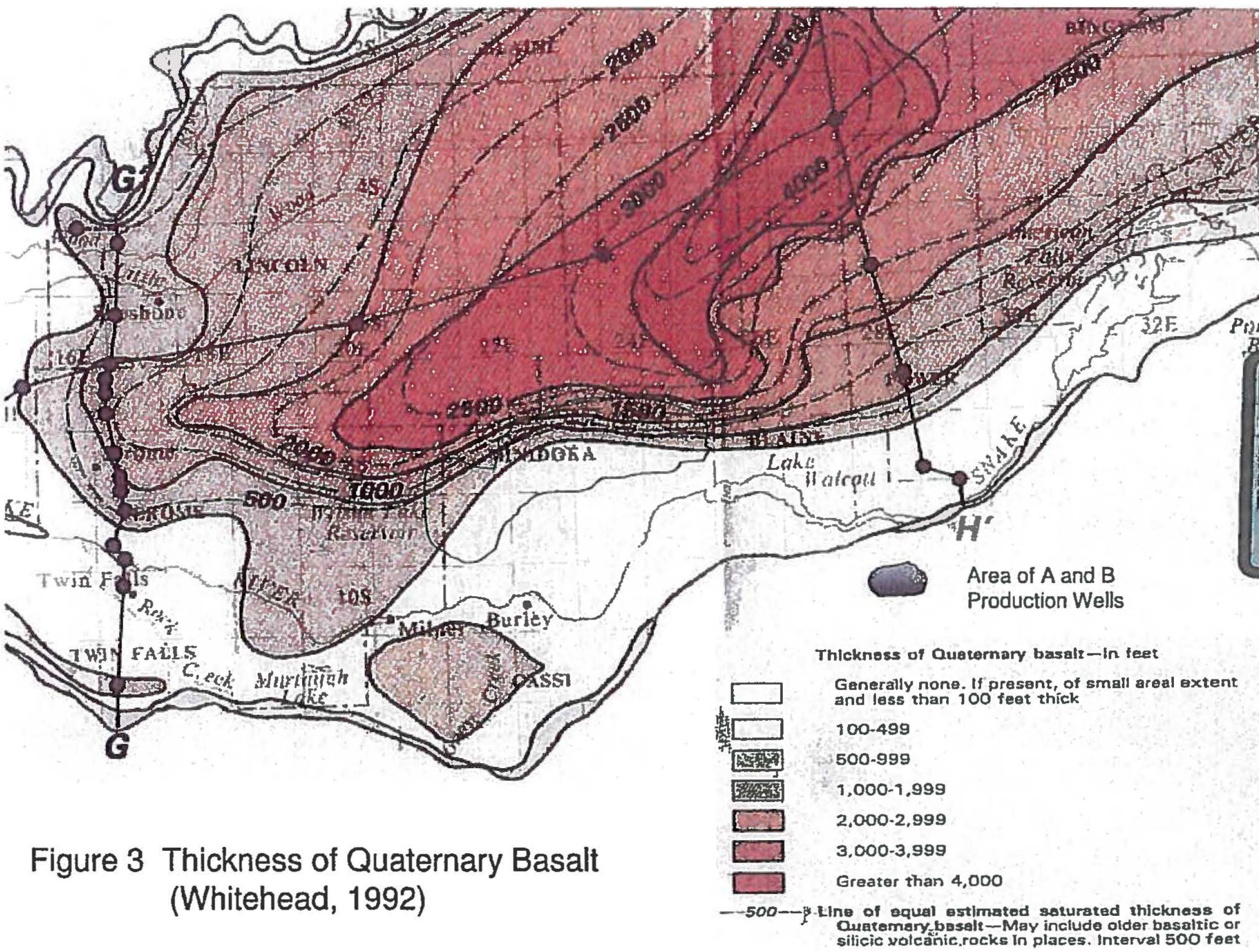


Figure 3 Thickness of Quaternary Basalt (Whitehead, 1992)

A&B 1097

EXHIBIT
121E

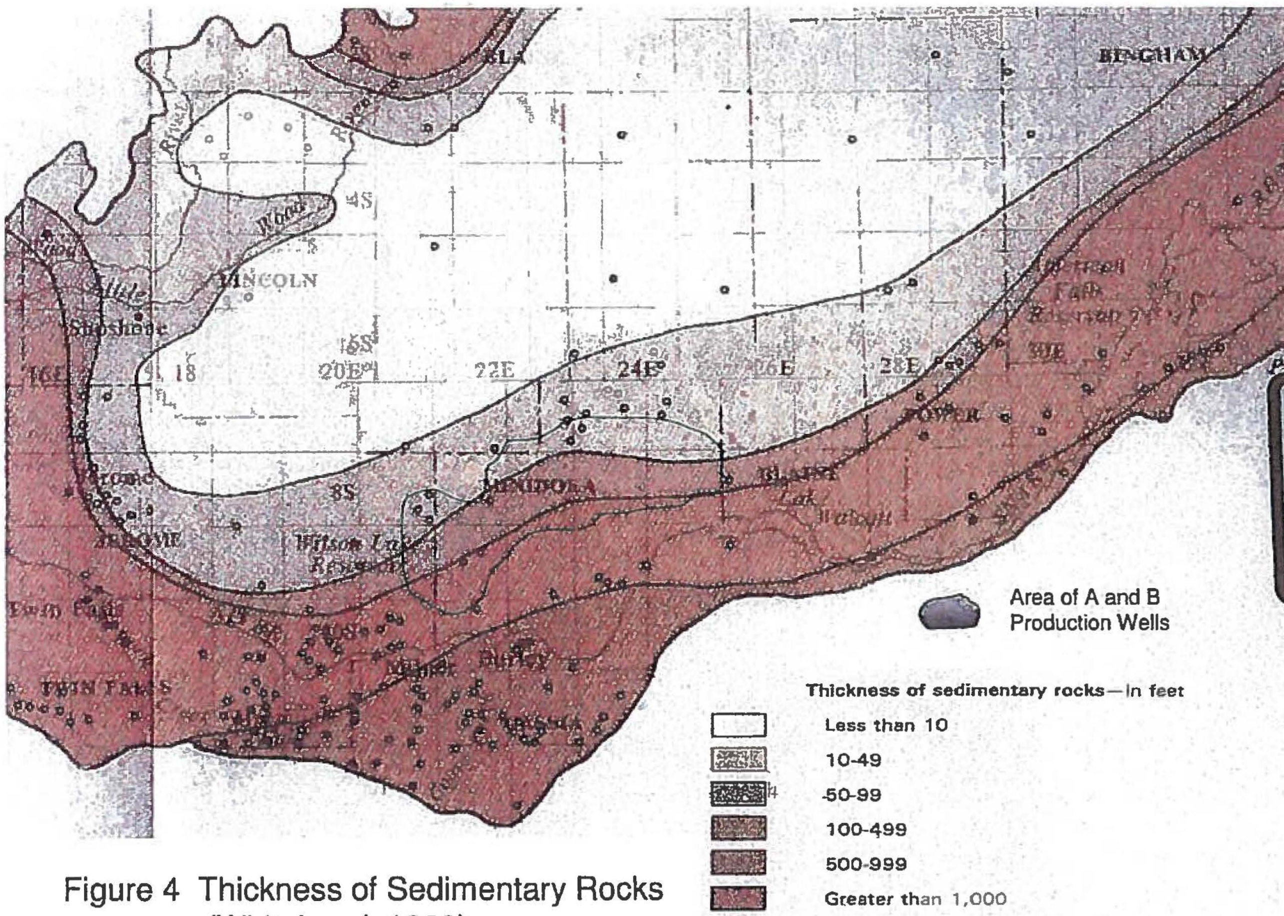


Figure 4 Thickness of Sedimentary Rocks
(Whitehead, 1992)

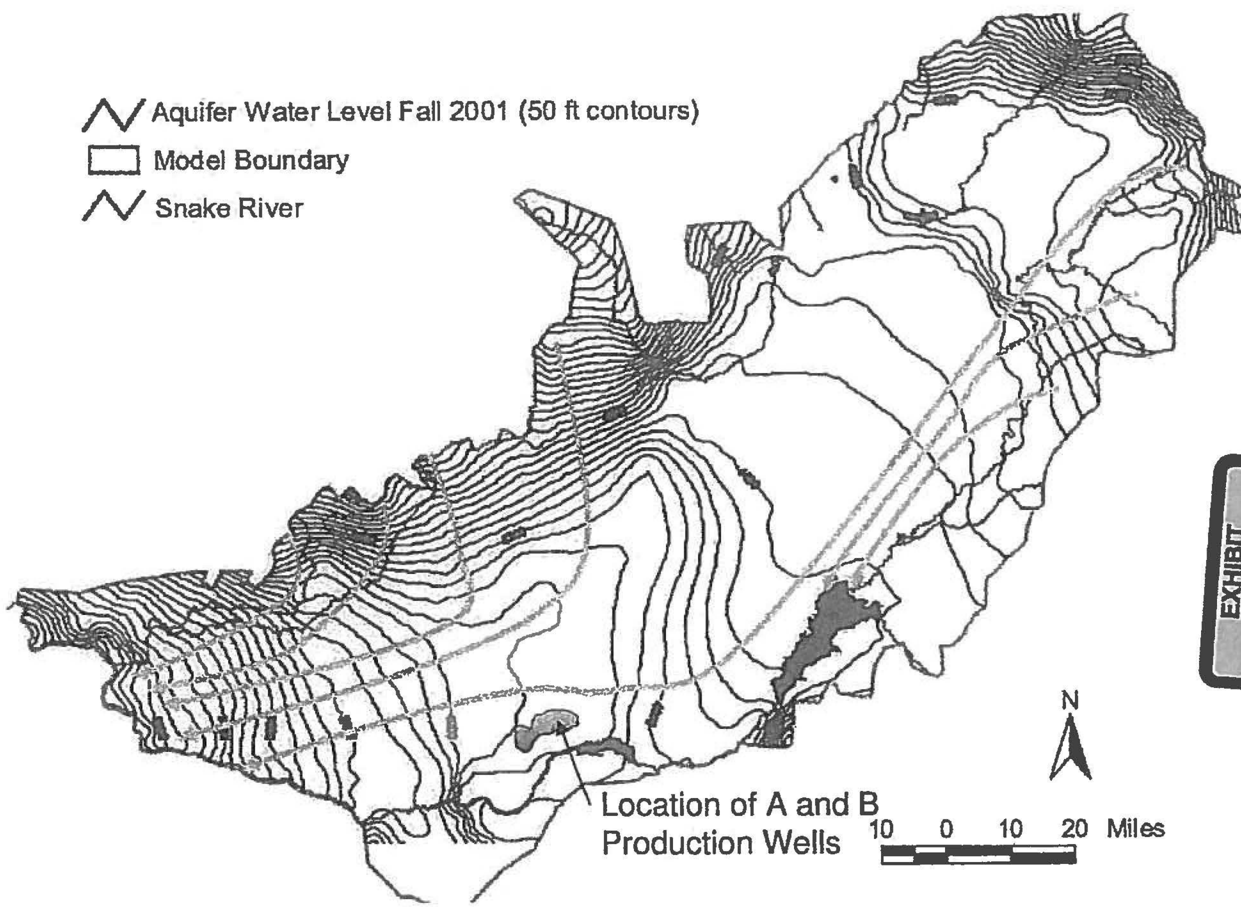


Figure 5 Water-Level Contours (from Cosgrove and others, 2006)

A&B 1099

EXHIBIT 121G

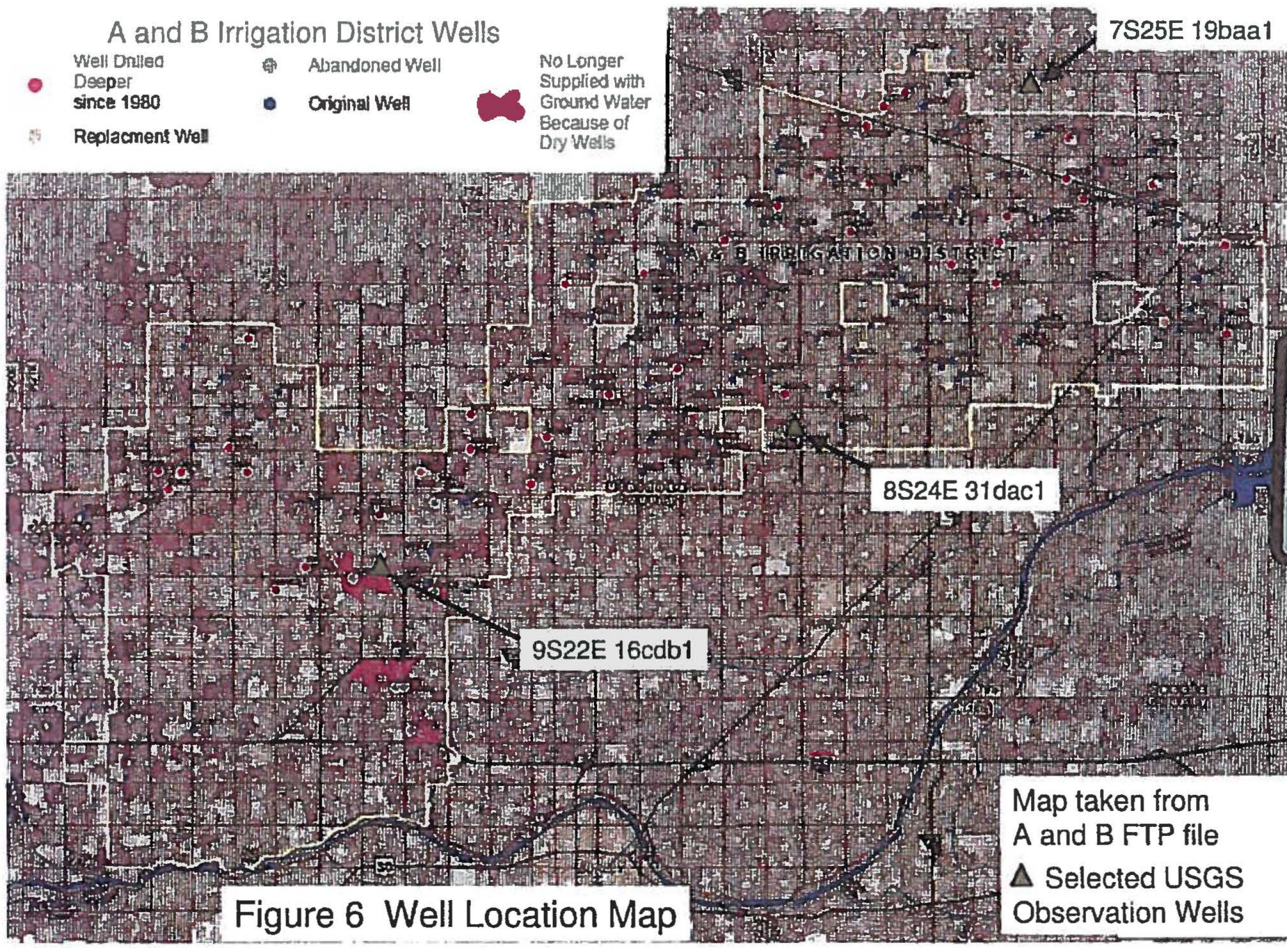


Figure 6 Well Location Map

A&B 1100

EXHIBIT 121H

A&B 1101

Figure 7 Hydrograph for Well 7S25E 19baa1

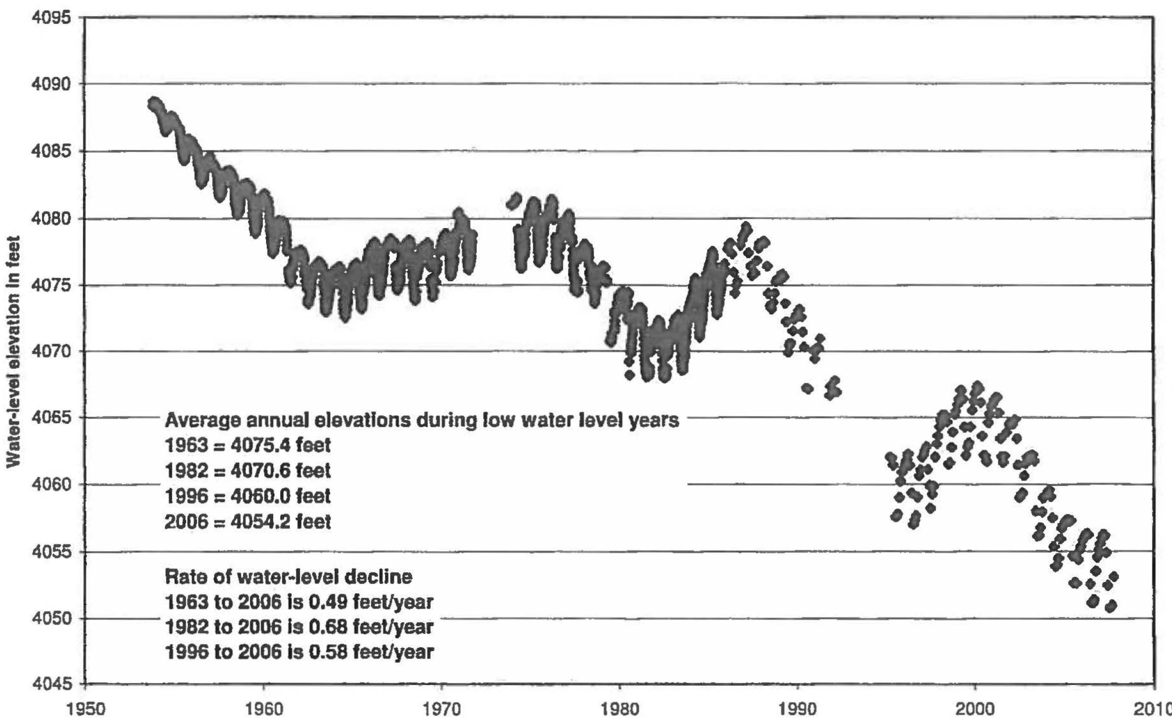


EXHIBIT 121 I

A&B 1102

Figure 8 Hydrograph for Well 8S24E 31dac1

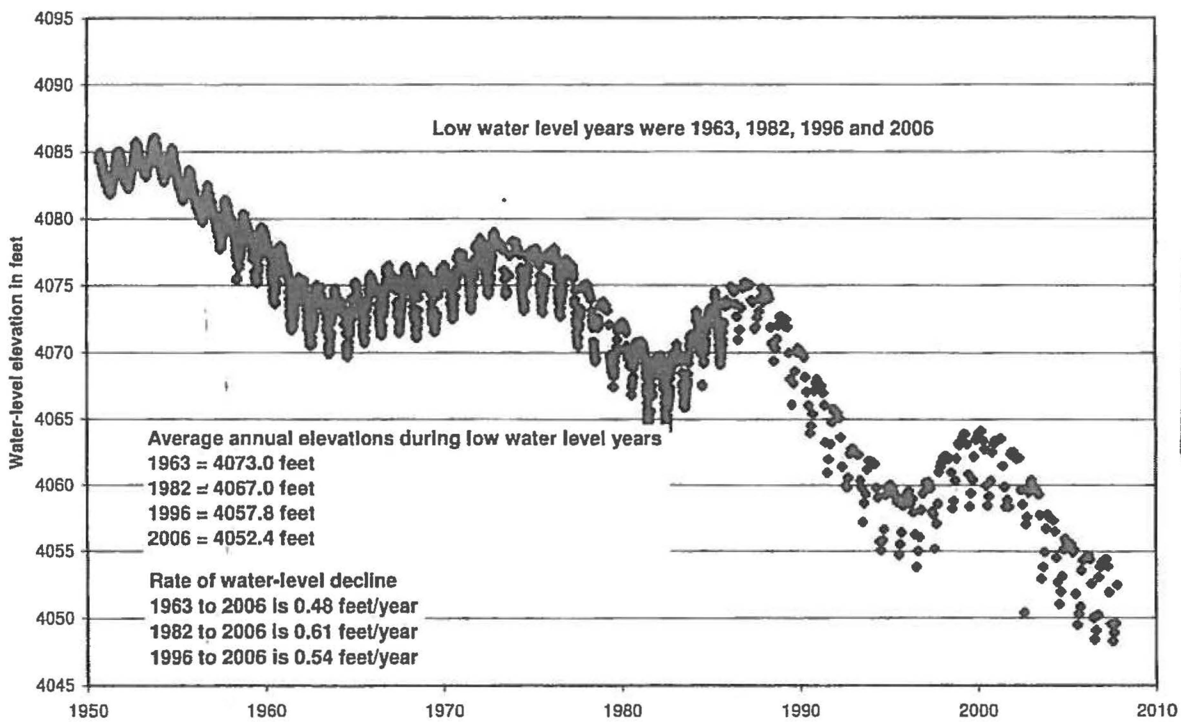


EXHIBIT 1217

Figure 9 Hydrograph for Well 9S 22E 16cdb1

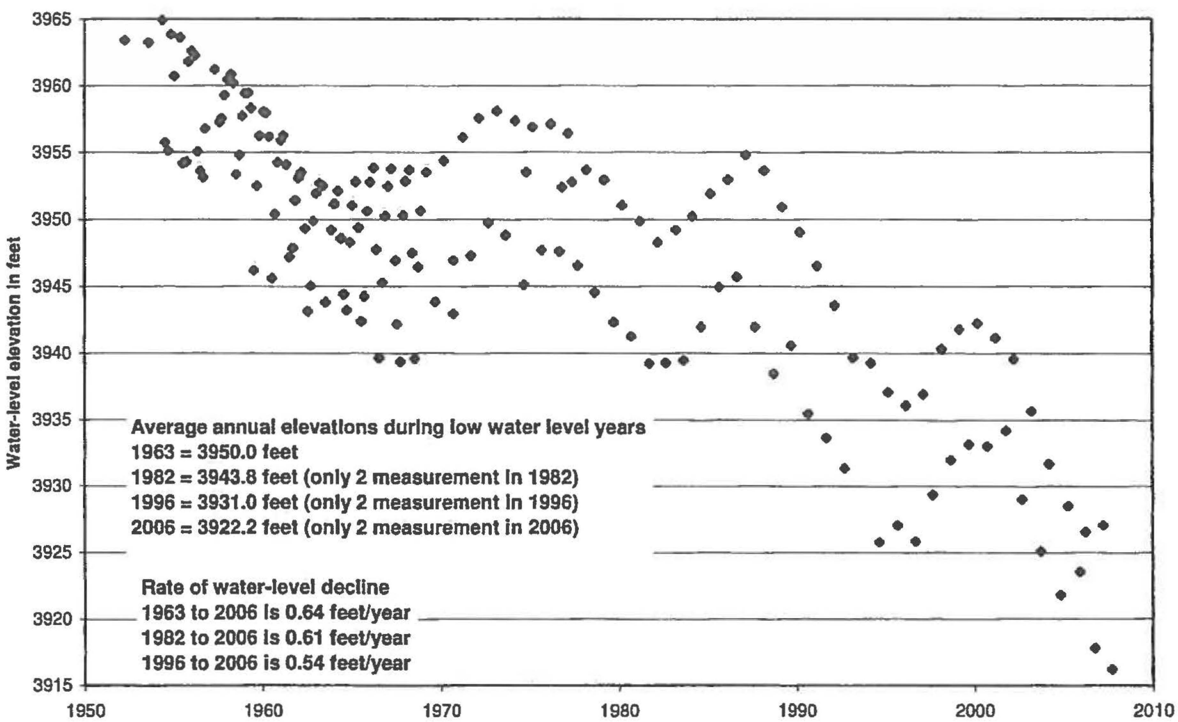
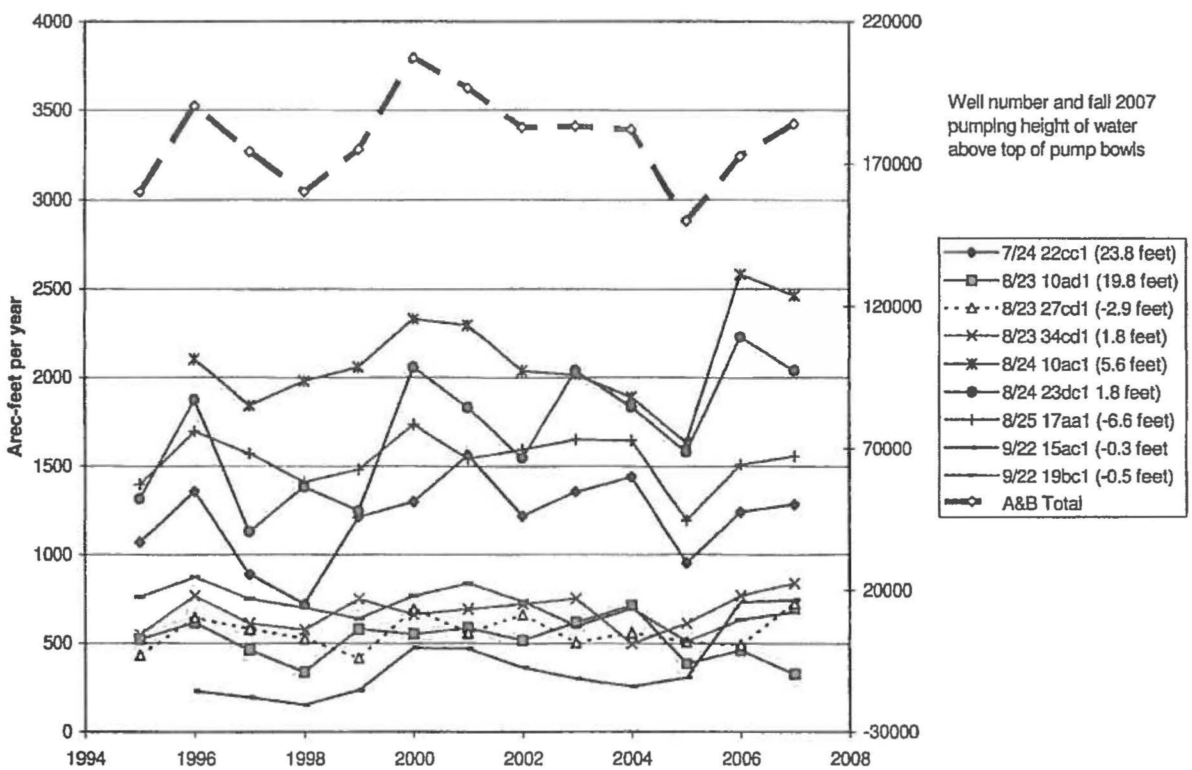


Figure 10 Temporal Pattern of Pumping From Selected Wells



A&B 1104

EXHIBIT 1211

Figure 11A Average High and Low Discharge Rates from Wells in T7S and R23E, R24E and R25E

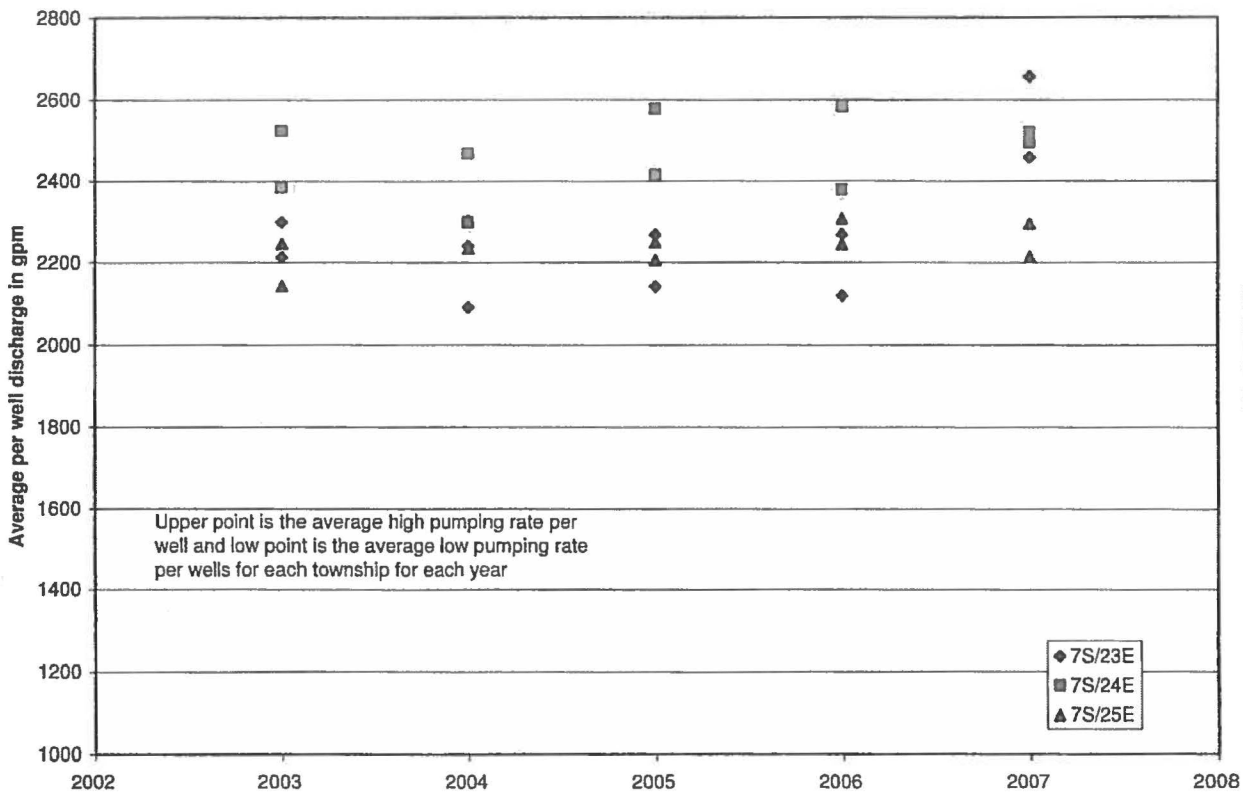
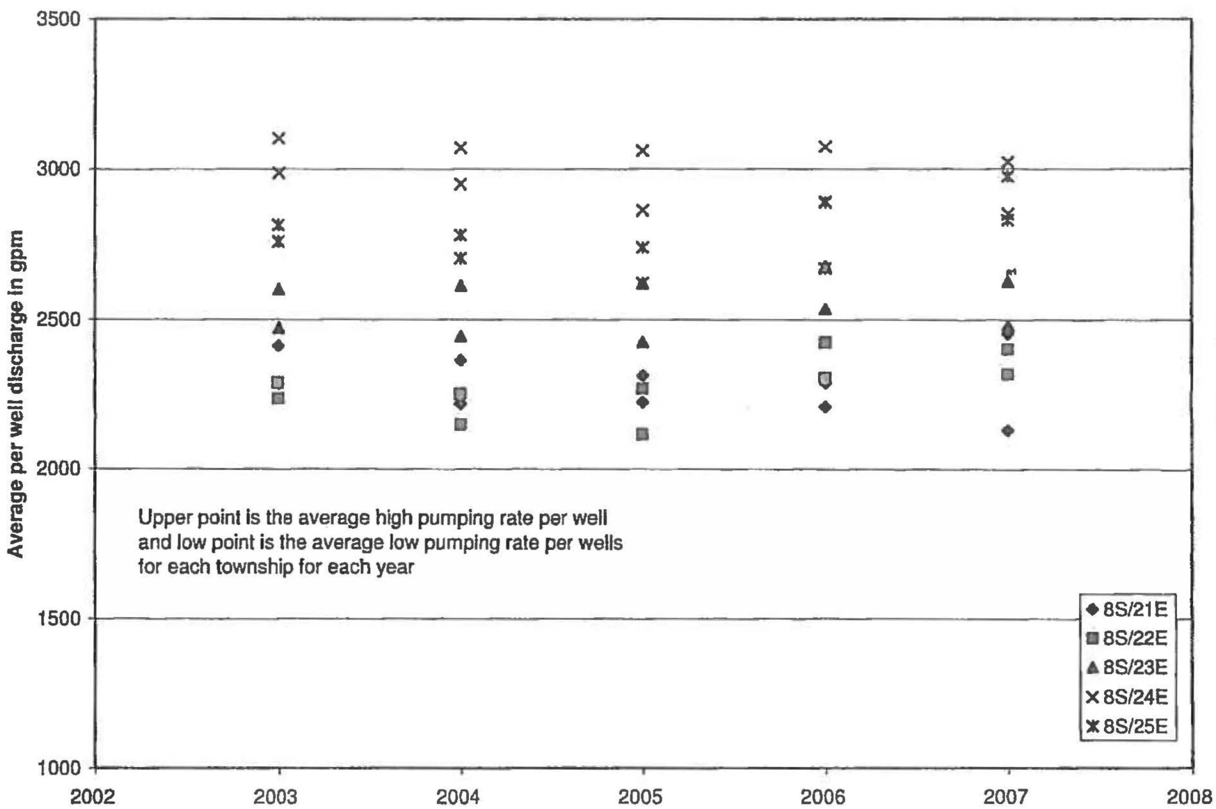


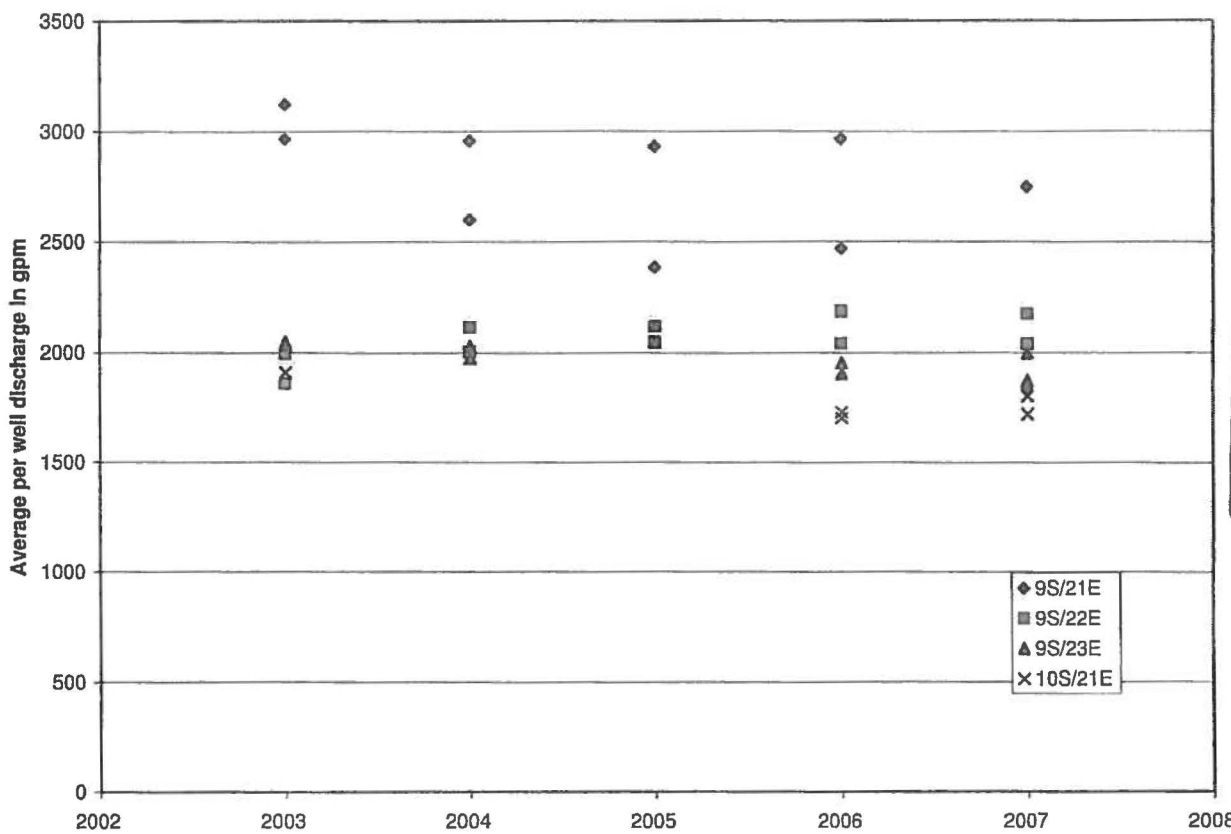
Figure 11B Average High and Low Discharge Rates from Wells in T8S and R21E, R22E, R23E, R24E and R25E



A&B 1106

EXHIBIT 121N

Figure 11C Average High and Low Discharge Rates from Wells in T9S and R21E, R22E and R23E and T10S and R21E



A&B 1107

EXHIBIT 121 "O"

Table 1 Project Wells Depth Data for Interbeds Below the Water Table

Location	Owner	Depth	Land	Depth to	Sediment Depth		Sediment Depth		Sediment Depth		Sediment Depth	
			Elevation	Water	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
7S 23E 34 DC	USBR	321	4288.08	229								
7S 23E 34 CD	USBR	325	4287.55	226								
7S 24E 7 AD	USBR	308	4270.87	188								
7S 24E 22 DB	USBR	318	4284.98	206								
7S 24E 22 DD	USBR	307	4477.48	197	194	205						
7S 24E 22 CC	USBR	352	4290.76	211								
7S 24E 23 AC	USBR	262	4288.01	206								
7S 24E 26 CB	USBR	290	4276.68	193								
7S 24E 28 AC	USBR	351	4274.97	213								
7S 24E 28	USBR	353	4293.17	213								
7S 24E 30 DB	USBR	394	4317.51	247	383	390						
7S 24E 30 DB	USBR	393		246								
7S 24E 31 AD	USBR	363	4305.1	234	356	363						
7S 24E 32 AD	USBR	395	4288.1	210	302	314						
7S 24E 32 BD	USBR	397	4285.1	210	308	314						
7S 24E 33 CB	USBR	282	4284.77	209	272	280						
7S 24E 33 DB	USBR	316	4284.9	203	260	284						
7S 24E 34 BD	USBR	259	4273.2	107								
7S 24E 34 DC	USBR	324	4287.55									
7S 24E 35 DC	USBR	230	4277	189								
7S 24E 35 DC	USBR	229	4477	188								
7S 24E 35 DC	USBR	270										
7S 24E 36 DB	USBR	516	4219.12	280								
7S 25E 19 AA	USBR	284		232								
7S 25E 27 CD	USBR	346	4299.4	208	216	244						
7S 25E 29 DA	USBR	296	4314.13	227								
7S 25E 29 CA	USBR	365	4328.66	241								
7S 25E 30 DA	USBR	296	4314.13	227								
7S 25E 31 DA	USBR	252	4271.6	186								
7S 25E 32 CA	USBR	257	4273.14	184								
7S 25E 33 BC	USBR	301	4294.01	204								
7S 25E 34 CA	USBR	340	4501.01	216								
8S 21E 22 DA	USBR	399	4219.45	307	395	399						
8S 21E 24 BD	USBR	480	4259.32	311	467	480						
8S 21E 26 DA	USBR	587	4249.6	325	280	286						
8S 21E 35 DD	USBR	425	4232.09	320	420	423						
8S 21E 35 DD	USBR	365	4232.09	320								
8S 21E 35 CC	USBR	406	4216.5	312								
8S 22E 30 DB	USBR	516	4219.12	280								
8S 22E 35 DC	USBR	290	4247.24	203	254	290						
8S 22E 35 AB	USBR	350	4280.11	237	290	313						
8S 22E 35 DC	USBR	246	4247.03	203								
8S 23E 1 AB	USBR	371	4302.9	235								
8S 23E 1 AB	USBR	309	4302.81	235								
8S 23E 1 CC	USBR	316		228								
8S 23E 1 C	USBR	369	4302.81	255								

EXHIBIT
121P

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location	Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)
8S 23E 2 CC	USBR	327	4268.05	214	212	220						
8S 23E 4 CC	USBR	368	4290.76	233								
8S 23E 4 CC	USBR	310	4290.37	232								
8S 23E 4 BD	USBR	238		196								
8S 23E 5 CB	USBR	263		224								
8S 23E 5 AD	USBR	333	4296.54	239								
8S 23E 5 AD	USBR	388	4296.98	238								
8S 23E 8 DC	USBR	168										
8S 23E 8 DA	USBR	351	4286.4	232								
8S 23E 10 AC	USBR	227		181								
8S 23E 10 CA	USBR	236		181								
8S 23E 10 DC	USBR	222		178								
8S 23E 10 DA	USBR	255	4267.62	204								
8S 23E 10 DA	USBR	332										
8S 23E 10 CC	USBR	261	4272.48	214								
8S 23E 10 CC	USBR	326										
8S 23E 11 BC	USBR	241		175								
8S 23E 12 CD	USBR	267	4263.25	198								
8S 23E 12 AC	USBR	316	#VALUE!	210								
8S 23E 12 AA	USBR	252		201								
8S 23E 12 CD	USBR	298	4263.01	196								
8S 23E 12 A	USBR	314	4276.66	211								
8S 23E 14 CC	USBR	238		176								
8S 23E 14 DC	USBR	207		163								
8S 23E 14 B	USBR	278	4258.66	198								
8S 23E 15 DD	USBR	287	4251.1	193								
8S 23E 15	USBR	307	4268.16	219	235	245						
8S 23E 15 A	USBR	302	4268.03	209								
8S 23E 17 DD	USBR	278	4253.73	198								
8S 23E 17 DD	USBR	305	4253.89	199								
8S 23E 17 BA	A and B	330		246	325	330						
8S 23E 19 DB	USBR	300	4265.93	216	292	300						
8S 23E 19 DD	USBR	260	4265.93	216								
8S 23E 20 AA	USBR	246		188								
8S 23E 21 CB	USBR	251										
8S 23E 21 AD	USBR	286	4243.91	187								
8S 23E 21 AD	USBR	257		112								
8S 23E 22 BA	USBR	210		175								
8S 23E 22 CA	USBR	201		157								
8S 23E 22 CD	USBR	281	4249.76	192								
8S 23E 22 BC	USBR	228		165								
8S 23E 22 CA	USBR	211		166								
8S 23E 22 DD	USBR	207		173								
8S 23E 23 CB	USBR	300	4255.2	199	289	300						
8S 23E 23 CB	USBR	290	4255.44	195	217	225						

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location	Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)
8S 23E 24 DC	USBR	257	4229.67	146	226	237						
8S 23E 24 BB	USBR	240		146								
8S 23E 24 DC	USBR	315	4229.57	149	226	238						
8S 23E 25 CC	USBR	188		132	159	168						
8S 23E 25 BD	USBR	225	4217.13	151	193	203						
8S 23E 25 AC	USBR	157		113								
8S 23E 25 DD	USBR	192		117								
8S 23E 26 BC	USBR	170										
8S 23E 26 AA	USBR	176		144								
8S 23E 26 DB	USBR	196	4223.29	163								
8S 23E 26 DA	USBR	285		151								
8S 23E 26 CD	USBR	150		57								
8S 23E 26 AA	A and B	280		151								
8S 23E 27 AA	A and B	370		209	285	300						
8S 23E 27 CC	A and B	217		168								
8S 23E 27 DC	USBR	229	4224.77	167								
8S 23E 27 BD	USBR	260	4235	178								
8S 23E 27 AA	USBR	370	4242.9	186	283	300						
8S 23E 28 CC	USBR	261	4237.37	183								
8S 23E 28 CC	USBR	262	4237.74	183								
8S 23E 28 CA	USBR	300	4232.09	176	272	292						
8S 23E 28 BB	USBR	237		170								
8S 23E 28 CD	USBR	230		159								
8S 23E 29 AD	USBR	285	4243.36	189								
8S 23E 29 AD	USBR	249	4243.57	189								
8S 23E 31 DA	USBR	235	4230.01	179								
8S 23E 34 BD	A and B	226										
8S 23E 34 DC	USBR	216		147	187	216						
8S 23E 34 BD	USBR	185		145								
8S 23E 34 AA	USBR	188		156								
8S 23E 34 BB	USBR	204		155								
8S 23E 34 CD	USBR	234	4222.36	145	184	188	221	233				
8S 23E 35 BB	USBR	234	4225.16	144	220	233						
8S 23E 35 DD	USBR	231	4222.5	140	154	171						
8S 23E 35 CC	USBR	298	4223.44	144	189	216						
8S 23E 35 DB	USBR	267	4224.9	143	164	176						
8S 24E 1 AD	USBR	227	4254.19	167								
8S 24E 1 BA	USBR	165		139								
8S 24E 1 AD	A and B	252		198	218	229	249	252				
8S 24E 2 DA	USBR	236	4248.31	165								
8S 24E 3 AA	USBR	340	4270.8	183	187	193						
8S 24E 3 AD	USBR	302	4270.02	184								
8S 24E 4 CD	USBR	304	4268	195								
8S 24E 4 CC	USBR	313	4269	192								
8S 24E 4 AC	USBR	320	4267.6	198	270	283						

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location			Owner	Depth	Land	Depth to	Sediment Depth		Sediment Depth		Sediment Depth		Sediment Depth	
					Elevation	Water	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
				(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
8S	24E	4	A and B			213	328	334						
8S	24E	5 AA	A and B	300		211								
8S	24E	5 AA	USBR	240		203								
8S	24E	5 BA	USBR	240		199								
8S	24E	6 DA	USBR	302	4262.27	197								
8S	24E	6 BA	USBR	339	4290.5	220	290	292						
8S	24E	6 CB	USBR	364	4296.05	229								
8S	24E	6 BA	A and B	290		249								
8S	24E	7 DA	A and B	307		218								
8S	24E	7 DA	USBR	240	4240	168								
8S	24E	7	USBR	285		168								
8S	24E	8 BB	USBR	233		157								
8S	24E	8 AD	USBR	265	4259	178								
8S	24E	9 DC	USBR	191		128								
8S	24E	10	USBR	258	4254.48									
8S	24E	10	USBR	238	4240.7	154								
8S	24E	10 BC	USBR	240	4245		214	225						
8S	24E	11 DB	A and B	415		183	290	293	325	415				
8S	24E	11 BA	USBR	200	4253.9	105	127	141						
8S	24E	11 DB	USBR	195	4245.4	156								
8s	24E	11 B	USBR	246	4253.9	165								
8S	24E	11	USBR	282										
8S	24E	12 AB	USBR	190	4235.1	148								
8S	24E	12 AB	A and B	266		179	267	270						
8S	24E	12 AB	A and B	258										
8S	24E	13 BC	USBR	250	4244.8	155								
8S	24E	13 DC	USBR	246		99								
8S	24E	13 AB	USBR	209	4244.8	154								
8S	24E	14 BA	A and B	210		174								
8S	24E	14 CD	USBR	235	4220.1	131								
8S	24E	14 A	USBR	175	4229.37	140								
8S	24E	15 DD	USBR	300		160								
8S	24E	15	USBR	232	4233.8		178	188						
8S	24E	18 BC	USBR	265	4247.5	182								
8S	24E	20 BC	USBR	366	4216.9	143	225	240	257	302	342	365		
8S	24E	20 BC	USBR	365	4216.9	142	225	248	257	302	342	365		
8S	24E	21 AB	USBR	346	4181	145								
8S	24E	21 B	USBR	155	4204.29	125								
8S	24E	21 CC	USBR	363	4224	140	204	221	333	363				
8S	24E	21 A	USBR	253	4231	145								
8S	24E	22 DA	USBR	246	4221.8	132	167	186						
8S	24E	22 DA	USBR	240	4221.8	132	167	186						
8S	24E	23 BC	USBR	230										
8S	24E	23 DC	USBR	250	4227.1	130	130	140						
8S	24E	24 DB	USBR	257		154	226	237						

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location	Owner	Depth	Land	Depth to	Sediment Depth		Sediment Depth		Sediment Depth		Sediment Depth	
			Elevation	Water	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
		(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
8S 24E 24 BB	USBR	174		83								
8S 24E 24 BA	USBR	191		101								
8S 24E 25 AD	USBR	277		79	182	189						
8S 24E 25 CC	USBR	194										
8S 24E 26 CC	USBR	165		94	118	135						
8S 24E 26 AC	USBR	208	4208.7	117								
8S 24E 27 CC	A and B	220		80	160	172						
8S 24E 27 CB	USBR	165			160	165						
8S 24E 29 C	USBR	234	4204.31	119								
8S 24E 30 DB	USBR	300	4206.26	124								
8S 24E 30 BA	USBR	258	4217.1	146	212	214						
8S 24E 31 CD	USBR	302	4243.44	159	127	173						
8S 24E 31 CD	USBR	270	4243.44	160	128	168						
8S 24E 31 CB	USBR	185		141	106	142						
8S 24E 31 CC	USBR	210	4243.44	160	128	168						
8S 24E 32 CB	USBR	178		87	85	125						
8S 24E 33 BA	USBR	340	4300.93	210	265	270	328	335				
8S 25E 3 BA	USBR	359	4301	208	261	269	327	334				
8S 25E 3 BB	USBR	367	4293.89		275	283	327	348				
8S 25E 3 BB	USBR	381	4494.12	203	275	282	337	340				
8S 25E 3 DA	USBR	340	4300.92	210	265	270	328	335				
8S 25E 5 AA	A and B	410		220								
8S 25E 5 AA	USBR	240	4284.59	198								
8S 25E 5 AA	USBR	280	4284.99	199								
8S 25E 6 DA	USBR	248	4252.43	166								
8S 25E 6 DA	USBR	257	4252.31	167								
8S 25E 6 DA	USBR	237	4262.27	197								
8S 25E 6 CB	USBR	365	4296.05	229								
8S 25E 11 CD	USBR	230	4263.57	172								
8S 25E 12 BB	USBR	275	4279.94	187	255	261	268	272				
8S 25E 12 BB	USBR	275	4280.33	187	255	261	268	272				
8S 25E 12 BB	USBR	295	4279.94	187	256	268						
8S 25E 13 CC	USBR	195	4249.57	157								
8S 25E 14 CA	USBR	257	4255.82	163	253	257						
8S 25E 15 CC	USBR	250	4244.45	153								
8S 25E 15 CC	USBR	271	4244.49	152	256	259						
8S 25E 15 CC	A and B	251		181								
8S 25E 17 AA	USBR	211	4220.57	131								
8S 25E 19 DC	USBR	123		86								
8S 25E 19 AB	USBR	221	4212.4	120								
8S 25E 19 BC	USBR	224	4218.51	127								
8S 25E 19 BC	USBR	222	4218.36	127								
8S 25E 21 CD	USBR	228	4216.11	128								
8S 25E 23 BB	USBR	252	4253.06	160	249	252						
8S 25E 23 BB	USBR	276	4252.77	160	253	276						

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location	Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)
8S 25E 24 BB	USBR	510	4249.32	155	234	246	390	400				
8S 25E 29 BA	USBR	145		83								
9S 21E 1 CA	USBR	587	4240.42	322	542	547	562	577				
9S 21E 3 DB	USBR	401		301	388	401						
9S 21E 3 CB	USBR	437		299	358	387						
9S 21E 3 CD	USBR	317		302								
9S 21E 3 CD	USBR	700	4197.65	302	447	460	535	545				
9S 21E 3 AB	USBR	420		330								
9S 21E 9 AA	USBR	317		292								
9S 22E 3 DD	A and B	350		242	349	350						
9S 22E 3 DD	USBR	327	4236.18	221								
9S 22E 3 AA	A and B	387		272	381	387						
9S 22E 3 AA	A and B	350		267	343	350						
9S 22E 3 DD	USBR	320	4235.78	222								
9S 22E 7 AA	USBR	543	4236.9	275	424	505	535					
9S 22E 7 AD	USBR	358	4238.44	276								
9S 22E 9 DA	A and B	590		258	256	271	301	320	405			
9S 22E 9	A and B	501		243	412	447						
9S 22E 9 CA	USBR	415	4212.56	249	256	271	301	320	405	424	505	535
9S 22E 9 BC	USBR	344	4218.13	250	270	283						
9S 22E 10 CB	USBR	429	4220.7	255	260	296	302	308	372	395		
9S 22E 10 AD	USBR	466	4220.61	210	294	340	455	466				
9S 22E 11 BD	A and B	435		220	425	433						
9S 22E 11 DB	USBR	322	4214.15	202	284	322						
9S 22E 11 DD	USBR	187		137								
9S 22E 11 BA	USBR	420	4212.64	191	308	372						
9S 22E 11 BA	USBR	494	4212	197	315	494						
9S 22E 15 AD	USBR	391	4208.28	236	382	391						
9S 22E 15 AC	USBR	239	4208.1	197	231	239						
9S 22E 18 DC	USBR	310	4201.39	247								
9S 22E 18 DC	USBR	332	4201.29	247								
9S 22E 18 DC	A and B	380										
9S 22E 19 BC	USBR	356		293								
9S 22E 20 AA	USBR	700	4209.21	251	372	426						
9S 22E 22	USBR	576	4207.85	245	309	312	360	503				
9S 22E 22 DC	USBR	456	4209.51	215	366	455						
9S 22E 22 AC	USBR	1000	4208.01	248	306	505	632	687	727	735		
9S 22E 28	USBR	442	4191.73	230	308	347	352	361	389	395		
9S 22E 30 AA	USBR	510	4186.89	236	267	302						
9S 22E 33 AA	A and B	302		245								
9S 22E 33 DA	USBR	463	4198.61	233	278	330						
9S 22E 33 DA	USBR	485	4197.12	239	278	292	306	324	376	382		
9S 23E 2 AC	USBR	247	4223.47	141	175	187						
9S 23E 3 BD	USBR	340	4222.91	167	221	249	326	348	358	380		
9S 23E 3 AA	USBR	285	4214.3	134	194	223						

Table 1 Project Wells Depth Data for Interbeds Below the Water Table (continued)

Location	Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)	Sediment Depth Top (ft)	Sediment Depth Bot. (ft)
9S 23E 6 A	USBR	259	4225.04	174	225	226	242	256				
9S 23E 6 CB	USBR	234	4206.11	158	226	234						
10S 21E 2 CB	USBR	646	4222.11	356	282	294	625	631				
10S 22E 3 CD	USBR	225		213								

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table

Location	Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
23E 34 DC	USBR	321	4288.08	229	3967.08						
23E 34 CD	USBR	325	4287.55	226	3962.55						
24E 7 AD	USBR	308	4270.87	188	3962.87						
24E 22 DB	USBR	318	4284.98	206	3966.98						
24E 22 DD	USBR	307	4477.48	197	4170.48	4283	4272				
24E 22 CC	USBR	352	4290.76	211	3938.76						
24E 23 AC	USBR	262	4288.01	206	4026.01						
24E 26 CB	USBR	290	4276.68	193	3986.68						
24E 28 AC	USBR	351	4274.97	213	3923.97						
24E 28	USBR	353	4293.17	213	3940.17						
24E 30 DB	USBR	394	4317.51	247	3923.51	3935	3928				
24E 30 DB	USBR	393		246							
24E 31 AD	USBR	363	4305.1	234	3942.1	3949	3942				
24E 32 AD	USBR	395	4288.1	210	3893.1	3986	3974				
24E 32 BD	USBR	397	4285.1	210	3888.1	3977	3971				
24E 33 CB	USBR	282	4284.77	209	4002.77	4013	4005				
24E 33 DB	USBR	316	4284.9	203	3968.9	4025	4001				
24E 34 BD	USBR	259	4273.2	107	4014.2						
24E 34 DC	USBR	324	4287.55		3963.55						
24E 35 DC	USBR	230	4277	189	4047						
24E 35 DC	USBR	229	4477	188	4248						
24E 35 DC	USBR	270									
24E 36 DB	USBR	516	4219.12	280	3703.12						
25E 19 AA	USBR	284		232							
25E 27 CD	USBR	346	4299.4	208	3953.4	4083	4055				
25E 29 DA	USBR	296	4314.13	227	4018.13						
25E 29 CA	USBR	365	4328.66	241	3963.66						
25E 30 DA	USBR	296	4314.13	227	4018.13						
25E 31 DA	USBR	252	4271.6	186	4019.6						
25E 32 CA	USBR	257	4273.14	184	4016.14						
25E 33 BC	USBR	301	4294.01	204	3993.01						
25E 34 CA	USBR	340	4501.01	216	4161.01						
21E 22 DA	USBR	399	4219.45	307	3820.45	3824	3820				
21E 24 BD	USBR	480	4259.32	311	3779.32	3792	3779				
21E 26 DA	USBR	587	4249.6	325	3662.6	3970	3964				
21E 35 DD	USBR	425	4232.09	320	3807.09	3812	3809				
21E 35 DD	USBR	365	4232.09	320	3867.09						
21E 35 CC	USBR	406	4216.5	312	3810.5						
22E 30 DB	USBR	516	4219.12	280	3703.12						
22E 35 DC	USBR	290	4247.24	203	3957.24	3993	3957				
22E 35 AB	USBR	350	4280.11	237	3930.11	3990	3967				
22E 35 DC	USBR	246	4247.03	203	4001.03						
23E 1 AB	USBR	371	4302.9	235	3931.9						
23E 1 AB	USBR	309	4302.81	235	3993.81						
23E 1 CC	USBR	316		228							

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
23E	1 C	USBR	369	4302.81	255	3933.81						
23E	2 CC	USBR	327	4268.05	214	3941.05	4056	4048				
23E	4 CC	USBR	368	4290.76	233	3922.76						
23E	4 CC	USBR	310	4290.37	232	3980.37						
23E	4 BD	USBR	238		196							
23E	5 CB	USBR	263		224							
23E	5 AD	USBR	333	4296.54	239	3963.54						
23E	5 AD	USBR	388	4296.98	238	3908.98						
23E	8 DC	USBR	168									
23E	8 DA	USBR	351	4286.4	232	3935.4						
23E	10 AC	USBR	227		181							
23E	10 CA	USBR	236		181							
23E	10 DC	USBR	222		178							
23E	10 DA	USBR	255	4267.62	204	4012.62						
23E	10 DA	USBR	332									
23E	10 CC	USBR	261	4272.48	214	4011.48						
23E	10 CC	USBR	326									
23E	11 BC	USBR	241		175							
23E	12 CD	USBR	267	4263.25	198	3996.25						
23E	12 AC	USBR	316	#VALUE!	210	#VALUE!						
23E	12 AA	USBR	252		201							
23E	12 CD	USBR	298	4263.01	196	3965.01						
23E	12 A	USBR	314	4276.66	211	3962.66						
23E	14 CC	USBR	238		176							
23E	14 DC	USBR	207		163							
23E	14 B	USBR	278	4258.66	198	3980.66						
23E	15 DD	USBR	287	4251.1	193	3964.1						
23E	15	USBR	307	4268.16	219	3961.16	4033	4023				
23E	15 A	USBR	302	4268.03	209	3966.03						
23E	17 DD	USBR	278	4253.73	198	3975.73						
23E	17 DD	USBR	305	4253.89	199	3948.89						
23E	17 BA	A and B	330		246							
23E	19 DB	USBR	300	4265.93	216	3965.93	3974	3966				
23E	19 DD	USBR	260	4265.93	216	4005.93						
23E	20 AA	USBR	246		188							
23E	21 CB	USBR	251									
23E	21 AD	USBR	286	4243.91	187	3957.91						
23E	21 AD	USBR	257		112							
23E	22 BA	USBR	210		175							
23E	22 CA	USBR	201		157							
23E	22 CD	USBR	281	4249.76	192	3968.76						
23E	22 BC	USBR	228		165							
23E	22 CA	USBR	211		166							
23E	22 DD	USBR	207		173							
23E	23 CB	USBR	300	4255.2	199	3955.2	3966	3955				

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
23E	23 CB	USBR	290	4255.44	195	3965.44	4038	4030				
23E	24 DC	USBR	257	4229.67	146	3972.67	4004	3993				
23E	24 BB	USBR	240		146							
23E	24 DC	USBR	315	4229.57	149	3914.57	4004	3992				
23E	25 CC	USBR	188		132							
23E	25 BD	USBR	225	4217.13	151	3992.13	4024	4014				
23E	25 AC	USBR	157		113							
23E	25 DD	USBR	192		117							
23E	26 BC	USBR	170									
23E	26 AA	USBR	176		144							
23E	26 DB	USBR	196	4223.29	163	4027.29						
23E	26 DA	USBR	285		151							
23E	26 CD	USBR	150		57							
23E	26 AA	A and B	280		151							
23E	27 AA	A and B	370		209							
23E	27 CC	A and B	217		168							
23E	27 DC	USBR	229	4224.77	167	3995.77						
23E	27 BD	USBR	260	4235	178	3975						
23E	27 AA	USBR	370	4242.9	186	3872.9	3960	3943				
23E	28 CC	USBR	261	4237.37	183	3976.37						
23E	28 CC	USBR	262	4237.74	183	3975.74						
23E	28 CA	USBR	300	4232.09	176	3932.09	3960	3940				
23E	28 BB	USBR	237		170							
23E	28 CD	USBR	230		159							
23E	29 AD	USBR	285	4243.36	189	3958.36						
23E	29 AD	USBR	249	4243.57	189	3994.57						
23E	31 DA	USBR	235	4230.01	179	3995.01						
23E	34 BD	A and B	226									
23E	34 DC	USBR	216		147							
23E	34 BD	USBR	185		145							
23E	34 AA	USBR	188		156							
23E	34 BB	USBR	204		155							
23E	34 CD	USBR	234	4222.36	145	3988.36	4038	4034	4001	3989		
23E	35 BB	USBR	234	4225.16	144	3991.16	4005	3992				
23E	35 DD	USBR	231	4222.5	140	3991.5	4069	4052				
23E	35 CC	USBR	298	4223.44	144	3925.44	4034	4007				
23E	35 DB	USBR	267	4224.9	143	3957.9	4061	4049				
24E	1 AD	USBR	227	4254.19	167	4027.19						
24E	1 BA	USBR	165		139							
24E	1 AD	A and B	252		198							
24E	2 DA	USBR	236	4248.31	165	4012.31						
24E	3 AA	USBR	340	4270.8	183	3930.8	4084	4078				
24E	3 AD	USBR	302	4270.02	184	3968.02						
24E	4 CD	USBR	304	4268	195	3964						
24E	4 CC	USBR	313	4269	192	3956						

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
24E	4 AC	USBR	320	4267.6	198	3947.6	3998	3985				
24E	4	A and B			213							
24E	5 AA	A and B	300		211							
24E	5 AA	USBR	240		203							
24E	5 BA	USBR	240		199							
24E	6 DA	USBR	302	4262.27	197	3960.27						
24E	6 BA	USBR	339	4290.5	220	3951.5	4001	3999				
24E	6 CB	USBR	364	4296.05	229	3932.05						
24E	6 BA	A and B	290		249							
24E	7 DA	A and B	307		218							
24E	7 DA	USBR	240	4240	168	4000						
24E	7	USBR	285		168							
24E	8 BB	USBR	233		157							
24E	8 AD	USBR	265	4259	178	3994						
24E	9 DC	USBR	191		128							
24E	10	USBR	258	4254.48		3996.48						
24E	10	USBR	238	4240.7	154	4002.7						
24E	10 BC	USBR	240	4245		4005						
24E	11 DB	A and B	415		183							
24E	11 BA	USBR	200	4253.9	105	4053.9	4127	4113				
24E	11 DB	USBR	195	4245.4	156	4050.4						
24E	11 B	USBR	246	4253.9	165	4007.9						
24E	11	USBR	282									
24E	12 AB	USBR	190	4235.1	148	4045.1						
24E	12 AB	A and B	266		179							
24E	12 AB	A and B	258									
24E	13 BC	USBR	250	4244.8	155	3994.8						
24E	13 DC	USBR	246		99							
24E	13 AB	USBR	209	4244.8	154	4035.8						
24E	14 BA	A and B	210		174							
24E	14 CD	USBR	235	4220.1	131	3985.1						
24E	14 A	USBR	175	4229.37	140	4054.37						
24E	15 DD	USBR	300		160							
24E	15	USBR	232	4233.8		4001.8						
24E	18 BC	USBR	265	4247.5	182	3982.5						
24E	20 BC	USBR	366	4216.9	143	3850.9	3992	3977	3960	3915	3875	3852
24E	20 BC	USBR	365	4216.9	142	3851.9	3992	3969	3960	3915	3875	3852
24E	21 AB	USBR	346	4181	145	3835						
24E	21 B	USBR	155	4204.29	125	4049.29						
24E	21 CC	USBR	363	4224	140	3861	4020	4003	3891	3861		
24E	21 A	USBR	253	4231	145	3978						
24E	22 DA	USBR	246	4221.8	132	3975.8	4055	4036				
24E	22 DA	USBR	240	4221.8	132	3981.8	4055	4036				
24E	23 BC	USBR	230									
24E	23 DC	USBR	250	4227.1	130	3977.1	4097	4087				

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
24E	24 DB	USBR	257		154							
24E	24 BB	USBR	174		83							
24E	24 BA	USBR	191		101							
24E	25 AD	USBR	277		79							
24E	25 CC	USBR	194									
24E	26 CC	USBR	165		94							
24E	26 AC	USBR	208	4208.7	117	4000.7						
24E	27 CC	A and B	220		80							
24E	27 CB	USBR	165									
24E	29 C	USBR	234	4204.31	119	3970.31						
24E	30 DB	USBR	300	4206.26	124	3906.26						
24E	30 BA	USBR	258	4217.1	146	3959.1	4005	4003				
24E	31 CD	USBR	302	4243.44	159	3941.44	4116	4070				
24E	31 CD	USBR	270	4243.44	160	3973.44	4115	4075				
24E	31 CB	USBR	185		141							
24E	31 CC	USBR	210	4243.44	160	4033.44	4115	4075				
24E	32 CB	USBR	178		87							
24E	33 BA	USBR	340	4300.93	210	3960.93	4036	4031	3973	3966		
25E	3 BA	USBR	359	4301	208	3942	4040	4032	3974	3967		
25E	3 BB	USBR	367	4293.89		3926.89						
25E	3 BB	USBR	381	4494.12	203	4113.12	4219	4212	4157	4154		
25E	3 DA	USBR	340	4300.92	210	3960.92	4036	4031	3973	3966		
25E	5 AA	A and B	410		220							
25E	5 AA	USBR	240	4284.59	198	4044.59						
25E	5 AA	USBR	280	4284.99	199	4004.99						
25E	6 DA	USBR	248	4252.43	166	4004.43						
25E	6 DA	USBR	257	4252.31	167	3995.31						
25E	6 DA	USBR	237	4262.27	197	4025.27						
25E	6 CB	USBR	365	4296.05	229	3931.05						
25E	11 CD	USBR	230	4263.57	172	4033.57						
25E	12 BB	USBR	275	4279.94	187	4004.94	4025	4019	4012	4008		
25E	12 BB	USBR	275	4280.33	187	4005.33	4025	4019	4012	4008		
25E	12 BB	USBR	295	4279.94	187	3984.94	4024	4012				
25E	13 CC	USBR	195	4249.57	157	4054.57						
25E	14 CA	USBR	257	4255.82	163	3998.82	4003	3999				
25E	15 CC	USBR	250	4244.45	153	3994.45						
25E	15 CC	USBR	271	4244.49	152	3973.49	3988	3985				
25E	15 CC	A and B	251		181							
25E	17 AA	USBR	211	4220.57	131	4009.57						
25E	19 DC	USBR	123		86							
25E	19 AB	USBR	221	4212.4	120	3991.4						
25E	19 BC	USBR	224	4218.51	127	3994.51						
25E	19 BC	USBR	222	4218.36	127	3996.36						
25E	21 CD	USBR	228	4216.11	128	3988.11						
25E	23 BB	USBR	252	4253.06	160	4001.06	4004	4001				

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth (ft)	Land Elevation (ft)	Depth to Water (ft)	Well Bot. Elevation (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)	Sediment Elevation Top (ft)	Sediment Elevation Bot. (ft)
25E	23 BB	USBR	276	4252.77	160	3976.77	4000	3977				
25E	24 BB	USBR	510	4249.32	155	3739.32	4015	4003	3859	3849		
25E	29 BA	USBR	145		83							
21E	1 CA	USBR	587	4240.42	322	3653.42	3698	3693	3678	3663		
21E	3 DB	USBR	401		301							
21E	3 CB	USBR	437		299							
21E	3 CD	USBR	317		302							
21E	3 CD	USBR	700	4197.65	302	3497.65	3751	3738	3663	3653		
21E	3 AB	USBR	420		330							
21E	9 AA	USBR	317		292							
22E	3 DD	A and B	350		242							
22E	3 DD	USBR	327	4236.18	221	3909.18						
22E	3 AA	A and B	387		272							
22E	3 AA	A and B	350		267							
22E	3 DD	USBR	320	4235.78	222	3915.78						
22E	7 AA	USBR	543	4236.9	275	3693.9	3813	3732	3702			
22E	7 AD	USBR	358	4238.44	276	3880.44						
22E	9 DA	A and B	590		258							
22E	9	A and B	501		243							
22E	9 CA	USBR	415	4212.56	249	3797.56	3957	3942	3912	3893	3808	3789
22E	9 BC	USBR	344	4218.13	250	3874.13	3948	3935				
22E	10 CB	USBR	429	4220.7	255	3791.7	3961	3925	3919	3913	3849	3826
22E	10 AD	USBR	466	4220.61	210	3754.61	3927	3881	3766	3755		
22E	11 BD	A and B	435		220							
22E	11 DB	USBR	322	4214.15	202	3892.15	3930	3892				
22E	11 DD	USBR	187		137							
22E	11 BA	USBR	420	4212.64	191	3792.64	3905	3841				
22E	11 BA	USBR	494	4212	197	3718	3897	3718				
22E	15 AD	USBR	391	4208.28	236	3817.28	3826	3817				
22E	15 AC	USBR	239	4208.1	197	3969.1	3977	3969				
22E	18 DC	USBR	310	4201.39	247	3891.39						
22E	18 DC	USBR	332	4201.29	247	3869.29						
22E	18 DC	A and B	380									
22E	19 BC	USBR	356		293							
22E	20 AA	USBR	700	4209.21	251	3509.21	3837	3783				
22E	22	USBR	576	4207.85	245	3631.85	3899	3896	3848	3705		
22E	22 DC	USBR	456	4209.51	215	3753.51	3844	3755				
22E	22 AC	USBR	1000	4208.01	248	3208.01	3902	3703	3576	3521	3481	3473
22E	28	USBR	442	4191.73	230	3749.73	3884	3845	3840	3831	3803	3797
22E	30 AA	USBR	510	4186.89	236	3676.89	3920	3885				
22E	33 AA	A and B	302		245							
22E	33 DA	USBR	463	4198.61	233	3735.61	3921	3869				
22E	33 DA	USBR	485	4197.12	239	3712.12	3919	3905	3891	3873	3821	3815
23E	2 AC	USBR	247	4223.47	141	3976.47	4048	4036				
23E	3 BD	USBR	340	4222.91	167	3882.91	4002	3974	3897	3875	3865	3843

Table 2 Project Wells Elevation Data for Interbeds Below the Water Table (continued)

		Owner	Depth	Land	Depth to	Well Bot.	Sediment Elevation		Sediment Elevation		Sediment Elevation	
				Elevation	Water	Elevation	Top	Bot.	Top	Bot.	Top	Bot.
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
23E	3 AA	USBR	285	4214.3	134	3929.3	4020	3991				
23E	6 A	USBR	259	4225.04	174	3966.04	4000	3999	3983	3969		
23E	6 CB	USBR	234	4206.11	158	3972.11	3980	3972				
21E	2 CB	USBR	646	4222.11	356	3576.11	3940	3928	3597	3591		
22E	3 CD	USBR	225		213							

Table 3 Specifications for A&B Irrigation District Production Wells

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
02A1021	10S/21E2cc1	20	5	32.5	69		336.0		646.0	1960					
03A1022	10S/22E3cb1	16	3.5	3.3	476	4220.7	255.0	3965.7	400.0	1956	429				
34A723	7S/23E34cd2	19	6.6	5.3	559	4288.1	229.3	4058.8	281.3	1955	321	1962			
22B724	7S/24E22cc1	20	6	4	673	4290.8	211.4	4079.4	280.5	1955	352	1983			
24A724	7S/24E22db1	16	2.5	0.7	1603	4285.0	206.0	4079.0	257.5	1956	318	1983			
22C724	7S/24E22dd1	20	5	0.22	10200	4277.5	196.7	4080.8	307.7	1955					
23A724	7S/24E23ac1	20	5.9	2.2	1204	4288.0	206.6	4081.4	262.6	1955	296	1961			
26B724	7S/24E26ac1	16	2.5	0		4270.9	187.7	4083.2	234.6	1956	308	1983			
26A724	7S/24E26cb1	20	6.2	1.5	1855	4276.7	192.9	4083.8	262.8	1955	290	1964			
28B724	7S/24E28ac1	20	3.1	0.5	2783	4293.0	212.7	4080.3	353.5	1955					
28A724	7S/24E28ac2	20	6.2	2.2	1265	4293.2	213.5	4079.7	303.0	1955	351	1984			
30B724	7S/24E30bd1	20	3.9	2	875	4318.8	247.0	4071.8	394.0	1954					
30A724	7S/24E30db2	24				4318.8	246.1	4072.7	393.8	1954					
31A724	7S/24E31ac1	24	4.3	2.6	742	4305.1	234.9	4070.2	363.7	1954					
32B724	7S/24E32ad1	20	3.3	2.7	549	4285.4	210.8	4074.7	250.0	1953	302	1958	397	1963	
32A724	7S/24E32ad2	24	7.7	5.05	684	4285.4	210.8	4074.7	394.8	1953					
33A724	7S/24E33db1	20	6.1	4.5	608	4284.0	207.2	4076.8	284.0	1954	289	1957			
33B724	7S/24E33db2	20	4.3	1.2	1608	4284.8	208.8	4076.0	283.6	1956	316	2004			
34A724	7S/24E34bd1	24	6.9	1.6	1935	4273.2	187.0	4086.2	259.6	1954					
35B724	7S/24E35dc1	20	3.7	0.59	2815	4277.0	189.7	4087.3	230.0	1954	270	1961			
35A724	7S/24E35dc2	24	7.5	0.43	7828	4277.0	189.9	4087.1	229.0	1954	270	1961			
27A725	7S/25E27cd1	16	2	0.35	2565	4299.4	208.3	4091.1	346.4	1956					
29A725	7S/25E29ca1	16	4.4	0.5	3949	4328.7	241.8	4086.9	268.5	1957	323	1960	365	1983	
30A725	7S/25E30da1	24				4314.1	227.0	4087.1	295.9	1957					
31A725	7S/25E31bd1	18	4.2	0		4271.6	186.0	4085.6	222.0	1956	252	1961			
32A725	7S/25E32ca1	12	4.1	1.9	968	4273.1	184.2	4088.9	230.0	1956	257	1962	268	2003	

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (In)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
33A725	7S/25E33bb1	18				4294.0	204.2	4089.8	246.0	1955	301	1961			
34A725	7S/25E34ca1	20				4301.0	216.0	4085.0	279.0	1956	340	1983			
22A821	8S/21E22da1	20	6.2	2.6	1070	4219.5	307.5	3912.0	351.0	1956	399.4	1962			
24A821	8S/21E24bd1	16	1.6	3.4	211	4259.3	311.0	3948.3	400.0	1956	434	1984	480	1992	
26B821	8S/21E26aa1	20	2.8	4.3	292	4249.4	326.8	3922.6	587.8	1955					
26A821	8S/21E26aa2	24	6.3			4249.6	324.9	3924.7	527.0	1956					
35A821	8S/21E35aa1	20	4.7	2.3	917	4213.3	304.0	3909.3	381.0	1956					
35D821	8S/21E35cc1	20	5.8	3.6	723	4216.5	311.9	3904.6	352.0	1956	406.5	1965			
35B821	8S/21E35dd1	19	5.8	4.2	620	4232.1	319.6	3912.5	360.0	1956	425	1982			
35C821	8S/21E35dd2	20	5.8	4.6	566	4232.1	320.0	3912.1	365.0	1956	417	1963			
30A822	8S/22E30cb1	20	3.7	5	332	4239.1	280.1	3959.0	516.0	1956					
35C822	8S/22E35ab1		2.2	2.8	353	4280.1	237.0	4043.1	285.0	1955	350	1983			
35A822	8S/22E35dc1	16	10	3	1496	4247.0	203.5	4043.5	246.0	1955	350	1983			
35B822	8S/22E35dc2	20	5	12.8	175	4247.2	203.5	4043.7	245.0	1955	290	1964			
10A823	8S/23E10ad1	20	3.2	4.6	312	4267.6	204.4	4063.2	255.7	1954	332	1961			
10B823	8S/23E10cc1	20	3.2	1.9	756	4272.5	214.3	4058.2	260.5	1954	326	1983			
12A823	8S/23E12ac1	20	6.5	1.2	2431	4276.5	210.7	4065.9	316.6	1954					
12B823	8S/23E12ac2	20	3.2	0.6	2394	4276.7	210.8	4065.9	314.2	1954					
12C823	8S/23E12cd1	24	7.8	4.05	864	4263.3	197.7	4065.6	267.5	1954	290				
12D823	8S/23E12cd2	20	3.9	3.3	530	4262.0	196.5	4065.5	298.6	1954					
14B823	8S/23E14bb1	20	4.5	6	337	4258.7	198.3	4060.4	278.6	1954					
14A823	8S/23E14bb2	16	9	0.56	7213	4258.5	198.2	4060.4	251.3	1954	296.8	1961			
15A823	8S/23E15ba1	24	10	3.8	1181	4268.2	209.4	4058.8	266.2	1954	307				
15B823	8S/23E15ba2	20	5	6.4	351	4268.0	209.3	4058.7	302.2	1954					
15D823	8S/23E15dd1	20	2.2	3	329	4251.1	193.0	4058.1	258.0	1955	287	1961			
17C823	8S/23E17ba1	12	1.9	1.3	656	4275.6	223.3	4052.3	302.0	1954	330	2003			

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
17A823	8S/23E17dd1	20	5.8	8.2	317	4253.9	198.7	4055.2	270.0	1955	305	1964			
17B823	8S/23E17dd2	16	2.9	2.9	449	4253.7	198.4	4055.3	278.0	1955					
19A823	8S/23E19dc1	20	6.6	6	494	4265.9	215.9	4050.0	282.0	1955	300	1963			
19B823	8S/23E19dc2	20	3.2	0.2	7181	4265.9	213.7	4052.2	259.0	1955	290	1963			
01B823	8S/23E1ab1	20	4.9	6.1	361	4302.9	235.3	4067.6	371.3	1954					
01A823	8S/23E1ab2	24	10	0.8	5610	4302.8	235.1	4067.7	369.4	1954					
01C823	8S/23E1cc1	20	7.4	4.5	738	4268.1	204.9	4063.2	298.9	1954	315.5	2004			
21A823	8S/23E21ad1	24	7.3	2	1638	4253.9	186.8	4067.1	286.0	1955					
22A823	8S/23E22cd1	20	5.9	8.4	315	4249.8	192.2	4057.6	243.0	1955	282	1962			
23A823	8S/23E23cb1	20	5.4	3.4	713	4255.4	195.2	4060.2	271.0	1955	291	1963			
23B823	8S/23E23cb2	16	2.7	0.8	1515	4255.2	198.7	4056.5	300.0	1955					
24C823	8S/23E24bb1	20	7	41	77		146.0		240.0	1956					
24B823	8S/23E24cd1	20	4.5	1.1	1836	4229.7	146.2	4083.5	257.2	1954					
24A823	8S/23E24cd2	24	9	11.6	348	4229.6	149.3	4080.4	315.0	1954					
25A823	8S/23E25bd1	20	3	0.9	1496	4217.1	150.7	4066.4	191.0	1954	226	1960			
26A823	8S/23E26db1	20	4.5	2.7	748	4223.3	162.6	4060.7	196.6	1955	300	1958			
27A823	8S/23E27aa1	20				4242.9	186.1	4056.8	243.0	1950	300	1962	370	1995	
27C823	8S/23E27bd1	20	4.5	8.5	238	4234.5	178.0	4056.5	262.0	1948					
27B823	8S/23E27cd1	20	3.3	1	1481	4224.8	167.5	4057.3	229.0	1954					
28C823	8S/23E28ca1	20	4.8	0.5	4308	4232.1	176.3	4055.8	251.0	1954	300	1984			
28A823	8S/23E28cc1	24	4.8	0.5	4308	4237.4	183.0	4054.4	261.0	1954					
28B823	8S/23E28cc2	20	5.5	0.5	4937	4237.7	183.0	4054.7	220.0	1954	263	1962			
29A823	8S/23E29ad1	20	7	3.7	849	4243.6	189.4	4054.2	249.0	1955	286	1963			
29B823	8S/23E29ad2	20	7.2	3.5	923	4243.4	188.6	4054.8	250.0	1956					
02A823	8S/23E2ca1	20				4279.0	214.1	4064.9	326.5						
31A823	8S/23E31da1	20	6.3	6	471	4230.0	179.5	4050.5	235.0	1955	243	1958			

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
34A823	8S/23E34cd1	16	4.2	4.2	449	4222.4	144.6	4077.8	354.0	1955					
35A823	8S/23E35bb1	18	6.8	10	305	4225.2	144.5	4080.7	266.0	1955	308	1964			
35C823	8S/23E35cc1	20	3.8	7.1	240	4223.4	144.3	4079.1	298.5	1955					
35B823	8S/23E35da1	16	2	0.4	2244	4224.9	143.0	4081.9	267.0	1955					
35D823	8S/23E35dd1	16	1.5	6.8	99	4222.5	139.7	4082.8	198.0	1955	231	1961			
04A823	8S/23E4cc1	24	4.5	0.6	3366	4290.8	233.0	4057.8	368.0	1954					
04B823	8S/23E4cc2	24	4.5	0.7	2885	4290.4	232.0	4058.4	311.0	1954					
05C823	8S/23E5aa1	24	3.1	1.5	928	4297.0	237.8	4059.2	388.0	1955					
05B823	8S/23E5aa2	24	6.3	5.6	505	4296.5	238.7	4057.8	338.8	1955					
08A823	8S/23E8da1					4286.4	232.5	4053.9	351.0	1950					
10A824	8S/24E10ac1	24	8.4	1	3770	4254.5	171.0	4083.5	211.8	1952	258				
10C824	8S/24E10cb1	20					169.5		240.0	1959					
10B824	8S/24E10cd1	20				4240.7	154.8	4085.9	238.0	1953					
11A824	8S/24E11ba1	20	4.7	3	703	4250.6	164.0	4086.6	225.0	1948	282	1964			
11B824	8S/24E11bd1	16	7.5	1.05	3206	4253.9	164.8	4089.1	198.7	1953	247	1962			
11C824	8S/24e11db1	12	4.1	0.09	20445	4245.4	155.8	4089.6	195.1	1954	203/234	1959/60	290	1983	415
12A824	8S/24E12ab1	20				4235.1	152.3	4082.8	191.0	1955	241	1962	258	2006	
13A824	8S/24E13ab1	20	10.3	0.44	10506	4244.8	154.8	4090.0	226.7	1954	250	1963			
13B824	8S/24E13ab2	20	5	0.21	10686	4244.8	154.8	4090.0	209.4	1954	246	1984			
14A824	8S/24E14cd1	24	8.46	1.3	2921	4220.0	132.3	4087.7	235.0	1952					
15A824	8S/24E15ca1	20	5.4	0.5	4847	4233.8	148.5	4085.3	232.0	1953					
18A824	8S/24E18bc1	24	8.9	5	799	4247.5	181.9	4065.6	265.0						
01A824	8S/24E1da1	20	5.7	1.1	2326	4254.2	166.7	4087.5	211.4	1955	227.4	1960	252	2006	
21B824	8S/24E21ab1	20				4230.8	146.0	4084.8	347.0	1953					
21A824	8S/24E21cc1	20					141.3		250.0	1951	363	1964			
22A824	8S/24E22da1	20	4.7	5.4	391	4221.8	132.3	4089.5	246.0	1953					

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
23A824	8S/24E23dc1	24	9.3	4.2	994	4227.1	136.7	4090.4	250.0	1953	260				
26A824	8S/24E26ac1	24	7.7	0.87	3972	4208.7	117.7	4091.0	172.1	1953	208	1963			
29A824	8S/24E29db1	20	4.9	0.75	2932	4204.3	118.9	4085.4	234.2	1954					
02A824	8S/24E2da1	12	1.9	0		4248.3	165.3	4083.0	204.0	1956	236	1961			
30A824	8S/24E30ba1	20				4217.1	145.5	4071.6	258.4	1955					
30B824	8S/24E30db1	20	3.4	1.3	1174	4208.3	123.5	4084.8	206.0		300	1992			
31A824	8S/24E31cd1	20	8.4	11.4	331	4243.4	158.5	4084.9	212.8	1954	252.8	1954	302.8	1960	
31B824	8S/24E31cd2	20	4.2	5	377	4243.4	158.7	4084.7	210.2	1954	270	1962			
03A824	8S/24E3da1	24	8.5	3.2	1192	4270.8	183.8	4087.0	340.0	1954					
03B824	8S/24E3da2	20	4.2	0.1	18850	4270.8	184.0	4086.8	302.3	1954					
04A824	8S/24E4ac1	24	8.9	6.9	579	4267.6	185.3	4082.3	321.0	1954					
04B824	8S/24E4ca1	24	8.2	6.2	594		192.4		302.0	1952	313	1962			
04C824	8S/24E4cd1	20					196.0		305.0	1960	370	1994			
06B824	8S/24E6ba1	20	5.7	7	365	4290.5	220.2	4070.3	297.0	1954	339	2004			
06A824	8S/24E6cb1	20				4296.1	229.0	4067.1	364.0	1949					
06C824	8S/24E6da1	16	2.1	5.1	185	4262.3	197.0	4065.3	237.0	1956	302	1962			
07B824	8S/24E7da1	20	4.7	1.1	1918	4228.1	168.0	4060.1	242.0	1948	285	1964			
08A824	8S/24E8ad1	20	8.5	9	424	4252.8	186.5	4066.3	265.0	1950	333	1956			
11A825	8S/25E11dc1	20	4.2	1.5	1257	4263.6	171.7	4091.9	230.0	1958					
12B825	8S/25E12bb1	16	5	4.1	547	4279.9	187.0	4092.9	228.5	1956	295	1983			
12A825	8S/25E12bb2	24	9.9	1.4	3174	4280.3	187.0	4093.3	230.0	1956	275	1961			
13A825	8S/25E13cc1	16	2.5	5.9	190	4249.9	157.0	4092.9	195.0	1956	251.3	1960			
14C825	8S/25E14ca1	16	2.2	0.1	9874	4255.8	162.7	4093.1	209.3	1955	257.7	1964			
15A825	8S/25E15cc1	24	8.7	5.2	751	4244.5	152.0	4092.5	208.0	1955	271	1963			
15B825	8S/25E15cc2	20	4	14.9	120	4244.5	152.7	4091.8	200.3	1956	250	1959			
17A825	8S/25E17aa1	20	6.8	2.7	1130	4220.6	131.3	4089.3	170.0	1956	211	1961			

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
19B825	8S/25E19ab1	24					122.5		217.5	1954					
19A825	8S/25E19ab2	24	9.4	4.2	1004	4212.4	120.1	4092.3	217.5	1954					
19C825	8S/25E19bd1	20	7.5	1.5	2244	4218.5	126.8	4091.7	224.7	1954					
19D825	8S/25E19bd2	20	3.7	1.6	1038	4218.4	126.5	4091.9	222.0	1954					
21A825	8S/25E21cd1	20	7.4	4.7	707	4218.1	127.3	4090.8	185.6	1956	228	1961			
23B825	8S/25E23bb1	20	7	3.3	952	4253.1	159.5	4093.6	215.5	1955	252.3	1964			
23A825	8S/25E23bb2	24	9.6			4252.8	159.5	4093.3	276.0	1956					
24A825	8S/25E24bc1	20	4.6	1.6	1290	4249.3	154.5	4094.8	195.1	1955	247	1962	510	1993	
03A825	8S/25E3ab1	24	7.8	6.7	522	4301.0	208.5	4092.5	359.0	1956					
03B825	8S/25E3ab2	20	5.7	5	512	4300.9	209.3	4091.6	340.4	1956					
03C825	8S/25E3bb1	20	5.8	6.4	407	4292.9	202.3	4090.6	367.0	1955					
03D825	8S/25E3bb2	16	2.9	3.4	383	4294.1	203.0	4091.1	258.0	1956	381	1964			
03E825	8S/25E3da1	20	4.1	0.4	4600	4300.9	210.8	4090.1	303.7	1957					
05A825	8S/25E5aa1	24	10.5	3	1571	4284.6	198.5	4086.1	238.2	1957	280	1963	290	1983	
05B825	8S/25E5aa2	18	5.3	0.8	2973	4285.0	199.8	4085.2	239.5	1957	280	1963	410	1995	
06B825	8S/25E6ad1	15	3.1	0.4	3478	4252.4	165.5	4086.9	205.5	1956	248	1962			
06A825	8S/25E6ad2	20	6.1	1.8	1521	4252.3	166.9	4085.4	205.0	1957	257	1961			
01A921	9S/21E1ca1	20	3.2	1.1	1306	4240.4	322.2	3918.2	406.1	1956	587	2005			
03A921	9S/21E3ad1	16	1.9	0.8	1066	4202.0	301.4	3900.6	342.0	1956	401	1962	420	2003	
03B921	9S/21E3bd1	16	6.7	1.3	2313	4196.6	299.7	3896.9	341.0	1956	390	1962	437	1984	
03C921	9S/21E3dc1	16	7	0.3	10472	4197.7	302.4	3895.3	337.0	1956	396	1956	424	1984	700
10A922	9S/22E10ac1	12	6.3	25.2	112	4220.6	210.0	4010.6	466.0	1955	466	1992			
11B922	9S/22E11ba1	16	3	14	96	4212.6	191.3	4021.3	306.5	1956	420	1960			
11C922	9S/22E11ba2	16				4212.0	197.0	4015.0	494.0	1961					
11A922	9S/22E11bd1	12	4.8	14.8	146	4214.2	202.0	4012.2	322.0	1956	399		435	1995	
15A922	9S/22E15ac1	24	2.8	30	42	4208.3	236.7	3971.6	388.0	1957					

Table 3 Specifications for A&B Irrigation District Production Wells (continued

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
15B922	9S/22E15ac2	16				4208.1	197.5	4010.6	239.0	1957	391	1959			
18A922	9S/22E18dc1	20	5.6	1.2	2094	4201.3	247.0	3954.3	298.5	1955	332	1961	332	2006	
18B922	9S/22E18dc2	20	2.8	0.75	1676	4201.4	247.5	3953.9	310.0	1956	340	1965	380	2006	
19A922	9S/22E19bc1	18	4.4	3.4	581	4202.9	293.4	3909.5	356.2	1955	422	1959	422	1985	
20A922	9S/22E20aa1	16	6.7	5	601	4209.1	251.0	3958.1	375.0	1956	700	1981			
22A922	9S/22E22ac2					4208.0	248.5	3959.5	651.0	1956	1000	1960			
28A922	9S/22E28dd1	14	2.5	18	62	4191.7	229.6	3962.1	302.0	1956	442	1964			
30A922	9S/22E30aa1	17	6.9	2.4	1290	4186.9	238.0	3948.9	360.0	1956	510	1959			
33B922	9S/22E33ad2	24	6.2	21.5	129	4197.1	239.1	3958.0	485.0	1956					
33C922	9S/22E33da1	12	3.3	17	87	4198.6	233.0	3965.6	388.0	1956	463	1962			
03A922	9S/22E3dd1	20	5.7	2.6	984		222.0		272.5	1955	320	1959			
03B922	9S/22E3dd2	16	4.4	0.5	3949	4236.2	221.5	4014.7	267.0	1955	327	1963			
07A922	9S/22E7aa1	20	9.5	7	609	4236.9	275.7	3961.2	412.0	1957	543.2	1963			
07B922	9S/22E7ad1	20	7.5	2.35	1432	4238.4	276.5	3961.9	327.0	1957	358.8	1962			
09B922	9S/22E9bc1	12	4.3	20	96	4218.1	250.2	3967.9	345.0	1956	425	1962	501	1969	501
09A922	9S/22E9ca1	16	5.6	4.6	546	4212.6	249.7	3962.9	289.3	1957	324	1959	415	1992	
09C922	9S/22E9da1	12	N/A	N/A		4212.6	258.0	3954.6	590.0	1994					
02A923	9S/23E2aa1	17	1.7	2	381	4223.5	141.6	4081.9	213.5	1955	247	1961			
03B923	9S/23E3ad1					4214.3	133.9	4080.4	285.0	1955					
03A923	9S/23E3cb1	12	4.5	16.2	125	4222.9	167.5	4055.4	289.0	1955	340	1955	380	1963	
06A923	9S/23E6aa1	16	7.8	1.2	2917	4225.0	174.3	4050.7	226.0	1950	259	1962			
06B923	9S/23E6dc1	20	4.3	4.3	449	4206.1	158.0	4048.1	206.0	1955	234	2005			
03C922		19				4236.2	242.0	3994.2	350.0	1993					
03D922		20					267.0		350.0	2003					
07A824		19					218.0		307.0	2001					
09A921		16							465.0	1993					

Table 3 Specifications for A&B Irrigation District Production Wells (continued

A&B 1128

Well ID	T/R Well ID	Well Dia. at Deep Point (in)	Aquifer Test Rate (cfs)	Aquifer Test Draw Down (ft)	Specific Capacity (gpm/ft)	Ground Elev. (ft)[1]	Depth to Ground Water at Time of Drilling (ft)	Ground Water Elev. at Time of Drilling (ft)	Initial Well Depth (ft)	Drill Date	2nd Well Depth (ft)	2nd Well Deep. Drill Date	3rd Well Depth (ft)	3rd Well Deep. Drill Date	4th Well Depth (ft)
15B824		20					160.0		300.0	2006					
15C825		17.5				4244.5	181.0	4063.5	251.0	2007					
21B823		24					112.0		257.0	1964					
26B823		20					151.0		285.0	2004					
34B723		24				4287.9	226.4	4061.5	324.0	1955					

Notes:

1. Ground elevations are taken from well logs supplied by A&B and BOR. The ground elevation as reported includes a reduction in elevation of 49.7 feet to account for a datum adjustment from the original BOR survey.
2. *2007 Low Ground Water Level column*: Data in italics means that drawdown was not recorded during pump operation and the data comes from static water levels.

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	02A1021	10S/21E2cc1	646	410		410						
	03A1022	10S/22E3cb1	429	290						X		
	34A723	7S/23E34cd2	321	270	272.6	290						
	22B724	7S/24E22cc1	352	250	246.2	270	X					
	24A724	7S/24E22db1	318		238.1	242	X					
	22C724	7S/24E22dd1	307.7	230	232	230						
	23A724	7S/24E23ac1	296	240	241.6	260						
	26B724	7S/24E26ac1	308	210	223	250	X					
	26A724	7S/24E26cb1	290	230	233.4	250						
	28B724	7S/24E28ac1	353.5	230	248.2	250						
	28A724	7S/24E28ac2	351	250	249.1	270	X					
	30B724	7S/24E30bd1	394	280	290.3	300						
	30A724	7S/24E30db2	393.8	280	298.8	320						
	31A724	7S/24E31ac1	363.7	280	279.1	300						
	32B724	7S/24E32ad1	397	240	243	240						
	32A724	7S/24E32ad2	394.8	240	247.3	260						
	33A724	7S/24E33db1	289	240		240						
	33B724	7S/24E33db2	283.6	240		270	X					
	34A724	7S/24E34bd1	259.6	220		220						
	35B724	7S/24E35dc1	270	220	229	240						
	35A724	7S/24E35dc2	270	220	241.2	240						
	27A725	7S/25E27cd1	346.4	240	240.9	240						
	29A725	7S/25E29ca1	365	270	275.2	300						
	30A725	7S/25E30da1	295.9	260	265.9	270						
	31A725	7S/25E31bd1	252	220	218.9	220						
	32A725	7S/25E32ca1	257	220	219.7	240	X					

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	33A725	7S/25E33bb1	301	230		250						
	34A725	7S/25E34ca1	340	240		260	X					
	22A821	8S/21E22da1	399.4	340	337.1	340						
	24A821	8S/21E24bd1	480	330	*349.9*	370	X					
	26B821	8S/21E26aa1	587.8	370	374.5	390						
	26A821	8S/21E26aa2	527	370	365.4	390						
	35A821	8S/21E35aa1	381	340	336.5	340						
	35D821	8S/21E35cc1	406.5	330		363.3						
	35B821	8S/21E35dd1	425	340	359.2	360	X					
	35C821	8S/21E35dd2	417	360		360						
	30A822	8S/22E30cb1	516	320	323.8	350						
	35C822	8S/22E35ab1	350	260		280	X					
	35A822	8S/22E35dc1	350	220		230	X					
	35B822	8S/22E35dc2	290	220	230.9	240						
	10A823	8S/23E10ad1	332	332	240.3	260						
	10B823	8S/23E10cc1	326	240			X			X		Accommodate wateruser
	12A823	8S/23E12ac1	316.6	250	250.8	270						
	12B823	8S/23E12ac2	314.2	250	251.1	270						
	12C823	8S/23E12cd1	290	240	248.5	270						
	12D823	8S/23E12cd2	298.6	230	249.5	270						
	14B823	8S/23E14bb1	278.6	220	242.9	260						
	14A823	8S/23E14bb2	296.8	297		260						
	15A823	8S/23E15ba1	307	250		250						
	15B823	8S/23E15ba2	302.2	260	249.9	260						
	15D823	8S/23E15dd1	287	230	226.7	230						
	17C823	8S/23E17ba1	302	260		280	X					

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	17A823	8S/23E17dd1	305	240	233	260						
	17B823	8S/23E17dd2	278	240	236.1	250						
	19A823	8S/23E19dc1	300	250	247.4	250						
	19B823	8S/23E19dc2	290	250	245.6	250						
	01B823	8S/23E1ab1	371.3	270		290						
	01A823	8S/23E1ab2	369.4	270	274.3	290						
	01C823	8S/23E1cc1	298.9	240	242.9	290						
	21A823	8S/23E21ad1	286	220	223.9	220						
	22A823	8S/23E22cd1	282	230	227.3	250						
	23A823	8S/23E23cb1	291	230	235.7	250						
	23B823	8S/23E23cb2	300	230	235.2	250						
	24C823	8S/23E24bb1	240	180	184.4	200						
	24B823	8S/23E24cd1	257.2	180	184.9	180						
	24A823	8S/23E24cd2	315	200	203	220						
	25A823	8S/23E25bd1	226	180	176.3	180						
	26A823	8S/23E26db1	300	190						X		Relocated to 26B823 to accommodate wateruser
	27A823	8S/23E27aa1	300	230	212	230	X					
	27C823	8S/23E27bd1	262	216	218.4	230						
	27B823	8S/23E27cd1	229	200	202.9	200						
	28C823	8S/23E28ca1	300	210	210	230						
	28A823	8S/23E28cc1	261	220	217	240						
	28B823	8S/23E28cc2	263	220		220						
	29A823	8S/23E29ad1	286	220	225	240						
	29B823	8S/23E29ad2	250	220	224.1	230						
	02A823	8S/23E2ca1	326.5	250	252.1	280						
	31A823	8S/23E31da1	243	210	211.5	230						

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

A&B 1132

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	34A823	8S/23E34cd1	354	180	178.2	180						
	35A823	8S/23E35bb1	308	180		200						
	35C823	8S/23E35cc1	298.5	180	182.5	200						
	35B823	8S/23E35da1	267	180	176.8	200						
	35D823	8S/23E35dd1	231	190	*174.8*	190						
	04A823	8S/23E4cc1	368	270	268.9	270						
	04B823	8S/23E4cc2	311	270	267.1	270						
	05C823	8S/23E5aa1	388	260	281.5	280						
	05B823	8S/23E5aa2	338.8	280	279.9	300						
	08A823	8S/23E8da1	351	255	266.1	280						
	10A824	8S/24E10ac1	258	190	204.4	210						
	10C824	8S/24E10cb1	240	240	195.2	200						
	10B824	8S/24E10cd1	238	238	191.4	200						
	11A824	8S/24E11ba1	282	195	202.9	220						
	11B824	8S/24E11bd1	247	200		200						
1994	11C824	8S/24e11db1	415	180	200.9	240	X					
	12A824	8S/24E12ab1	241	190	186.9	210	X					
	13A824	8S/24E13ab1	250	200	191.5	200						
	13B824	8S/24E13ab2	246	180		200	X					
	14A824	8S/24E14cd1	235	160	167.7	180						
	15A824	8S/24E15ca1	232	170	186.6	210						
	18A824	8S/24E18bc1	265	212		240						
	01A824	8S/24E1da1	227.4	200	204.6	220	X					
	21B824	8S/24E21ab1	347	180	187.3	200						
	21A824	8S/24E21cc1	363	182	177.2	190						
	22A824	8S/24E22da1	246	180	171.6	180						

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	23A824	8S/24E23dc1	260	180	178.2	180						
	26A824	8S/24E26ac1	208	160	156.9	160						
	29A824	8S/24E29db1	234.2	140	156.6	180						
	02A824	8S/24E2da1	236	190		210						
	30A824	8S/24E30ba1	258.4	180	179	200						
	30B824	8S/24E30db1	300	160	157.6	160	X					
	31A824	8S/24E31cd1	302.8	200	198.7	200						
	31B824	8S/24E31cd2	270	200	195.1	200						
	03A824	8S/24E3da1	340	220		220						
	03B824	8S/24E3da2	302.3	220	221.1	220						
	04A824	8S/24E4ac1	321	220	241.3	260						
	04B824	8S/24E4ca1	313	230		230						
	04C824	8S/24E4cd1	305	240	226.3	240	X					
	06B824	8S/24E6ba1	297	260	258.9	280	X					
	06A824	8S/24E6cb1	364	251	265.3	290						
	06C824	8S/24E6da1	302	260		230						
	07B824	8S/24E7da1	285	205						X		Replaced by 7A824
	08A824	8S/24E8ad1	333	202	208.1	223						
	11A825	8S/25E11dc1	230	190	204.1	210						
	12B825	8S/25E12bb1	32	210	220.5	230	X					
	12A825	8S/25E12bb2	275	220	221.8	220						
	13A825	8S/25E13cc1	251.3	190		190						
	14C825	8S/25E14ca1	257.7	200	196.6	200						
	15A825	8S/25E15cc1	271	190	188.1	220						
	15B825	8S/25E15cc2	250	180						X		Replaced by 15C825
	17A825	8S/25E17aa1	211	160	166.6	160						

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	19B825	8S/25E19ab1	217.5	160	161.1	160						
	19A825	8S/25E19ab2	217.5	160	159.9	180						
	19C825	8S/25E19bd1	224.7	160	166.2	180						
	19D825	8S/25E19bd2	222	160	163.9	180						
	21A825	8S/25E21cd1	228	160		180						
	23B825	8S/25E23bb1	252.3	180		200						
	23A825	8S/25E23bb2	276	200	209.7	220						
	24A825	8S/25E24bc1	510	190	195	210	X					
	03A825	8S/25E3ab1	359	240	248.8	260						
	03B825	8S/25E3ab2	340.4	250	248.5	250						
	03C825	8S/25E3bb1	367	240		280						
	03D825	8S/25E3bb2	381	250	241.1	250						
	03E825	8S/25E3da1	3037	220	242.3	240						
	05A825	8S/25E5aa1	290	230	232.5	250						
	05B825	8S/25E5aa2	280	230	231.1	250	X					
	06B825	8S/25E6ad1	248	200	198.5	200						
	06A825	8S/25E6ad2	257	200		200						
	01A921	9S/21E1ca1	406.1	360	371.8	400	X					
	03A921	9S/21E3ad1	401	330	373.7	400	X					
	03B921	9S/21E3bd1	437	330	338.4	363	X					
1993	03C921	9S/21E3dc1	700	330	356.5	380	X					
	10A922	9S/22E10ac1	466	250			X			X		Abandoned due to insufficient water, replaced by 3C92
	11B922	9S/22E11ba1	420	406	258.6	260						
	11C922	9S/22E11ba2	494	230	241.8	270						
	11A922	9S/22E11bd1	435				X			X		Converted to injection well. Insufficient water for produ
	15A922	9S/22E15ac1	388	300	300.3	300						

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	15B922	9S/22E15ac2	391	330		330						
	18A922	9S/22E18dc1	322	280	297.4	310	X					
	18B922	9S/22E18dc2	340	280	298.5	320	X					
	19A922	9S/22E19bc1	422	320	340.5	340	X					
	20A922	9S/22E20aa1	700	290			X			X		Abandoned due to insufficient water supply
	22A922	9S/22E22ac2	1000	300						X		
	28A922	9S/22E28dd1	442	280		300						
	30A922	9S/22E30aa1	510	330	334.9	390						
	33B922	9S/22E33ad2	485	290						X		
	33C922	9S/22E33da1	463	290						X		
	03A922	9S/22E3dd1	320	250		270						
	03B922	9S/22E3dd2	327	260	262	260						
	07A922	9S/22E7aa1	543.2	320	351.8	390						
	07B922	9S/22E7ad1	358.8	310	322.1	330						
2007	09B922	9S/22E9bc1	425	310		350	X					
	09A922	9S/22E9ca1	415	290			X			X		Abandoned due to insufficient water, replaced by 9C92
	09C922	9S/22E9da1			287	320	X	X	X			To replace 9A922, insufficient water, so supplemented
	02A923	9S/23E2aa1	247	160	175.8	180						
	03B923	9S/23E3ad1	285	160	170.4	200						
	03A923	9S/23E3cb1	380	200		200						
	06A923	9S/23E6aa1	259	200		200						
	06B923	9S/23E6dc1	206	180	181.3	200	X					
	03C922				263.1	272	X		X			Replaced 10A922
	03D922				274.9	301.5	X	X	X			Replaced 9A922 & supplemented 9C922
	07A824				254.8	270	X		X			Replaces 7B824
	09A921					360	X	X				purchased to supplement 3B921 & 3C921

Table 3 Specifications for A&B Irrigation District Production Wells (continued)

4th Well Deep. Drill Date	Well ID	T/R Well ID	Most Recent Well Depth (ft)	1964 Depth to Top Pump Bowl (ft)	2007 Low Ground Water Level	2007 Depth to Top Pump Bowl	Well Deepened Since 1980	New Well, Supplemental	New Well, Replacement	Well Abandoned	Relocation	Comments
	15B824					203	X	X				Supplements 10A824 & 10B824
	15C825				188.7	220	X		X			Replaces 15B825
	21B823				201.1	242		X				Supplements 15A823 & 15B823
	26B823					222	X				X	Relocated from 26A823 to accommodate wateruser
	34B723				271.9	280						

Notes:

1. Ground elevations are taken from well logs supplied by A&B and BOR. The ground elevation as reported includes a reduction in elevation of 49.7 feet to account for a datum adjustment from the original BOR survey.
2. *2007 Low Ground Water Level column*: Data in italics means that drawdown was not recorded during pump operation and the data comes from static water levels.

Table 4 Example Well Yield Information

YEAR		Yield in acre feet for time period						
1995	A&B ID	April-May	May-June	June-July	July-Aug	Aug-Sept	Sept-Oct	Totals
	10A823	19.6	31.3	191.1	110.4	76.9	92.2	521.5
	10A922	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10AB824	82.1	215.5	763.0	854.9	579.3	339.1	2833.9
	10B823	0.0	17.9	82.9	52.3	0.0	58.2	211.3
	10C824	23.9	27.8	191.1	252.3	161.9	36.1	693.1
	11A825	0.0	63.6	218.7	264.0	205.1	95.4	846.8
	11ABC824	129.5	192.4	742.8	1050.0	845.8	441.5	3402.0
	11BC922	45.9	75.0	351.0	0.0	297.7	146.6	916.2
	12A824	0.0	46.9	163.0	189.5	87.8	33.7	520.9
	12AB823	23.6	146.9	512.9	470.8	323.8	270.9	1748.9
	12AB825	160.9	273.3	654.8	496.5	548.8	177.3	2311.6
	12CD823	43.1	216.2	550.8	563.3	405.0	121.7	1900.1
	13A825	18.9	11.6	49.5	107.0	84.1	81.9	353.0
	13AB824	103.3	156.3	491.4	637.6	563.9	312.0	2264.5
	14A824	0.0	70.4	316.9	415.7	189.5	177.7	1170.2
	14AB823	21.0	103.6	424.4	473.7	380.3	319.7	1722.7
	14C824	0.0	42.6	119.4	42.0	74.1	15.8	293.9
	15A824	77.5	145.4	330.1	347.9	248.3	107.8	1257.0
	15AB823	84.0	213.7	812.7	616.2	419.7	205.6	2351.9
	15AB825	62.8	196.8	703.0	723.3	541.9	271.5	2499.3
	15AB922	17.8	71.4	156.2	189.0	165.7	48.3	648.4
	15D823	0.0	9.3	96.8	96.0	25.8	55.6	283.5
	17A825	31.3	123.7	375.1	319.5	338.2	208.9	1396.7
	17AB823	22.0	97.0	370.1	340.8	312.3	161.0	1303.2
	17C823	5.5	8.3	94.0	59.9	26.4	32.5	226.6
	18AB922	22.4	52.3	379.7	431.1	194.9	129.8	1210.2
	19A922	0.0	7.2	181.8	210.1	205.6	158.5	763.2
	19AB823	54.3	89.4	485.6	471.6	321.2	194.0	1616.1
	19AB825	115.5	175.6	720.4	609.0	425.5	481.8	2527.8
	19CD825	76.8	204.5	514.9	595.0	444.9	317.7	2153.8
	1A824	13.3	85.3	277.8	234.0	161.2	71.6	843.2
	1A921	25.2	71.1	334.1	365.4	307.5	167.5	1270.8
	1ABC823	172.7	153.9	937.6	1051.9	1007.3	636.3	3959.7
	21A823	0.0	19.1	325.5	253.7	152.9	73.4	824.6
	21A824	100.1	113.7	329.5	554.0	443.7	128.5	1669.5
	21A825	35.7	114.6	312.7	468.4	320.0	66.2	1317.6
	21B824	71.0	86.1	310.4	279.6	176.7	182.7	1106.5
	22A724	30.5	78.3	144.5	65.2	47.9	12.1	378.5
	22A821	45.7	94.1	307.8	299.9	269.8	157.6	1174.9
	22A823	42.8	40.2	231.0	254.1	209.4	156.9	934.4
	22A824	31.9	58.5	234.0	123.0	115.5	112.9	675.8
	22B724	37.2	90.6	343.5	303.9	240.6	54.4	1070.2
	22C724	31.0	107.7	326.4	269.0	144.6	143.5	1022.2
	23A724	44.0	16.6	223.1	272.4	196.0	198.6	950.7
	23A824	118.3	46.7	421.2	389.5	243.7	95.9	1315.3
	23AB823	44.9	122.4	511.2	457.5	402.0	203.1	1741.1
	23AB825	73.3	181.3	539.9	674.1	604.2	401.4	2474.2

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Table 5 Average Annual Pumping Rate for Production Wells

T/R Well ID	Well ID	(AF/yr)	Starting	Ending	Comments
7S/23E34cd2	34AB723	1891.9	1995	2007	
7S/24E22cc1	22A724	528.5	1995	2007	
7S/24E22cc1	22B724	1199.2	1995	2007	
7S/24E22dd1	22C724	1160.6	1995	2007	
7S/24E23ac1	23A724	903.6	1995	2007	
7S/24E26ac1	26B724	406.9	1995	2007	
7S/24E26cb1	26A724	1301.6	1995	2007	
7S/24E28ac1	28AB724	1937.4	1995	2007	
7S/24E30db2	30AB724	2435.2	1995	2007	
7S/24E31ac1	31A724	768.4	1995	2007	
7S/24E32ad2	32AB724	2863.3	1995	2007	
7S/24E33db1	33A724	1201.9	1995	2007	
7S/24E33db2	33AB724	2027.7	1995	2007	
7S/24E34bd1	34A724	1371.8	1995	2007	
7S/24E35dc2	35AB724	2166.4	1995	2007	
7S/25E27cd1	27A725	267.7	1995	2007	
7S/25E29ca1	29A725	790.8	1995	2007	
7S/25E30da1	30A725	1044.8	1995	2007	
7S/25E31bd1	31A725	719.2	1995	2007	
7S/25E32ca1	32A725	717	1995	2007	
7S/25E34ca1	34A725	1246.4	1995	2007	
8S/21E22da1	22A821	1114.9	1995	2007	
8S/21E24bd1	24A821	257.5	1995	2007	
8S/21E26aa1	26AB821	2202.6	1995	2007	
8S/21E35aa1	35A821	888.9	1995	2007	
8S/21E35cc1	35D821	1108.8	1996	2007	Yield for 2006 and 2007 combined with 35BC821
8S/21E35dd1	35BC821	2577.2	1995	2007	Includes 35BCD821 for 1995
8S/22E30cb1	30A822	609.1	1995	2007	
8S/22E35ab1	35C822	506.3	1995	2007	
8S/22E35dc1	35AB822	2833.9	1995	2007	
8S/23E10ad1	10A823	512.2	1995	2007	
8S/23E10cc1	10B823	238.6	1995	2005	
8S/23E12ac1	12AB823	1977.3	1995	2007	
8S/23E12cd1	12CD823	2152.7	1995	2007	
8S/23E14bb2	14AB823	1444.2	1995	2007	
8S/23E15ba1	15AB823	2403.8	1995	2007	
8S/23E15dd1	15D823	297.9	1995	2007	
8S/23E17ba1	17C823	335	1995	2007	
8S/23E17dd1	17AB823	1520.8	1995	2007	
8S/23E19dc1	19AB823	2019.6	1995	2007	
8S/23E1ab2	1AB823	3100.9	1995	2007	Includes 1ABC823 for 1995
8S/23E1cc1	1C823	1166.3	1996	2007	
8S/23E21	21B823	504.1	2005	2007	
8S/23E21ad1	21A823	936.9	1995	2007	
8S/23E22cd1	22A823	983.3	1995	2007	
8S/23E23cb1	23AB823	1622.3	1995	2007	
8S/23E24bb1	24C823	987.3	1995	2007	
8S/23E24cd2	24AB823	2565.1	1995	2007	
8S/23E25bd1	25A823	556.7	1995	2007	

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Table 5 Average Annual Pumping Rate for Production Wells (continued)

T/R Well ID	Well ID	(AF/yr)	Starting	Ending	Comments
8S/23E26	26B823	919.3	2005	2007	
8S/23E26db1	26A823	677.6	1995	2004	
8S/23E27aa1	27A823	990.6	1995	2007	Includes 27A823 for 1995
8S/23E27bd1	27C823	693	1996	2007	
8S/23E27cd1	27B823	560.6	1995	2007	
8S/23E28ca1	28C823	724.5	1995	2007	
8S/23E28cc1	28AB823	2981.2	1995	2007	
8S/23E29ad1	29AB823	2182.9	1995	2007	
8S/23E2ca1	2A823	987.1	1995	2007	
8S/23E31da1	31A823	1130.6	1995	2007	
8S/23E34cd1	34A823	677.4	1995	2007	
8S/23E35bb1	35A823	1228.4	1995	2007	
8S/23E35cc1	35C823	626.4	1995	2007	
8S/23E35da1	35B823	263.5	1995	2007	
8S/23E35dd1	35D823	163.1	1995	2007	
8S/23E4cc1	4AB823	2566.5	1995	2007	
8S/23E5aa2	5BC823	1657.7	1995	2007	
8S/23E8da1	8A823	1305.3	1995	2007	
8S/24E10ac1	10A824	2102.7	1996	2007	
8S/24E10cb1	10C824	742.1	1995	2007	
8S/24E10cd1	10AB824	2833.9	1995		
8S/24E10cd1	10B824	1322.1	1996	2007	Yield for 2006 and 2007 combined with 10A824
8S/24E11ba1	11AB824	2784.8	1995	2007	Includes 11AB824 for 1995
8S/24e11db1	11C824	1120.7	1996	2007	Yield for 2006 and 2007 combined with 11AB824
8S/24E12ab1	12A824	658.1	1995	2007	
8S/24E13ab1	13AB824	2636.1	1995	2007	
8S/24E14	14C824	346.3	1995	2007	
8S/24E14cd1	14A824	1477.3	1995	2007	
8S/24E15	15B824	743.7	2006	2007	
8S/24E15ca1	15A824	1193.9	1995	2007	
8S/24E18bc1	18A824	1960.9	1996	2007	
8S/24E1da1	1A824	1021.4	1995	2007	
8S/24E21ab1	21B824	1473.5	1995	2007	
8S/24E21cc1	21A824	2227.8	1995	2007	
8S/24E22da1	22A824	1148.3	1995	2007	
8S/24E23dc1	23A824	1700.6	1995	2007	
8S/24E26ac1	26A824	1266.4	1995	2007	
8S/24E29db1	29A824	1164.1	1995	2007	
8S/24E2da1	2A824	336.9	1995	2007	
8S/24E30ba1	30A824	636	1995	2007	
8S/24E30db1	30B824	535	1995	2007	
8S/24E31cd1	31AB824	2448.3	1995	2007	
8S/24E3da1	3AB824	2577.6	1995	2007	
8S/24E4ac1	4A824	1835.3	1995	2007	
8S/24E4ca1	4BC824	3050.9	1996	2007	
8S/24E4cd1	4BC-8A824	3911.4	1995		May be same as 4BC824
8S/24E6ba1	6B824	1323.7	1995	2007	
8S/24E6cb1	6A824	2725.4	1995	2007	
8S/24E6da1	6C824	292.7	1995	2007	

Table 5 Average Annual Pumping Rate for Production Wells (continued)

T/R Well ID	Well ID	(AF/yr)	Starting	Ending	Comments
8S/24E7	7A-18A824	2123.5	1995		
8S/24E7	7A824	2407.5	2001	2007	
8S/24E8ad1	8A824	1679.2	1996	2007	Yield for 2006 and 2007 combined with 4BC824
8S/25E11dc1	11A825	958.1	1995	2007	
8S/25E12bb2	12AB825	2557.1	1995	2007	
8S/25E13cc1	13A825	349.9	1995	2007	
8S/25E15cc1	15AB825	2594.1	1995	2007	
8S/25E15cc2	15AC825	3199.9		2007	
8S/25E17aa1	17A825	1535.7	1995	2007	
8S/25E19ab2	19AB825	3007.8	1995	2007	
8S/25E19bd1	19CD825	2323.3	1995	2007	
8S/25E21cd1	21A825	1470	1995	2007	
8S/25E23bb2	23AB825	2866.8	1995	2007	
8S/25E24bc1	24A825	627.6	1995	2007	
8S/25E3ab1	3AB825	2940.6	1995	2007	
8S/25E3bb1	3CD825	1671.5	1995	2007	
8S/25E3da1	3E825	829.4	1995	2007	
8S/25E5aa1	5AB825	3363.6	1996	2007	Includes 5AB-6AB825 for 1995
8S/25E6ad2	6AB825	1899	1995	2007	
9S/21E1ca1	1A921	1085.1	1995	2007	
9S/21E3ad1	3A921	308.8	1995	2007	
9S/21E3bd1	3B921	1348.4	1995	2007	
9S/21E3dc1	3C921	1265	1995	2007	
9S/21E9	9A921	594.5	2005	2007	
9S/22E10ac1	10A922	152.1	1996	2003	
9S/22E11ba1	11B922	681.3	1996	2007	
9S/22E11ba1	11BC922	916.2	1995		May be same as 11B922
9S/22E11ba2	11C922	761.8	1996	2007	
9S/22E15ac1	15A922	371.5	1996	2007	
9S/22E15ac2	15AB922	658.4	1995		
9S/22E15ac2	15B922	400	1996	2007	Yield for 2006 and 2007 combined with 15A922
9S/22E18dc1	18AB922	1657.3	1995	2007	
9S/22E19bc1	19A922	706.4	1995	2007	
9S/22E22ac2	22A922	0			
9S/22E28dd1	28A922	358.9	1995	2007	
9S/22E3	3C922	480.8	1995	2007	
9S/22E3	3D922	687	2004	2007	
9S/22E30aa1	30A922	1269.8	1995	2007	
9S/22E33ad2	33BC922	0			
9S/22E3dd1	3AB922	2446.5	1995	2007	
9S/22E7aa1	7A922	1643.9	1996	2007	
9S/22E7ad1	7AB922	1333.8	1995	2000	
9S/22E7ad1	7B922	1859.3	1996	2007	
9S/22E9bc1	9B922	826.2	1995	2007	
9S/22E9ca1	9AC922	628.5	1995	2007	
9S/23E2aa1	2A923	433.3	1995	2007	
9S/23E3ad1	3A923	932.8	1995	2007	
9S/23E3ad1	3B923	370.3	1995	2007	No pumping in 2000
9S/23E6aa1	6A923	1307.3	1995	2007	

Table 5 Average Annual Pumping Rate for Production Wells (continued)

T/R Well ID	Well ID	(AF/yr)	Starting	Ending	Comments
9S/23E6dc1	6B923	611	1995	2007	
10S/21E2cc1	2A1021	52.4	2000	2007	No pumping in 2002, 2004 and 2005
10S/22E3cb1	3A1022	155.7	1995		

Table 6 Average Pumping Rate Per Well for Each Township in Gallons Per Minute

	7S/23E	7S/24E	7S/25E
Number of Wells	2	18	7
2003 high	2300	2525	2143
2003 low	2214	2384	2246
2004 high	2241	2469	2304
2004 low	2093	2299	2235
2005 high	2268	2579	2250
2005 low	2142	2416	2206
2006 high	2268	2584	2308
2006 low	2120	2380	2245
2007 high	2655	2521	2295
2007 low	2457	2495	2214

	8S/21E	8S/22E	8S/23E	8S/24E	8S/25E
Number of Wells	8	4	50	35	26
2003 high	2411	2286	2600	3100	2814
2003 low	2283	2234	2472	2985	2759
2004 high	2363	2250	2614	3069	2782
2004 low	2216	2149	2444	2950	2705
2005 high	2312	2268	2620	3059	2740
2005 low	2222	2115	2424	2863	2622
2006 high	2286	2423	2678	3073	2888
2006 low	2206	2302	2536	2891	2670
2007 high	2451	2401	2627	3022	2974
2007 low	2129	2315	2481	2852	2830

	9S/21E	9S/22E	9S/23E	10S/21E
Number of Wells	3	19	5	1
2003 high	3123	1996	2047	1908
2003 low	2966	1861	2034	1908
2004 high	2957	2114	2027	
2004 low	2597	2003	1973	
2005 high	2931	2116	2119	
2005 low	2382	2047	2045	
2006 high	2964	2185	1951	1728
2006 low	2466	2041	1903	1701
2007 high	2745	2173	1996	1800
2007 low	1841	2039	1872	1719

ADDENDUM C

MEMO

State of Idaho
Department of Water Resources
322 E Front Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 287-4800 Fax: (208) 287-6700

Date: February 27, 2013

To: Gary Spackman, Hearing Officer

From: Jennifer Sukow

cc: Rick Raymondi, Sean Vincent, Allan Wylie, Neal Farmer, Tim Luke, Cindy Yenter

Subject: Staff memorandum in response to expert reports submitted for Rangen Delivery Call (In the Matter of Distribution for Water to Water Right Nos. 36-02551 and 36-07694)

Table of Contents

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PROFESSIONAL CERTIFICATION

Professional Engineer
Idaho No. 11347
Oregon No. 81421

Professional Geologist
Idaho No. 1089

EXPERIENCE

Idaho Department of Water Resources
Technical Engineer II, Hydrology Section, 2010 - present
Develop numerical groundwater flow models to support water management decision-making and water supply planning. Develop water budgets for groundwater flow models and hydrogeologic studies. Analyze hydrologic effects of water management practices using numerical groundwater flow models. Review engineering and hydrogeologic reports submitted to the agency in connection with water right permit and transfer applications, adjudication claims, and contested cases.

SPF Water Engineering, LLC
Senior Project Engineer, 2006 - 2010
Project Engineer, 2004 - 2006
Provided water supply consulting services for public water systems in southern Idaho. Services included groundwater resource evaluations, quantification of water demands, conceptual and final design of water system facilities, and application for water right and water system permits. Sited and designed municipal and irrigation wells, with design capacities ranging from 30 to 2,500 gpm. Supervised well construction and pumping tests. Sited and supervised testing of exploration wells in granitic and basalt aquifers for evaluation of potential water supply. Designed and managed construction of pumping stations for municipal and irrigation systems. Designed and managed construction of pressure reducing/sustaining valve stations for municipal water systems. Performed hydraulic modeling of pressurized water distribution systems for drinking water and irrigation.

Idaho Department of Water Resources
Staff Engineer, Water Distribution Section, 2004 – 2004
Associate Engineer, Water Distribution Section, 2002 - 2004
Provided technical support to assist with water management and administration of water rights. Performed water distribution modeling for water right administration, analyzed water measurement data and water rights for evaluation of distribution issues, integrated water right and water measurement data using GIS and database applications, provided training and assistance to local watermasters, inspected diversion works and measuring devices for compliance with standards, and measured discharge in open channels and closed conduits for the purposes of calibrating measuring devices and developing power consumption coefficients.

HDR Engineering, Inc.
Project Engineer, 2001 - 2002
Provided engineering services for water and wastewater projects. Designed water and wastewater treatment plant improvements, an industrial pretreatment facility, and sanitary sewer collection systems.

Terracon, Inc.
Staff Engineer, 1997 - 2001
Provided engineering services for environmental and geotechnical projects. Evaluated public water system well site evaluations, performed water quality and hydrogeologic studies, characterized soil and groundwater contamination, designed and supervised construction of monitoring wells, collected soil and groundwater samples, designed and operated soil and groundwater remediation systems, and performed geotechnical investigations for roadway and bridge projects.

Utah Water Research Laboratory
Graduate Research Assistant, 1995 - 1997
Planned and conducted groundwater and soil gas tracer tests, collected and analyzed groundwater and soil gas samples.

USDA Natural Resources Conservation Service
Geologist, Nebraska Engineering Staff, 1994 - 1995
Geologist Student Trainee, Montana Engineering Staff, 1992 – 1993
Conducted geologic and geotechnical investigations for earth fill dam sites and canal structures, performed hydrogeologic assessments for stockwater and irrigation well sites, and provided geologic and hydrogeologic consulting to soil survey and field office staff on various conservation projects.

PUBLICATIONS

Berkey, J.S., T.E. Lachmar, W.J. Doucette, R.R. Dupont, 2003. *Tracer Studies for Evaluation of In Situ Air Sparging and In-well Aeration System Performance at a Gasoline Contaminated Site in Layton, Utah*, Journal of Hazardous Materials, Volume 98, No. 1-3, p. 127-144, March 17, 2003.

Berkey, J.S., 2001. *Tracer Studies for Evaluation of In Situ Air Sparging and In-well Aeration System Performance at a Gasoline Contaminated Site in Layton, Utah*, Utah State University, Department of Civil and Environmental Engineering, M.S. Thesis, 137 p.

OTHER TECHNICAL REPORTS

Sukow, J.S., 2012. *Comparison of Enhanced Snake Plain Aquifer Model Version 2.1 with Version 1.1 via the Curtailment Scenario*, Addendum to Comparison of Eastern Snake Plain Aquifer Model Version 2.0 with Version 1.1 via the Curtailment Scenario

Sukow, J.S., 2012. *Comparison of Eastern Snake Plain Aquifer Model Version 2.0 with Version 1.1 via the Curtailment Scenario*, Idaho Department of Water Resources.

Sukow, J.S., 2012. *Comparison of Superposition Model with Fully Populated Model for Eastern Snake Plain Aquifer Model Version 2.0*, Idaho Department of Water Resources.

Sukow, J.S., 2012. *Irrigation Return Flows and Snake River Reach Gains for Calibration of Eastern Snake Plain Aquifer Model Version 2*, Idaho Department of Water Resources, Eastern Snake Plain Aquifer Model Version 2, ESPAM2 Design Document DDW-V2-15.

Sukow, J.S., 2011. *Estimation of Ground Water Contribution from the South Side of the Snake River, Milner to King Hill, Eastern Snake Plain Aquifer Model Version 2*, Idaho Department of Water Resources, ESPAM2 Design Document DDW-V2-14.

Sukow, J., 2008. *Addendum to Groundwater Supply Evaluation for Brundage Mountain Parcel*, SPF Water Engineering, LLC, submitted to Idaho Department of Water Resources in support of application for water right permit 78-12332.

Sukow, J., 2007. *Groundwater Supply Evaluation for Brundage Mountain Parcel*, SPF Water Engineering, LLC, submitted to Idaho Department of Water Resources in support of application for water right permit 78-12332.

Sukow J., 2007. *Groundwater Supply Evaluation for Elk Creek Village, Application for Permit No. 61-12090*, SPF Water Engineering, LLC, submitted to Idaho Department of Water Resources in support of application for water right permit 61-12090.

Technical reports submitted to the Idaho Department of Environmental Quality in support of public water system projects (2005 - 2010):

Public Water System Facility Plans, various projects

Well Site Evaluations and Well Construction Plans and Specifications, various projects

Well Completion Reports, various projects

Preliminary Engineering Reports for Well Pumping Facilities, various projects

Plans and Specifications for Well Pumping Facilities, various projects

Public Water System Technical, Financial and Managerial Capacity Plans, various projects

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Executive Summary

This report was prepared in response to expert reports submitted for the Rangen Delivery Call, which requests curtailment of groundwater users with water right priority dates junior to July 13, 1962 for distribution of water to water rights 36-2551 and 36-7694. A total of 18 expert reports and rebuttal reports were submitted to the Idaho Department of Water Resources (IDWR) on behalf of Rangen, Inc. (Rangen), the Idaho Ground Water Appropriators (IGWA), the City of Pocatello, and Freemont Madison Irrigation District (FMID). The main issues raised by the parties' experts appear to be[1]:

1. Whether Rangen is entitled to make a call based on discharge from the entire spring complex or only discharge from Martin-Curren Tunnel, which is the source listed on the partial decrees for Rangen's water rights.
2. Whether Martin-Curren Tunnel is a surface water source.
3. Whether Rangen is beneficially using available water with reasonable efficiency, or is using water inefficiently and wasting water.
4. Whether Rangen has suffered material injury because of reduced water availability.
5. Whether the economic impact of curtailment outweighs the economic benefit to Rangen and Rangen's right to water.
6. Whether Rangen's water measurement methods are acceptable.
7. Whether Rangen has made sufficient efforts to increase water availability to its facility.
8. Whether ESPAM2.1 is capable of providing a reasonable prediction of the effects of curtailment at the Rangen spring complex, or is only capable of providing predictions to a larger reach.
9. Whether some groundwater users should be excluded from curtailment based on the fraction of their curtailed use that will accrue to springs and river reaches other than Rangen.
10. Whether water that would accrue to springs and river reaches other than Rangen would be wasted.

Several of these issues are legal or policy issues that cannot be appropriately addressed by IDWR technical staff. This memorandum was prepared by IDWR staff with the intent of summarizing the parties' expert reports and providing IDWR staff opinions regarding Rangen's water measurement methods and the use of ESPAM2.1 as a tool to provide information on the hydrologic effects of curtailment of junior groundwater use. IDWR staff contributors to this memorandum included:

[1] This is a summary of the issues identified in the expert and rebuttal reports and is not intended to convey agreement or disagreement regarding the relevancy of these issues.

- Jennifer Sukow, P.E., P.G., primary author, ESPAM2.1 analyses
- Dr. Allan Wylie, P.G., Ph.D., report reviewer, ESPAM2.1 analyses
- Tim Luke, contributing author, water measurement methods
- Neal Farmer, report reviewer, geology
- Sean Vincent, P.G., report reviewer
- Rick Raymondi, report reviewer
- Cindy Yenter, report reviewer, water measurement methods

Between the 1960s and the present, discharge of the Rangen spring complex has decreased in response to changes in the ESPA water budget. These changes include increased groundwater pumping, decreased incidental recharge associated with surface water irrigation, and changes in natural recharge derived from precipitation. Between 1966 and 2011, the average annual discharge at the Rangen spring complex decreased from 51 cfs to 15 cfs. Because the Rangen spring complex is hydraulically connected to the ESPA, it is clear that groundwater pumping has contributed to the decrease in discharge, but decreases in incidental recharge and natural recharge derived from precipitation have also contributed. The portion of the decrease that is attributable to groundwater pumping is more difficult to determine. ESPAM2.1 is a numerical groundwater model that was developed for the purpose of determining the effects of groundwater pumping on discharge to spring and river reaches, such as the Rangen spring cell.

Numerical models are recognized by the U.S. Geological Survey as the most robust approach for predicting the effects of groundwater pumping on surface-water discharge (Barlow and Leake, 2012). A numerical model is able to account for spatial variation in hydrogeologic features and aquifer stresses, and the temporal variation of aquifer stresses. ESPAM2.1 accounts for these features within the constraints of a one-square-mile model grid and one-month stress periods, which is superior to any other predictive method developed for the ESPA to date. Geologic controls on hydrologic responses to aquifer stress are reflected in the discharge and aquifer head data used to calibrate the model. ESPAM2.1, like all groundwater models, is an imperfect approximation of a complex physical system, but it is the best available scientific tool for predicting the effects of groundwater pumping on discharge at the Rangen spring cell and other spring and river reaches. ESPAM2.1 is a regional groundwater model and is suitable to predict the effects of junior groundwater pumping on discharge at the Rangen spring cell because the spring discharge responds to regional aquifer stresses, and junior groundwater pumping is a dispersed, regional aquifer stress.

The parties' experts disagree on whether or not ESPAM2.1 is capable of providing a reasonable prediction of the response to groundwater pumping at the model cell containing the Rangen spring complex. In the opinion of Brockway et al. (2012), the model is capable of predicting the response at the Rangen spring cell. In the opinion of Contor (2012), the model is only capable of providing a reasonable prediction of the response at the Buhl to Lower Salmon Falls reach. Brendecke (2012) appears to offer two opinions. Dr. Brendecke argues that the model prediction of the response at the Rangen spring cell is too uncertain to be used. He also argues that if IDWR uses ESPAM2.1, the steady state response functions, which are the model-predicted responses at the Rangen spring cell to curtailment within individual model cells, should be used to delineate a 10% trimline.

IDWR staff recommend using ESPAM2.1 as a predictive tool to evaluate the effects of groundwater pumping and curtailment of groundwater pumping on discharge at the Rangen spring cell and to evaluate the portion of curtailed use that will accrue to the Rangen spring cell. ESPAM2.1 predicted responses to curtailment of junior groundwater pumping within various areas are summarized in Table 1. These areas were selected in response to areas or de minimis standards discussed in the parties' expert reports, and are not intended to convey an opinion regarding the use of a trimline and/or the area of common groundwater supply to limit the area of curtailment.

ESPAM2.1 may also be used to predict the effects on discharge in the Buhl to Lower Salmon Falls reach and the portion of curtailed use that will accrue to the reach, as suggested by Contor (2012a). If ESPAM2.1 is not used to predict to the spring cell, apportioning the change in reach gain to the Rangen spring cell would need to be accomplished using an alternative method. The parties' experts did not suggest methods for apportioning the change in reach gain to the Rangen spring complex. IDWR staff evaluated potential alternative methods for predicting effects at the Rangen spring cell, but note that the alternative methods consider fewer data and are less robust than the ESPAM2.1 numerical model.

ESPAM2.1 was developed in an open, collaborative environment, with guidance from the Eastern Snake Hydrologic Modeling Committee (ESHMC). During development of ESPAM2.1, the ESHMC provided a forum for discussing model design, providing parties to this water call (and other interested parties) the opportunity for technical review and input throughout the model development process. Decisions regarding the conceptual model, model grid size, drain elevations, locations of transmissivity pilot points, spring discharge and aquifer head targets, the location of general head boundaries, calibration bounds, and other model features were presented to the ESHMC with opportunity for committee members to provide comments and suggest alternative approaches.

Summary of IDWR staff conclusions

Use of ESPAM2.1 as a predictive tool

1. ESPAM2.1 is the best available scientific tool for answering the following questions that may be relevant to this water call.

    a. What is the effect of junior groundwater pumping within the ESPA on discharge at the Rangen spring cell?

    b. What portion of curtailed groundwater use will accrue to the Rangen spring cell?

    c. What portion of curtailed groundwater use will accrue to other spring cells and reaches of the Snake River?

    d. How long will it take for the effects of curtailment of junior groundwater pumping to reach the Rangen spring cell?

    e. What is the effect of junior groundwater pumping within the ESPA on discharge at the Buhl to Lower Salmon Falls reach?

2. ESPAM2.1 incorporates the spatial distribution of aquifer recharge and discharge and regional-scale hydrogeology within the constraints of a one-mile square grid size and transmissivity pilot point spacing, which is approximately two to four miles in the vicinity of the Buhl to Lower Salmon Falls reach. The grid and transmissivity pilot point spacing allow ESPAM2.1 to reflect variations in aquifer stress and hydrogeologic properties with greater resolution than other available predictive methods.

3. Junior groundwater pumping within the ESPA occurs over an approximately 11,000 square mile area. The effect of this pumping on springs and river reaches is a regional-scale question that cannot be addressed with a small-scale, local model.

4. ESPAM2.1 was calibrated to over 43,000 observed aquifer water levels, over 2,000 monthly river gain and loss estimates, and over 2,000 monthly spring discharge observations collected from 14 different spring complexes, including 283 monthly spring discharge observations at the Rangen spring cell. These calibration targets reflect the impact of geologic features on hydrologic responses. Because the ESPAM2.1 calibration process considered such a large number of data, ESPAM2.1 is superior to other available predictive methods that consider significantly fewer data.

5. ESPAM2.1 was calibrated to observed monthly discharge data from May 1985 through October 2008 at the Rangen spring cell. The observed discharge is the response to regional aquifer stresses within the ESPA. ESPAM2.1 provides reasonable predictions of the response to changes in regional aquifer stress within the range of stress encountered during the May 1980 through October 2008 simulation period. The Rangen spring complex is the only spring complex in the Rangen model cell.

6. ESPAM2.1 was developed in an open, collaborative environment, with guidance from the Eastern Snake Hydrologic Modeling Committee (ESHMC). During development of ESPAM2.1, the ESHMC provided a forum for discussing model design, providing parties to this water delivery call (and other interested parties) the opportunity for technical review and input throughout the model development process. Decisions regarding the conceptual model, model grid size, drain elevations, locations of transmissivity pilot points, spring discharge and aquifer head targets, the location of general head boundaries, calibration bounds, and other model features were presented to the ESHMC with opportunity for committee members to provide comments and suggest alternative approaches. At the completion of ESPAM2.1, the ESHMC recommended, "*The Eastern Snake Hydrologic Modeling Committee recommends that the Department begin using ESPAM version 2.1 rather than ESPAM version 1.1 for ground water modeling.*" Two members of the committee (Mr. Sullivan and Dr. Brendecke) qualified this recommendation with, "*although other tools or models may be more appropriate in certain circumstances.*" Two other members of the committee (Mr. Warner and Mr. Contor) dissented from the recommendation.

7. The consumptive use of groundwater associated with irrigation water rights junior to July 13, 1962 within the ESPAM2.1 model boundary averages approximately 1.2 MAF/year. Curtailment of this use would increase net aquifer recharge to a volume within the range encountered during the model calibration period. For example, curtailment of this use during the years 2003-2007 (when average annual net ESPA recharge was approximately 4.4 MAF/year) would increase the net ESPA recharge to 5.6 MAF/year, which was the average annual net ESPA recharge during the years 1993-1997. Therefore, it is important that ESPAM2.1 was calibrated with equal consideration for each observed monthly value at the Rangen spring complex. It would not be appropriate to increase the weight of post-2000 observations during model calibration as suggested by Brendecke (2012, 2013) and Hinckley (2013).

8. Contor (2012a), Hinckley (2012, 2013), and Brendecke (2012, 2013) conclude that ESPAM2.1 does not include sufficient local-scale detail to be capable of providing a reasonable prediction of responses at the Rangen spring cell, but do not suggest alternative methods for estimating the response at the Rangen spring cell. If ESPAM2.1 is used to predict the response at the Buhl to Lower Salmon Falls spring reach, as suggested by Contor (2012a), then an alternative method for apportioning the reach response between the Rangen spring complex and other springs would need to be used. ESPAM2.1 incorporates the spatial distribution of recharge and groundwater pumping, a large number of water level and aquifer discharge observations, regional-scale hydrogeology, and the transient response of aquifer discharge to spatially and temporally distributed recharge and pumping. An alternative approach would likely neglect one or more of these factors and be inferior to using ESPAM2.1 to predict the response at the Rangen spring cell.

9. Steady state response functions for the Rangen spring cell consist of 11,236 model predictions of response at the Rangen spring cell to pumping in a single model cell. If ESPAM2.1 were not capable of providing a reasonable prediction of the effects of model-wide curtailment on discharge at the Rangen spring cell, it would also be incapable of reasonably predicting response functions for the Rangen spring cell and would not be able to provide a reasonable prediction of the location of the 10% trimline that Brendecke (2012) proposes.

10. Whether a trimline should be applied, and the basis for delineating a trimline, are policy and/or legal decisions. If a trimline is based on steady state response functions, as proposed by Brendecke (2012), the trimline delineates an area within which the portion of curtailed use that will accrue to the Rangen spring cell exceeds a given threshold percentage. Groundwater users outside of this area would be excluded from curtailment because the portion of their curtailed use that accrues to the Rangen spring cell is predicted to be less than the threshold percentage.

11. The ESPAM2.1 predicted response functions used to delineate the 10% trimline proposed by Dr. Brendecke are subject to the same types of model uncertainty as the ESPAM2.1 predicted response to model-wide curtailment. Use of the steady state response functions to delineate a trimline requires accepting that the ESPAM2.1 provides the best available prediction of response at the Rangen spring cell.

12. Delineation of a trimline based on steady state response functions is a direct application of ESPAM2.1-predicted responses, and is not an "*adjustment to model predictions*" as suggested by Brockway et al. (2012, 2013).

13. ESPAM2.1 is an improvement to ESPAM1.1, which was used as a tool to predict the effects of groundwater pumping, curtailment, and mitigation practices for administration of previous ESPA water calls.

ESPAM2.1 predictions

1. ESPAM2.1 predicted responses to junior groundwater curtailment within various areas are summarized in Table 1. These areas were selected in response to areas or de minimis standards discussed in the parties' expert reports, and are not intended to convey an opinion regarding the use of a trimline and/or the area of common groundwater supply to limit the area of curtailment.

2. ESPAM2.1 predicts that a model-wide curtailment of groundwater irrigation junior to July 13, 1962 would increase discharge at the Rangen spring cell by 17.9 cfs and reach gains in the Buhl to Lower Salmon Falls reach by 242 cfs at steady state. It would take approximately 13 years to reach 90% of the steady state response. The simulated curtailment would affect approximately 565,000 acres and would increase net aquifer recharge by approximately 1.2 MAF/year (1,705 cfs). The benefit predicted at the Rangen spring cell is only 1% of the curtailed use. The other 99% of the benefit would accrue to other springs and reaches of the Snake River. The predicted benefit to the Buhl to Lower Salmon Falls reach is 14% of the curtailed use. This curtailment simulation includes areas located outside of the current area of common groundwater supply.

3. Based on comparison of the historic response of the Rangen spring complex to changes in net recharge to the ESPA, the ESPAM2.1 predicted response of 17.9 cfs to a 1.2 MAF/year increase in net recharge appears to be reasonable. Rangen discharge data indicate that spring discharge decreased approximately 35 cfs between 1966 and 2007, in response to a decrease in average annual net recharge of approximately 1.7 MAF. Linear regression of Rangen spring complex discharge with a 5-year trailing average of net ESPA recharge indicates that spring discharge has historically changed by approximately 13 cfs per MAF change in the ESPA water budget (Figure 1), indicating that the response to a 1.2 MAF decrease in consumptive groundwater use should result in an increase on the order of 16 cfs in spring discharge. IDWR staff consider this predictive method inferior to ESPAM2.1, but it does provide a "reality check" that indicates the ESPAM2.1 prediction is not unreasonable given historic responses observed at the Rangen spring complex.

Area of curtailment	Predicted increase in discharge (cfs)			Portion of curtailed use accrued to reach (%)		
	Rangen spring cell	Buhl to Lower Salmon Falls reach[2]	Buhl to Lower Salmon Falls springs[3]	Rangen spring cell	Buhl to Lower Salmon Falls reach	Other reaches
Model domain	18	242	236	1%	14%	86%
Area of common groundwater supply (ACGW)	17	229	223	1%	15%	85%
10% trimline based on response at Buhl to Lower Salmon Falls reach (within ACGW)	15	198	193	3%	34%	66%
5% trimline based on response at Rangen cell	3.3	29	28	7%	59%	41%
10% trimline based on response at Rangen cell	0.01	0.08	0.08	13%	81%	19%

Table 1. Summary of ESPAM2.1 predicted responses to curtailment of groundwater irrigation junior to July 13, 1962.

[2] Includes increase in base flow modeled at general head boundaries.

[3] Excludes increase in base flow modeled at general head boundaries.

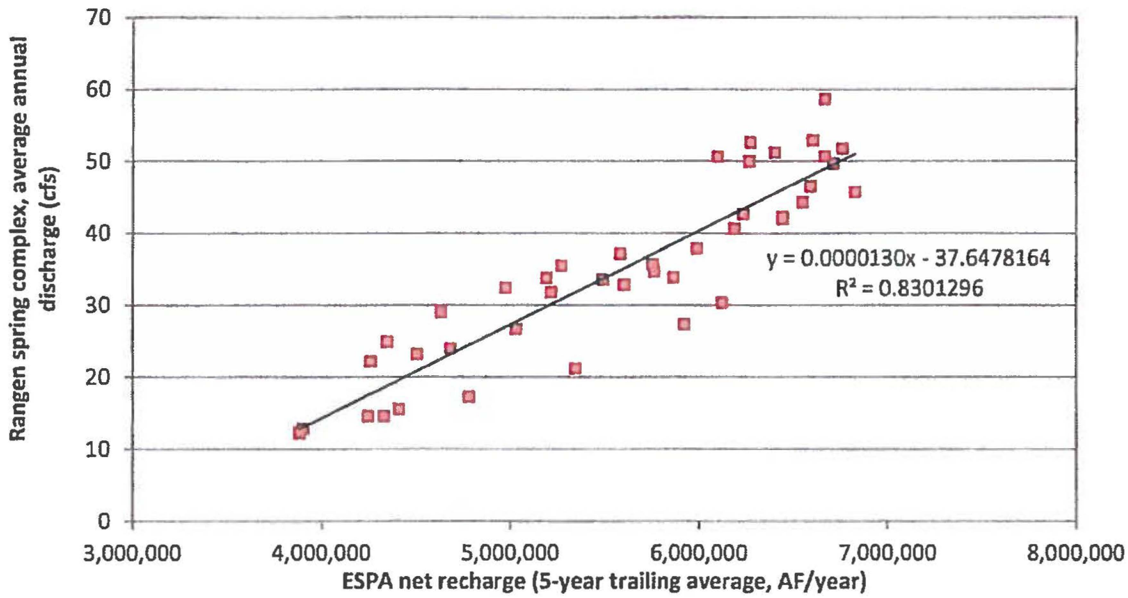

Figure 1. Comparison of average annual discharge at Rangen spring complex with net ESPA recharge.

4. ESPAM2.1 steady state response functions (Figure 2) indicate that discharge in the Rangen spring cell responds to stresses dispersed throughout the ESPA. Collectively, model-wide groundwater pumping has a significant effect on discharge at the Rangen spring cell, but more than 84% of the effects of groundwater pumping in any individual model cell propagate to other springs or reaches of the Snake River. The percentage of the effects of groundwater pumping that accrue to the Rangen spring cell generally decreases as distance from Rangen increases. Less than 1% of the effects of groundwater pumping east of the Great Rift[4] accrue to the Rangen spring cell.

5. If simulation of curtailment of groundwater irrigation is limited to the current area of common groundwater supply, ESPAM2.1 predicts that the benefit to the Rangen spring cell would be 16.9 cfs and the benefit to reach gains in the Buhl to Lower Salmon Falls reach would be 229 cfs. It would take approximately 11 years to reach 90% of the steady state response. The simulated curtailment would affect approximately 479,000 acres and would increase net recharge by approximately 1.1 MAF/year (1,509 cfs). The benefit predicted at the Rangen spring cell is only 1% of the curtailed use. The other 99% of the benefit would accrue to other springs and reaches of the Snake River.

[4] The Great Rift extends north to south across the plain from the Big Lost River Valley to just west of American Falls Reservoir. The transmissivity of the Great Rift is low relative to adjacent areas of the ESPA (IDWR, 2013).

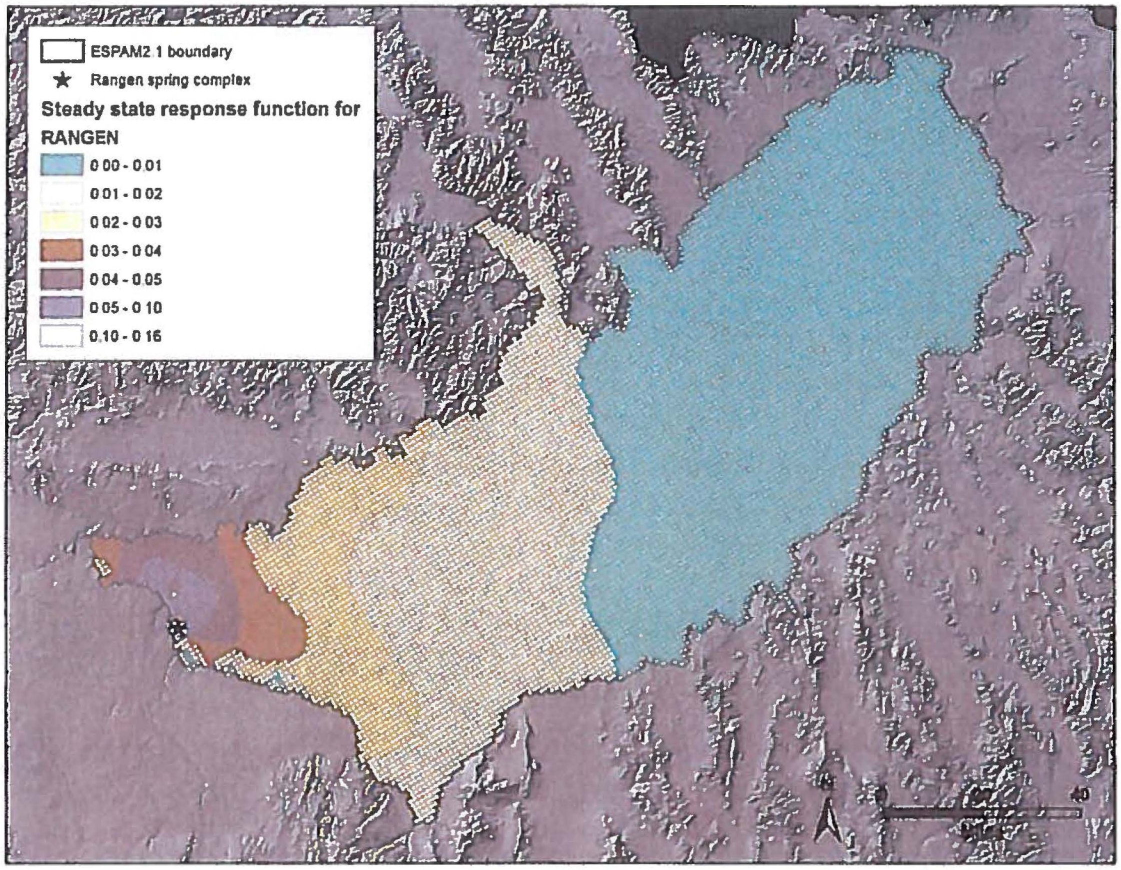

Figure 2. Steady state response functions indicating the portion of curtailed use that would accrue to the Rangen spring cell.

6. If simulation of curtailment of groundwater irrigation is limited to areas where at least 10% of the benefit is predicted to occur at the Rangen spring complex, ESPAM2.1 predicts that the benefit will be negligible (0.01 cfs).

7. If simulation of curtailment of groundwater irrigation is limited to areas where at least 5% of the benefit is predicted to occur at the Rangen spring complex, ESPAM2.1 predicts that the benefit would be 3.3 cfs. The simulated curtailment would affect approximately 12,300 acres and would increase net aquifer recharge by approximately 36,000 AF/year (49.6 cfs). Approximately 7% of the benefit would accrue to the Rangen cell, the other 93% would accrue to other springs and river reaches.

8. If simulation of curtailment of groundwater irrigation is limited to areas within the area of common groundwater supply where at least 10% of the benefit is predicted to occur at springs within the Buhl to Lower Salmon Falls reach, ESPAM2.1 predicts reach gains in the Buhl to Lower Salmon Falls reach would increase by 198 cfs and spring discharge at the Rangen cell would

increase by 14.7 cfs. The simulated curtailment would affect approximately 169,000 acres and would increase net aquifer recharge by approximately 419,000 AF/year (578 cfs). Approximately 34% of the curtailed use would benefit the Buhl to Lower Salmon Falls reach, and approximately 2.5% would benefit the Rangen cell.

9. ESPAM2.1 was calibrated to total discharge at the Rangen spring cell, and is not capable of predicting the effects of curtailment on Curren Tunnel discharge and other spring discharge separately. If there is a need to predict the effects of curtailment on tunnel discharge, IDWR staff recommend using the slope of the linear regression of tunnel discharge with total spring complex discharge. This method indicates that the response at the tunnel will be 70% of the total response (i.e., the predicted response at the tunnel would be 12.5 cfs for model-wide curtailment, 11.9 cfs for the area of common groundwater supply, 2.3 cfs for a 5% trimline, and negligible for a 10% trimline).

Model uncertainty

1. The ESPAM2.1 predicted responses to curtailment at the Rangen spring complex and the Buhl to Lower Salmon Falls spring reach are the best available predictions. Because of predictive uncertainty associated with using the model, the actual response may be lower or higher than the prediction. Predictive uncertainty was evaluated by Wylie (2012a). Model uncertainty was evaluated Contor (2012a, 2012b), and Brendecke (2012).

2. Wylie (2012a) evaluated the uncertainty of the ESPAM2.1 calibration with respect to predictive uncertainty at the Clear Lakes spring cell. None of the analyses involving Clear Lakes resulted in significant uncertainty.

3. The ESPAM2.1 calibration procedure allowed adjustment of several components of the water budget (including evapotranspiration, tributary underflow, recharge on non-irrigated lands, canal seepage, and non-Snake River seepage) within ranges of uncertainty determined by the ESHMC. The IDWR predictive uncertainty analysis (Wylie, 2012a) incorporated the impact of uncertainty associated with these components of the water budget on predictive uncertainty.

4. Contor (2012a) concluded that model uncertainty is at least 17%, based on uncertainty of the water budget input data. IDWR staff note that not all sources of uncertainty significantly impact every prediction. This is illustrated by the IDWR predictive uncertainty analysis (Wylie, 2012a), which incorporated the uncertainty associated with many of the components of the water budget and indicated that predictive uncertainty is low with respect to the response at the Clear Lakes spring cell. Further, a 17% increase or decrease (as suggested by Contor, 2012a) in the predicted response to curtailment at the Rangen spring complex would only be a change of 3 cfs (i.e. 17.9 cfs $\pm$ 17% would be a range of 14.9 to 20.9 cfs).

5. Brendecke (2012) evaluated conceptual model uncertainty by developing two alternative models that he asserts better represent local conditions in the vicinity of the Rangen spring cell. IDWR staff simulated a model-wide curtailment with these models and found that the models

predicted responses of 18.5 cfs and 18.0 cfs at the Rangen spring cell. These responses are less than 0.6 cfs different from the response of 17.9 cfs predicted by ESPAM2.1.

6. IDWR staff also used Dr. Brendecke's alternative conceptual model to simulate the response to curtailment within the four mile square area located within a 10% trimline defined using ESPAM2.1 predictions of responses at the Rangen spring cell. The response to this curtailment simulation was a negligible amount of water (0.01 cfs) using both alternative models and ESPAM2.1.

7. The evaluations of model uncertainty performed by Contor (2012a, 2012b) and Brendecke (2012) have not been subjected to peer review by the ESHMC, and IDWR staff disagree with some of the methods used and conclusions drawn by these parties.

8. The evaluations performed by IDWR and the parties' experts are partial evaluations of model uncertainty and do not fully explore or quantify all aspects of model uncertainty. These evaluations do not contradict IDWR's conclusion that ESPAM2.1 is capable of providing a reasonable prediction of the response to groundwater pumping at the Rangen spring cell. These evaluations also do not contradict IDWR's conclusion that ESPAM2.1 is the best available scientific tool to estimate the quantity of the response.

Consideration of alternative predictive methods

1. Contor (2012a), Hinckley (2012), and Brendecke (2012) conclude that ESPAM2.1 does not include sufficient local-scale detail to be capable of providing a reasonable prediction of responses at the Rangen spring complex, but do not propose alternative methods for predicting the effects of curtailment of junior groundwater pumping at Rangen. IDWR staff considered the following alternative predictive methods.

    a. Do not predict the effects of curtailment. This alternative provides the hearing officer with no information regarding the magnitude of effects of curtailment at Rangen or other springs and river reaches, no information for delineating an area of de minimis effects, and no information regarding potential mitigation requirements or the effects of proposed mitigation plans.

    b. Use ESPAM2.1 to predict the response at springs within the Buhl to Lower Salmon Falls reach and use an inferior method to estimate the portion of the reach gains that would benefit the Rangen spring complex.

        i. Use the Covington and Weaver ratio method previously used with ESPAM1.1 to apportion discharge to the Rangen spring complex. This method results in a predicted accrual of 2.9 cfs at the Rangen spring complex in response to model-wide curtailment, and 2.4 cfs in response to curtailment within a 10% trimline for the reach. This method is inferior to using the ESPAM2.1 prediction for the Rangen spring cell, because it considers fewer data than ESPAM2.1, neglects regional hydrogeologic conditions that are included in ESPAM2.1, neglects the spatial distribution of aquifer recharge and discharge, and neglects the sensitivity of higher elevation springs to changes in aquifer head.

ii. Use a linear regression of Rangen spring complex discharge with reach gain to predict change in Rangen spring discharge corresponding to the modeled change in reach gain. This method results in a predicted accrual of 6.8 cfs at the Rangen spring complex in response to model-wide curtailment and 5.5 cfs in response to curtailment within a 10% trimline for the reach. This method is inferior to using the ESPAM2.1 prediction for the Rangen spring cell, because it considers fewer data than ESPAM2.1, neglects regional hydrogeologic conditions that are included in ESPAM2.1, and neglects the spatial distribution of aquifer recharge and discharge.

c. Use ESPAM2.1 to predict the response at Well 989, which is the closest head target and water level change target to the Rangen spring cell, located approximately ½ mile northeast of the Rangen spring complex. Use a linear regression of observed Rangen spring complex discharge with observed water level elevation to evaluate the response at the Rangen spring complex to change in head at Well 989. This method predicts accrual of 16.5 cfs at the Rangen spring complex in response to model-wide curtailment. This method considers nearly all of the data used by ESPAM2.1, but the correlation between Well No. 989 and Rangen spring discharge does not consider the transient response time between the two locations.

d. Use a linear regression between observed Rangen discharge and the estimated annual net recharge to the ESPA to predict the response to curtailment. This method is inferior to ESPAM2.1 because it considers far fewer data than ESPAM2.1, neglects regional hydrogeologic conditions that are included in ESPAM2.1, and neglects the spatial distribution of aquifer recharge and discharge. This method predicts a response of 16.1 cfs to a model-wide curtailment of junior groundwater irrigation.

2. ESPAM2.1, like many other groundwater models, was developed as a tool to answer questions that could not be addressed adequately with other predictive methods. The groundwater model is able to incorporate more observed data than other predictive methods, and can calibrate hydrogeologic properties that cannot be measured to best fit the observed data. ESPAM2.1 is the best developed scientific tool for predicting the effects of junior groundwater pumping on the Buhl to Lower Salmon Falls spring reach and at the Rangen spring complex.

3. Numerical models are recognized by the U.S. Geological Survey as the best approach for predicting the effects of groundwater pumping on surface-water discharge. The U.S. Geological Survey states, "*Numerical models provide the most robust approach for determining the rates, locations, and timing of streamflow depletion by wells.*" (Barlow and Leake, 2012). The use of a numerical model, like ESPAM2.1, is able to account for the irregular geometry of aquifer

boundaries, irregular geometry of rivers and spring locations, heterogeneous aquifer properties, and time-varying aquifer stresses applied at various locations within a basin. ESPAM2.1 accounts for these features within the constraints of a one-square-mile model grid, the transmissivity pilot point spacing, and one-month stress periods, which is superior to any other predictive method developed for the ESPA to date.

Adequacy of Rangen discharge measurements

1. Rangen submitted annual water measurement reports directly to IDWR from 1995 through 2009, and to Water District 36A from 2010 to 2012. IDWR has accepted these annual water measurement reports during this period of record understanding that Rangen estimates hatchery diversions or flows using fish raceway check boards as non-standard weir measuring devices.

2. Check board weirs are not considered standard measurement devices. IDWR's *Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices* specify that construction, installation and operation of open channel measuring devices, including contracted rectangular weirs and suppressed rectangular weirs, should follow published guidelines such as those published by the United States Bureau of Reclamation (USBR, 1997).

3. Although the raceway check boards are not considered standard measuring devices, IDWR accepts measurements using these structures at Rangen and many hatcheries in the area because IDWR's standards allow an accuracy of +/-10 percent for open channel measuring devices when compared to measurements using standard portable measuring devices. Rangen likely under-measures actual flows, but an error up to -10% is acceptable pursuant to IDWR's *Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices.*

4. The calibration target used for ESPAM2.1 was submitted to the ESHMC for review and comment in the fall of 2009. ESHMC members were provided the opportunity to review and comment on the proposed calibration target during development of ESPAM2.1.

5. Systematic under-measurement of discharge at the Rangen spring cell by 10% would be expected to result in slightly lower model predictions of discharge and response to curtailment at the Rangen spring cell. This would favor the groundwater users, not Rangen.

Summary of expert reports

This section summarizes and responds to the following expert reports submitted in the Matter of Distribution for Water to Water Right Nos. 36-02551 and 36-07964, hereafter referred to as the Rangen Delivery Call.

1. Brockway, C.E., D. Colvin, and J. Brannon, 2012. *Expert Report in the Matter of Rangen, Inc. – Availability of Spring Flow and Injury to Water Rights*, prepared for Rangen, Inc., December 20, 2012.
2. Smith, C. E., 2012. *Expert Report in the Matter of Distribution of Water to Rangen, Inc's Water Right Nos. 36-02551 and 36-07694*, prepared for Rangen, Inc.
3. Hinckley, B., 2012. *Rangen Groundwater Discharge and ESPAM2.1 Hydrogeologic Investigation*, prepared for Racine, Olson, Nye, Budge, and Bailey, Chartered, December 20, 2012.
4. Brendecke, C.M., 2012. *Hydrology, Water Right and Groundwater Modeling Evaluation of Rangen Delivery Call*, prepared for Racine, Olson, Nye, Budge, and Bailey, Chartered, December 21, 2012.
5. Rogers, T.L., 2012. *Expert Witness Report by Thomas L. Rogers, Fisheries Biologist/Fish Culturist*, prepared on behalf of the Idaho Ground Water Appropriators, Inc., December 21, 2012.
6. Church, J.S., 2012. *Expert Witness Report by John S. Church, Economist*, prepared on behalf of the Idaho Ground Water Appropriators, Inc., December 21, 2012.
7. Contor, B.A., 2012a. *Technical Report on ESPAM2.0 Modeling Issues*, prepared for Fremont Madison Irrigation District, October 1, 2012.
8. Contor, B.A., 2012b. *Supplement to Technical Report on ESPAM2.0 Modeling Issues*, prepared for Fremont Madison Irrigation District, December 13, 2012.
9. Sullivan, G.K., 2012. *Spronk Water Engineers, Inc. Expert Report in the Matter of Distribution for Water to Water Right Nos. 36-02551 and 36-07694 (Rangen, Inc.)*, prepared for the City of Pocatello, December 21, 2012.

Summary of expert reports submitted on behalf of Rangen, Inc. (Rangen)

Brockway et al. (2012) provide brief descriptions of eastern Snake Plain aquifer (ESPA) geology and hydrogeology, the historical response of the ESPA to changing water use, the history of the Rangen Hatchery, and the history of Rangen's delivery calls. The report addresses historical water availability at the Rangen Hatchery, water measurement procedures, and provides a brief discussion of alternatives Rangen has evaluated for increasing water supply. The report discusses the development of ESPAM2.1, evaluates IDWR tools developed for simulating curtailment of junior groundwater pumping with ESPAM2.1, and evaluates the algorithm used to represent spring discharge in ESPAM2.1. The report also discusses incidental benefits to other water users resulting from the requested curtailment.

Regarding adequacy of measurement, Brockway et al. (2012) state that Rangen applies a modified weir coefficient to calculate discharge from stage measured over 2-inch thick boards at the CTR raceways and Lodge Pond Dam. They state this is consistent with standard practice at aquaculture facilities.

Brockway et al. (2012) indicate that Rangen has evaluated six alternatives for increasing water supply to the hatchery. The first alternative, diverting water formerly used for agricultural irrigation, was implemented after construction of the Sandy Pipeline. The other alternatives considered included withdrawing water from vertical wells, constructing a horizontal well below the Curren Tunnel, diverting water from the Weatherby Springs/Hoagland Tunnel complex, reducing possible downward flow through existing wells upgradient of Curren Tunnel, treating and re-using hatchery tailwater. The report provides explanations for why these five alternatives are not considered feasible.

Brockway et al. (2012) present results of one modeling simulation performed using the ESPAM2.1. Input data were processed using tools and methodology developed by IDWR for simulating curtailment of groundwater irrigation. Curtailment of groundwater irrigation junior to July 13, 1962 was simulated using ESPAM2.1 in superposition mode. The simulation predicts 17.9 cfs will accrue to the Rangen spring complex at steady state, in response to curtailment of junior groundwater irrigation within the ESPAM2.1 model boundary.

Brockway et al. (2012) present correlations of the Rangen spring complex discharge with water levels measured in seven wells to demonstrate the relationship between aquifer head and spring discharge. They conclude that this analysis demonstrates that Rangen spring complex responds to regional aquifer head, and that this response supports use of ESPAM2.1 to predict responses to changes in aquifer head at the Rangen spring complex.

Brockway et al. (2012) provided sixteen statements of opinion on pages 26 and 27 of their report. Selected points are summarized in this paragraph. In their opinion, the exercise of Rangen's water rights has been impacted by junior groundwater rights, Rangen is appropriately measuring and using available spring flow, Rangen does not have feasible alternatives for increasing water flow through the hatchery via either alternative sources or reuse of hatchery tailwater, and curtailment to mitigate injury to a senior water right is not a waste of the water resource. In their opinion, ESPAM2.1 is the best available science and the IDWR tools and methodology developed for simulating curtailment are sufficient for calculating the impacts of curtailment on water levels and spring flows. Their simulation of curtailment of groundwater pumping junior to July 13, 1962 within the ESPAM2.1 model boundary resulted in a predicted steady state impact of 17.9 cfs at the Rangen spring complex. In their opinion, this prediction is the best available prediction and should not be modified or adjusted using estimates of model uncertainty.

Smith (2012) provided opinions on beneficial use of the water supply currently available to Rangen, and addressed Rangen's ability to put additional water to beneficial use. Mr. Smith visited the hatchery in July and October 2012, and stated that Rangen was using all of the available water to raise fish and conduct research. Mr. Smith stated that 20 of 20 small raceways, 21 of 30 large raceways, and 6 of 9 CTR raceways were unused because of insufficient water flow. Mr. Smith provides additional detail regarding Rangen's use of water to raise fish for research testing of fish feeds and for sale to Idaho Power Company. Mr. Smith states that Rangen currently orders eggs only three times per year because of low water flows, and that trout eggs must be ordered one to two years in advance. Mr. Smith states that fish production is constrained by fish loadings (lbs/gpm of water flow) and fish densities (lbs/ft^3 of space) and acknowledges that the allowable loading and density for rainbow trout currently raised for sale to Idaho Power Company are lower than required for fish sold to processors. Mr. Smith notes that Idaho Power Company pays a higher price per pound than local processors.

Mr. Smith states that water currently being used at the Rangen hatchery is of excellent quality, having optimum temperature for growth of rainbow trout (59-60° F), pH between 7.8 and 8.1, hardness of approximately 130 ppm as $CaCO_3$, and is saturated with dissolved oxygen. Mr. Smith concluded that Rangen is using all of the currently available water in a reasonable manner to raise fish, and that Rangen could raise more fish and/or conduct more research if more water was available.

Summary of expert reports submitted on behalf of Idaho Ground Water Appropriators, Inc. (IGWA)

Hinckley (2012) evaluates geology and hydrogeology in a study area encompassing Thousand Springs to Malad Gorge and the Wendell area and evaluates the ESPAM2.1 representation of this area. Mr. Hinckley concludes that ESPAM2.1 does not adequately represent the details and complexity of geologic and hydrogeologic conditions in his study area, and that there is "*considerable uncertainty in the use of the ESPAM2.1 to inform detailed hydrologic analyses of the groundwater discharges at Rangen*." Mr. Hinckley concludes that the Curren Tunnel is a horizontal flowing well that was not constructed to maximize sustainable, year-round production. Mr. Hinkley concludes that "*there are opportunities to develop substantially more robust access to quantities of groundwater to those historically measured at the Curren Tunnel*" by moving the point of diversion and constructing a vertical well above the rim in the area east of Rangen.

Brendecke (2012) discusses hydrology of the Eastern Snake Plain, water rights for the Rangen Hatchery, ESPAM development, simulation of curtailment of junior water rights, and model uncertainty. Dr. Brendecke provides 87 conclusions in Section 1.3 of his report; selected points are summarized in this paragraph. Dr. Brendecke concludes that the source for water rights 36-2551 and 36-7694 is the Martin-Curren Tunnel, which he argues meets the definition of a well, and implies that Rangen does not have a right to divert from the "*natural springs*" that have also historically supplied the hatchery. Dr. Brendecke concludes that water shortages should be evaluated with respect to historic flow in the Martin-Curren Tunnel, not historic diversions to the hatchery. Dr. Brendecke argues that ESPAM2.1 is not capable of separating the effects of groundwater pumping on flows from Martin-Curren Tunnel from other springs in the Rangen complex, and that ESPAM2.1 is not sufficiently detailed in its general formulation or its representation of hydrogeologic conditions at Rangen to be used reliably to predict effects of curtailment at Rangen. Dr. Brendecke presents two alternative calibrated models, which he asserts better reflect hydrogeologic conditions near Rangen. Dr. Brendecke claims that benefits predicted at Rangen using his alternative models are significantly less than predicted by ESPAM2.1, and argues these models illustrate the potential effects of conceptual model uncertainty on predicted responses at the Rangen spring complex. Although Dr. Brendecke argues that ESPAM2.1 is not sufficiently detailed to be used reliably to predict effects of curtailment at Rangen, Dr. Brendecke does not propose other tools, models, or methodology for predicting these effects. Dr. Brendecke concludes that "*application of ESPAM2.1 should at a minimum restrict curtailment to junior rights for which ESPAM2.1 predicts at least 10% of the curtailed water will accrue to Rangen*", and that any curtailment of groundwater is a waste of the water resource because the majority of the foregone use would not accrue to Rangen.

Rogers (2012) discusses fish hatchery operation, operations at the Rangen Hatchery, and hypothetical fish-rearing scenarios. Mr. Rogers notes the Rangen hatches eggs in incubators and the fry are reared in troughs until they are large enough to be moved to the small raceways. As the fish grow and approach maximum density or flow indices in the small raceways, they are transferred to the large raceways. According to Mr. Rogers, Rangen currently rears triploid (sterile) rainbow trout under contract to Idaho Power Company (IPCO). The fish are released for sport fishing. Mr. Rogers states that Rangen also continues to perform research related to fish feed, fish flesh, color development and disease, and that Rangen sells some excess rainbow trout on the spot market. Mr. Rogers states that the IPCO contract requires adherence to strict water flow and fish density guidelines, which is consistent with a conservation hatchery program because of the desire to produce good quality fish with increased ability to survive in the natural environment. Mr. Rogers also states that the IPCO contract, which requires fish be ready for release in the months of May and June, prevents Rangen from timing the production cycle to coincide with seasonal fluctuations in water flow. Mr. Rogers concludes that Rangen could raise more fish if flow and density standards, and timing of the production cycle, were not dictated by Rangen's contract with IPCO.

Rogers (2012) concludes that even with the density restraints imposed by the IPCO contract, Rangen could raise more fish with its current water flows. Mr. Rogers bases his analysis on one lot of fish reared in 2011-2012. He states that constraints on production due to water quality generally occur during final rearing, when the fish are largest in size. He also states that estimates at the end of the rearing cycle in the large raceways noted a Density Index of 0.295 and a Flow Index of 0.74, which were below the maximum levels of 0.3 and 0.8 required by the IPCO contract. Mr. Rogers also provides analyses of how many additional fish could be reared if less restrictive Density and Flow Indices were used.

Rogers (2012) offers two suggestions for maximizing water supply to the hatchery. These suggestions include pumping water from Rangen's lower diversion up to the small raceways and developing wells in the ESPA above the canyon rim.

Church (2012) discusses the economics of rearing trout for food, Rangen's grant applications under the Eastern Snake Plain Aquifer Assistance Grants program, grant applications from other spring users, and the economic impacts of curtailment of groundwater irrigation. He asserts that Rangen should have implemented some of the measures outlined in these grant applications. Mr. Church concludes, "*Clearly Rangen has not expended even a minimum effort...to more efficiently use or to augment the waters available to its facility,*" and, "*it would be absurd to curtail ground water use in order to fractionally* *increase water flows to Rangen, without first requiring Rangen to undertake efforts on its own to augment or more efficiently use its water supply by employing measures that are available and have been utilized at other aquaculture facilities."*

Summary of expert reports submitted on behalf of Freemont Madison Irrigation District (FMID)

Contor (2012a) was submitted on October 1, 2012 and is based on analyses performed using ESPAM2.0. Mr. Contor states that the determination and application of a de minimis threshold is a policy question, and that a de minimis policy could be defined in terms of a threshold fraction below which propagating effects are considered de minimis, or in terms of a threshold total volume per time, below which effects are considered de minimis. Either approach could be implemented using ESPAM.

Contor (2012a) simulated benefits to the Buhl to Lower Salmon Falls reach from curtailment of groundwater irrigation on the Egin Bench using ESPAM2.0. Using ESPAM2.0, Mr. Contor predicted the cumulative benefit to the Buhl to Lower Salmon Falls reach from curtailment on the Egin Bench junior to July 13, 1962 is 1.90 AF after 150 years, or 0.04% of the curtailed volume. Contor (2012b) concludes that the differences between ESPAM2.0 and ESPAM2.1 do not appear to substantially change the model results relied upon in Contor (2012a). Mr. Contor did not submit an analysis using ESPAM2.1.

Contor (2012b) recommends that ESPAM results be applied using Administrative Reaches that are comprised of entire Calibration Reaches and are no smaller than the distance between nearby transmissivity pilot points. He asserts this will greatly reduce uncertainty (p. 7). He also recommends that administrative decisions that hinge on the timing of arrival of effects be strongly informed by both the short-term temporal performance of the model during calibration and that great caution be exercised whenever administrative outcome is sensitive to timing differences shorter than approximately four months.

Contor (2012b) provides discussions of temporal and spatial uncertainty, the effect of uncertainty, and potential sources of uncertainty. He concludes that the uncertainty arising from the water budget is likely at least 17%, and that overall uncertainty exceeds this estimate. Mr. Contor concludes that uncertainty will always decrease as questions are asked on larger spatial scales and longer cumulative time scales.

Summary of expert reports submitted on behalf of the City of Pocatello

Sullivan (2012) discusses the Rangen Hatchery facilities, water rights for the hatchery and other diversions from the Curren Tunnel, historical flow records, Rangen fish production data, and the City of Pocatello's water rights and water use.

Mr. Sullivan concludes that the Rangen facility has a capacity of slightly greater than 50 cfs, which is the combined flow rate of Rangen's 1957 and 1962 priority water rights. Mr. Sullivan notes that the decreed source of water for the Rangen water rights is the Martin-Curren Tunnel and does not include the spring sources below the tunnel. He concludes that it is not clear that Rangen can demand curtailment to satisfy deliveries associated with the springs below the tunnel.

Sullivan (2012) evaluates fish production data and concludes that the number of fish raised at the Rangen Hatchery is limited by density and flow indices in Rangen's contracts with Idaho Power. Mr. Sullivan suggests that Rangen could increase flow to their upper, small raceways by pumping water from above their lower diversion structure.

Mr. Sullivan identifies City of Pocatello water rights junior to July 13, 1962 that are within the current area of common groundwater supply and analyzes the effect of curtailment of these water rights on Rangen spring complex discharge using ESPAM2.1 response functions. His analysis indicates that the steady state response to curtailment of approximately 3,200 AF/yr would be 13.7 AF/yr (0.019 cfs) at the Rangen spring cell.

IDWR staff comments regarding expert reports

IDWR staff comments regarding expert reports submitted on behalf of Rangen

On page 5, Brockway et al. (2012) state, *"USGS records for Curren Tunnel indicate 50 cfs in 1902 and 96 cfs in 1917"*, citing Nace et al. (1958) as a reference. IDWR staff disagrees with this statement. Published records referenced by Nace suggest that these are measurements of the flow in Billingsley Creek and may include discharge from other springs tributary to Billingsley Creek downstream from Curren Spring. Published records do not suggest these records represent the discharge from Curren Tunnel as stated by Brockway et al. (2012).

Nace et al. (1958) provided a compilation of historic spring measurements published by the USGS and the State of Idaho. In April 1902, J.D. Stannard measured and estimated seepage at 119 locations along the Snake River for the Idaho State Engineer. These measurements were first published by Ross (1902) and were referenced by Nace et al. (1958). In April 1902, Mr. Stannard measured 54.4 cfs in Billingsley Creek at a location described as *"4 miles below Salmon Falls"*. Nace et al. (1958) states that the location of the measured section is not accurately determinable. In IDWR's opinion, it cannot be conclusively determined from the published information whether this measurement represents the discharge of only the Rangen spring complex, or includes contributions from other springs to Billingsley Creek. Because the Rangen spring complex is located approximately 2.5 miles east-northeast of Upper Salmon Falls and the mouth of Billingsley Creek is about 4.5 miles south of Upper Salmon Falls, it seems more likely that Stannard's measurement includes discharge from the Rangen spring complex and other springs tributary to Billingsley Creek.

The location of the 1917 measurement cited by Brockway et al. (2012) is also uncertain. Nace et al. (1958) cite USGS (1921), Meinzer (1927), and Stearns et al. (1938) as references for a 91.8 cfs measurement in September 1917. These three sources describe a measurement of Kearns Springs located in Section 36, Township 7 South, Range 13 East by the Twin Falls North Side Land and Water

Company. Nace et al. (1958) state that Kearns was probably a misunderstanding of a vocal reference to Curran Spring and believe this measurement likely applies to Curran Spring. However, IDWR staff note the location described by USGS (1921), Meinzer (1927), and Stearns et al. (1938) is consistent with Billingsley Creek near the Vader Grade road, and the measurement may or may not include discharge from Spring Creek Spring.

On page 14, Brockway et al. (2012) state, "*ESPAM2.1 utilizes the MODFLOW Drain Package to represent 90 spring discharges from the aquifer...*" IDWR staff note that although ESPAM2.1 has 90 drains, many of the spring discharge targets used in model calibration are represented by two, three, or four drains located in one or two model cells. ESPAM2.1 represents spring discharge at 50 spring complexes or groups of springs. Fourteen of these had transient calibration targets (Group A & B springs), and 36 had a single, average calibration target. Individual drains do not explicitly represent a particular discharge point within a given spring complex.

On pages 21-23, Brockway et al. (2012) present results from a steady state ESPAM2.1 simulation of curtailment of groundwater irrigation within the model boundary junior to July 13, 1962. Their analysis predicts a benefit of 17.9 cfs at the Rangen spring complex. Their report states that curtailment results in "*a decrease in ESPA depletion of 1,456,405 acre feet per year,*" but their model files indicate that the modeled stress was actually 1.24 MAF/year. This may be the result of misinterpreting the MKMOD output table values for "*total pumping*", which includes water that seeps back into the ESPA and is not equal to the net stress. The net stress is equal to the crop irrigation requirement, which is listed in the MKMOD output table as "*CIR*".

IDWR staff performed a steady state model simulation of the same curtailment to verify the results presented by Brockway et al. (2012). The IDWR analysis was performed using methodology described in Sukow (2012a, 2012b). IDWR's analysis predicts that curtailment within the model boundary will result in a 1.24 MAF/year reduction in depletions to the ESPA, while curtailing irrigation on approximately 565,000 acres. At steady state, this will result in a corresponding increase in gains to the Snake River and springs of 1,705 cfs, with 416 cfs predicted to accrue to springs and reach gains below Milner, 242 cfs predicted to accrue to the Buhl to Lower Salmon Falls reach, and 17.9 cfs predicted to accrue at the Rangen spring complex. IDWR's results are consistent with those presented in Dr. Brockway's Table 2, except for the totals presented at the bottom of his table, which are not consistent with his model files. Results of IDWR's analysis are provided in Attachment A.

It should be noted that the curtailment analysis performed by Brockway et al. (2012) includes curtailment in areas currently outside the area of common groundwater supply as defined by IDAPA 37.03.11.050. If the curtailment simulation is limited to the current area of common groundwater supply, curtailment is reduced to approximately 479,000 acres and the reduction in depletions to the ESPA is 1.09 MAF/year. At steady state, this will result in a corresponding increase in gains to the Snake River and springs of 1,509 cfs, with 392 cfs predicted to accrue to springs and reach gains below Milner, 229 cfs predicted to accrue to the Buhl to Lower Salmon Falls reach, and 16.9 cfs predicted to accrue at Rangen Spring. Results of IDWR's analysis are provided in Attachment A.

On pages 25-26 and in Appendix C, Brockway et al. (2012) discuss the development of relationships between groundwater levels and discharge at the Rangen spring complex as an alternative method. Dr. Brockway states that regression analyses indicate that over 88% of the variability in Rangen spring discharge can be explained by the water level variability in a predictor well. IDWR staff note that this approach generally appears to be valid, but that use of ESPAM2.1 or another method would still be required to predict the change in water level in the predictor well in response to curtailment.

IDWR staff agree with Brockway et al. (2012) that ESPAM2.1 is the best available science for predicting the response at Rangen Spring to curtailment of groundwater irrigation on the Eastern Snake Plain. IDWR staff also agree that measures of specific components of model uncertainty (uncertainty in model input data, uncertainty in measured observations used as calibration targets, uncertainty in calibrated aquifer parameters) are not equivalent to the uncertainty of a specific model prediction. Predictive uncertainty, as shown in Wylie (2012a), varies with the locations of stresses and responses and cannot be assigned a single numeric value. Regardless of the numeric value of uncertainty, the ESPAM2.1 prediction is currently the best available and most unbiased prediction.

IDWR staff comments regarding expert reports submitted on behalf of IGWA

On page 22 and Figure 12, Mr. Hinckley discusses a schematic MODFLOW model comparison developed by AMEC that is intended to illustrate the potential increase in discharge resulting from construction of Curren Tunnel. IDWR staff note that this model assumes there are no outlets for spring discharge other than the tunnel and thus does not illustrate the potential increase in total discharge to the Rangen spring complex. The lack of an alternative outlet for groundwater in the AMEC model is acknowledged by Mr. Hinckley on page 22.

On page 22, Hinckley (2012) states, "*The outlet elevation of Curren Tunnel has been variously reported as 3138 ft. (Covington and Weaver, 1990), 3145 ft. (Farmer, 2009) and 3150 ft. (IDWR, 2011).*" IDWR staff disagree with part of this statement. Covington and Weaver (1990) mapped "*Rangen Spring*" emerging from Malad Basalt pillow lava facies at an elevation of 3,138 feet, but did not suggest that this elevation represented the tunnel.

On page 24, Hinckley (2012) states, "*Farmer (2009) also rejects a multiple-pathways-through-the-talus interpretation...*" IDWR staff note that Farmer (2009) stated, "*One theory posed is that the actual spring discharge elevation from in-situ geology may be higher than where the spring is visible on the slope due the concept of water flowing out of the in-situ layer (buried beneath the slope material) and then flowing downward through talus and overburden slopes vertically in the subsurface, then flowing laterally again to where it daylights or is visible on the hillside. In my opinion, this phenomenon doesn't occur at Rangen or other springs north of Rangen up to Malad Gorge to as great of a degree as other upriver springs such as Crystal or Clear Springs because of the presence of the GFF in this reach and less overburden and talus.*" Mr. Farmer did not reject the possibility of discharge pathways through the talus. He stated that he believes it is not as significant at Rangen spring as at Crystal or Clear Springs. IDWR staff agree that Mr. Farmer identifies two discrete geologic contacts that may control a substantial portion of the discharge to the Rangen spring complex (see Figure 24 in Farmer, 2009), but IDWR staff note that this is a conceptual model that is intended to describe apparent major pathways for spring discharge, not all potential pathways for discharge.

On pages 26-27 and Figure 16, Hinckley (2012) criticizes the groundwater elevation contours published in Farmer and Blew (2012), and provides an alternative interpretation of groundwater elevation contours in an approximately 3.5 square mile area adjacent to the Rangen spring complex. The Farmer and Blew (2012) elevation contours were compiled based on water levels measured in 196 wells and 39 springs during November 2011. Mr. Hinckley contoured groundwater elevations in a smaller area based on 18 water level measurements. Mr. Hinckley removed three measurements from the Farmer and Blew dataset and added three measurements taken during different time periods. The measurements collected by Mr. Hinckley included a measurement from November 2007, from well T7S R14E 28DCB1. Measurements collected from the same well in October 2008 and February 2010 indicate water levels 9 to 12.5 feet lower than the November 2007 measurement selected by Mr. Hinckley. IDWR staff disagree with Mr. Hinckley's use of any measurements from well T7S R14E 28DCB1, because none of the measurements are representative of conditions during the November 2011 mass measurement.

Farmer and Blew (2012) contoured groundwater elevations with Surfer software using the Kriging option. This procedure has the advantage of being objective, and does not represent details that are not explicitly defined by the available data. Mr. Hinckley appears to have contoured groundwater elevations using Kriging, then manually adjusted some of the contours based on professional judgement and his interpretation of local conditions. This procedure has the advantage of incorporating geologic knowledge, but also has the disadvantage of incorporating bias based on interpretations that may not accurately reflect the complexity of local conditions. For example, Mr. Hinckley argues on page 26, "*the contouring* [of Farmer and Blew, 2012] *includes a closed contour approximately 1 mile northeast of Rangen. This represents a depression in the potentiometric surface, an unlikely occurrence in a prolific aquifer outside the active irrigation season.*" IDWR staff note that the November 2011 synoptic measurement occurred shortly after the end of the irrigation season and that residual transient effects of irrigation well pumping and recharge from surface water irrigation activities may still have resulted in local water level variations, such as depressions or mounds in the potentiometric surface.

On page 27, Mr. Hinckley concludes based on his Figure 16, "*A groundwater divide to the south distinguishes the local Rangen system from the Thousand Springs area. A groundwater divide to the north distinguishes the local Rangen system from rim springs between Rangen and the Malad River.*" IDWR staff are unclear what Mr. Hinckley means by "*distinguishes from*" or why Mr. Hinckley believes the existence of these local groundwater divides is significant. Groundwater divides are relevant in controlling contaminant transport, but do not result in hydraulic disconnection nor prevent responses to aquifer stress such as recharge or pumping. Well pumping results in drawdown that propagates radially in all directions (Figure 3). In a finite aquifer without unlimited recharge, drawdown will occur throughout the aquifer. The reduction in aquifer head will be largest near the well and may be very small in distant parts of the aquifer. A groundwater divide is not a hydraulic disconnection, unless caused by a continuous impermeable barrier. A stress applied on one side of a groundwater divide will affect aquifer heads on the other side of the divide and may affect the presence or location of a groundwater divide, which may change seasonally with changes in aquifer stresses. While Hinckley

(2012) and Farmer and Blew (2012) provide different interpretations of head contours in this area, the presence or absence of these groundwater divides is not relevant to the hydraulic connectivity of the Rangen spring complex to the larger ESPA. As shown in Hinckley (2012) Figure 7, the area contoured in his Figure 16 extends less than two miles from the rim. The extent of the groundwater divides shown by Mr. Hinckley is small relative to the area contoured by Farmer and Blew (2012). Regardless of the precise details of preferred flow pathways and direction in the immediate vicinity of the rim, spring discharge responds to head in the aquifer, and head in the aquifer responds to stresses applied throughout the aquifer.

On page 27, Hinckley (2012) states, "*Groundwater gradients also determine the discharge rates of springs and drainage tunnels. Given an opportunity for discharge, discharge rate is a function of the gradient.*" IDWR staff note that this is only partially true, the discharge rate is the product of the gradient and the conductance of the feature (spring or tunnel) at which the discharge occurs. A site with a low gradient may have high discharge if conductance is high, conversely a site with a high gradient may have low discharge if conductance is low. Because spring conductance is a lumped parameter that incorporates all of the head loss between the drain and the point where aquifer head is known or modeled, values for conductance vary over a large range. Conductance depends on the characteristics of the convergent flow pattern toward the drain, as well as on the characteristics of the drain and its immediate environment (Harbaugh, 2005; McDonald and Harbaugh, 1988). Conductance may be influenced by flow turbulence, the size of the drain feature, the size and interconnectivity of fractures or pore spaces, and other physical properties that are difficult or impossible to measure. Because of the number of factors that influence conductance, and the large natural variability in each of these factors, the large range in drain conductance modeled by ESPAM2.1 is realistic.

On page 27 and Figure 17, Hinckley (2012) presents the relationship between discharge of the Rangen spring complex and groundwater level measurements collected in a domestic well (07S 14E33 BBB1) located approximately one mile east-northeast of the Rangen spring complex. Water level measurements from this well were collected approximately bi-monthly by the USGS from 1985 to 2009, and by IDWR beginning in 2009. Mr. Hinckley asserts there is considerable uncertainty in the relationship between aquifer head and spring discharge. IDWR staff disagree, because Mr. Hinckley is not comparing spring discharge with aquifer head immediately adjacent to the spring complex his analysis ignores other factors, such as localized water level responses to nearby pumping wells or recharge sources, potential measurement error in both water level and spring discharge, and transient timing of responses to stress. Figure 4 shows a time-series graph of water level in well 07S 14E BBB1 and discharge at the Rangen spring complex. Figure 5 shows a graph of the relationship between measured water level and spring discharge. Note that much of the scatter discussed by Mr. Hinckley is associated with points in Figure 5 that appear to be outliers occurring when water levels above 3,166 feet were measured in mid-summer. These spikes in the water level measurements suggest that the well is responding to changes in nearby stresses. Changes in aquifer head immediately adjacent to the spring complex will be a function of the transient response time to these and other aquifer stresses.

On page 28 and Figure 18, Hinckley (2012) presents the relationship between discharge of the Curren Tunnel and groundwater level measurements collected in a monitoring well located approximately 600 feet east of the Rangen spring complex. The monitoring well was installed by the Idaho Water Resource Board (IWRB) in 2008, and daily water level measurements were collected by IDWR beginning in October 2009. In Figure 18, Mr. Hinkley compares daily measurements of water level and Curren Tunnel discharge. Mr. Hinkley asserts that this relationship indicates there is considerable uncertainty in the relationship between aquifer head and Curren Tunnel discharge, again ignoring potential measurement error and transient timing of spring responses to aquifer stresses. Further, linear regression of this relationship (Figure 6) indicates that 85% of the variability in the tunnel discharge during this 3-year period can be explained by a linear relationship with head in the monitoring well (Figure 5). Because the monitoring well was not installed until 2008, these data do not provide sufficient information to evaluate the response to water level changes that would be expected to occur if the aquifer water budget was changed by a model-wide curtailment of groundwater irrigation junior to 1962.

A more representative comparison of aquifer head and Rangen spring complex discharge would be comparison with IDWR Well No. 989, which is located approximately ½ mile northeast of the Rangen spring complex. This well is closer to the Rangen spring complex than well 07S 14E 33 BBB1 and has a longer record of water level measurements than the IWRB monitoring well. Well No. 989 has a record of 68 water level measurements collected between March 1998 and October 2008, representing a broader range of aquifer water budget conditions than the IWRB monitoring well. Well No. 989 was also used as a water level change calibration target in ESPAM2.1 (Figure 7). Comparison of measured water levels with spring discharge indicates that linear regression explains approximately 91% of the variability in the relationship between aquifer head at this location and discharge at the Rangen spring (Figure 8). These data indicate that there is a strong relationship between the change in discharge at the Rangen spring complex and change in aquifer head at the location of Well No. 989, with the discharge increasing by approximately 3.7 cfs per foot of increase in head.

12 Streamflow Depletion by Wells—Understanding and Managing the Effects of Groundwater Pumping on Streamflow

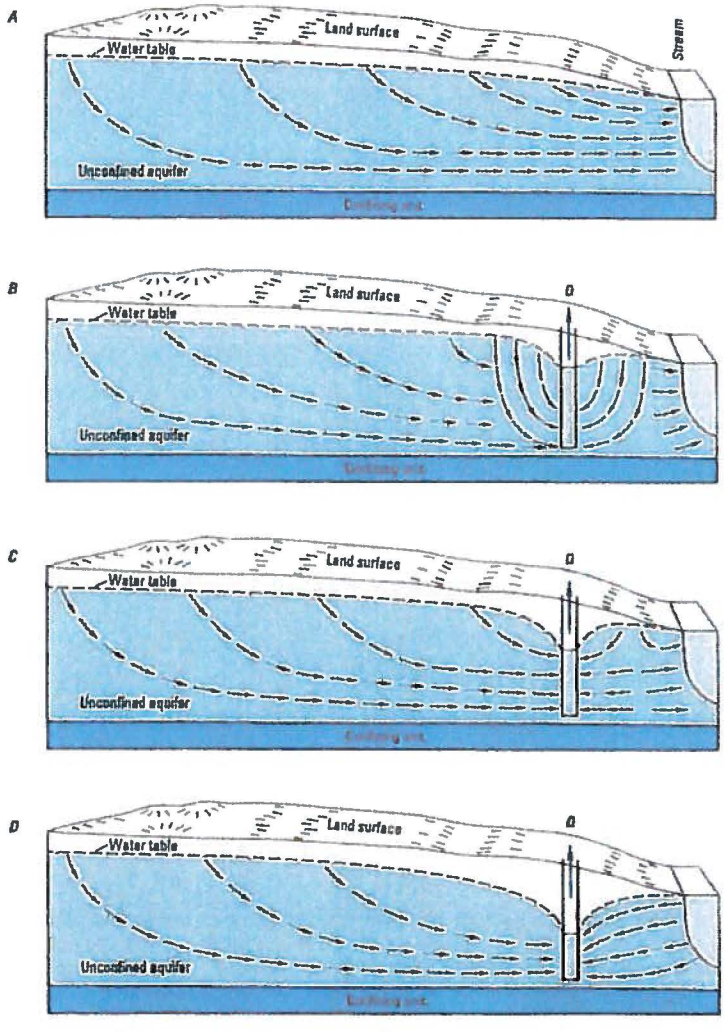

Figure 7. Effects of pumping from a hypothetical water-table aquifer that discharges to a stream. *A*, Under natural conditions, recharge at the water table is equal to discharge at the stream. *B*, Soon after pumping begins, all of the water pumped by the well is derived from water released from groundwater storage. *C*, As the cone of depression expands outward from the well, the well begins to capture groundwater that would otherwise have discharged to the stream. *D*, In some circumstances, the pumping rate of the well may be large enough to cause water to flow from the stream to the aquifer, a process called induced infiltration of streamflow. Streamflow depletion is equal to the sum of captured groundwater discharge and induced infiltration (modified from Heath, 1983; Alley and others, 1999). [*Q*, pumping rate at well]

Figure 3. Effects of well pumping on aquifer head and surface water discharge (from Barlow and Leake, 2012).

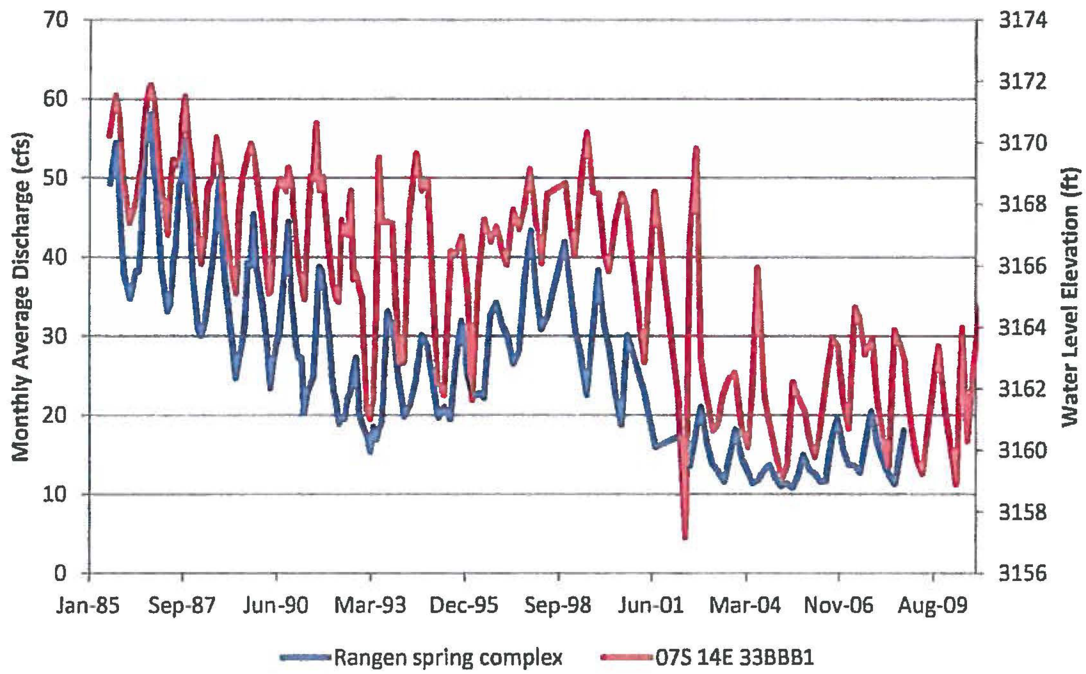

Figure 4. Measured water level in well 07S 14E 33 BBB1 and monthly average discharge at Rangen spring complex.

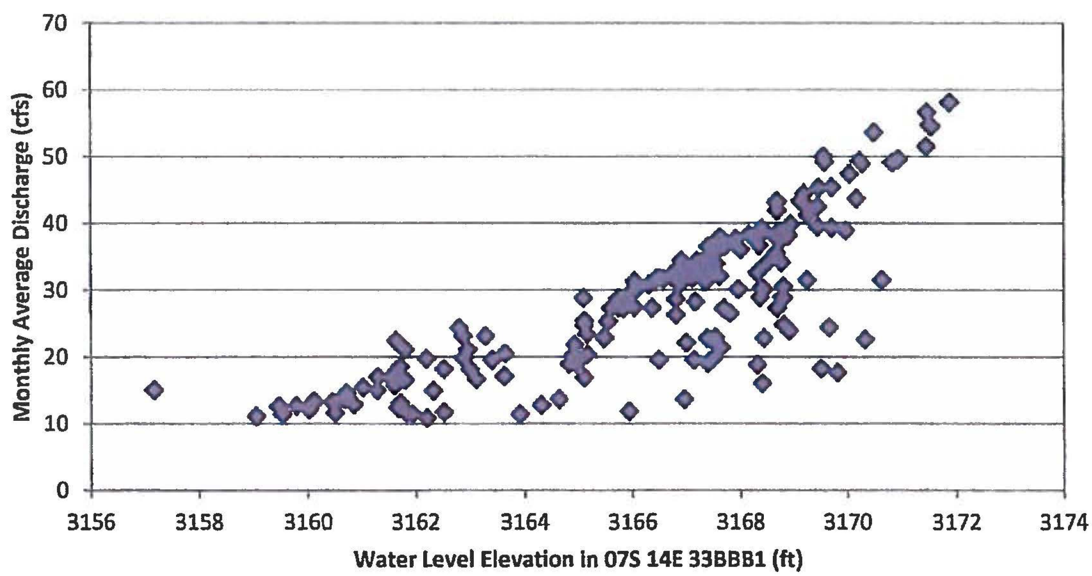

Figure 5. Relationship between measured water level in well 07S 14E 33 BBB1 and monthly average discharge at Rangen spring complex.

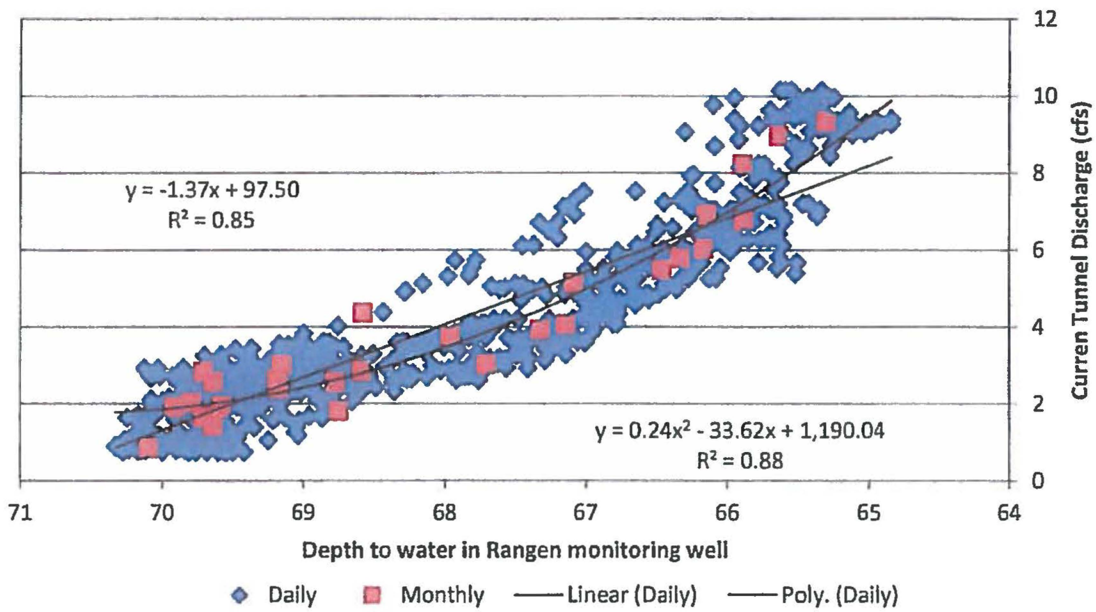

Figure 6. Relationship between Curren Tunnel discharge and water level in Rangen monitoring well, August 2008 to January 2012.

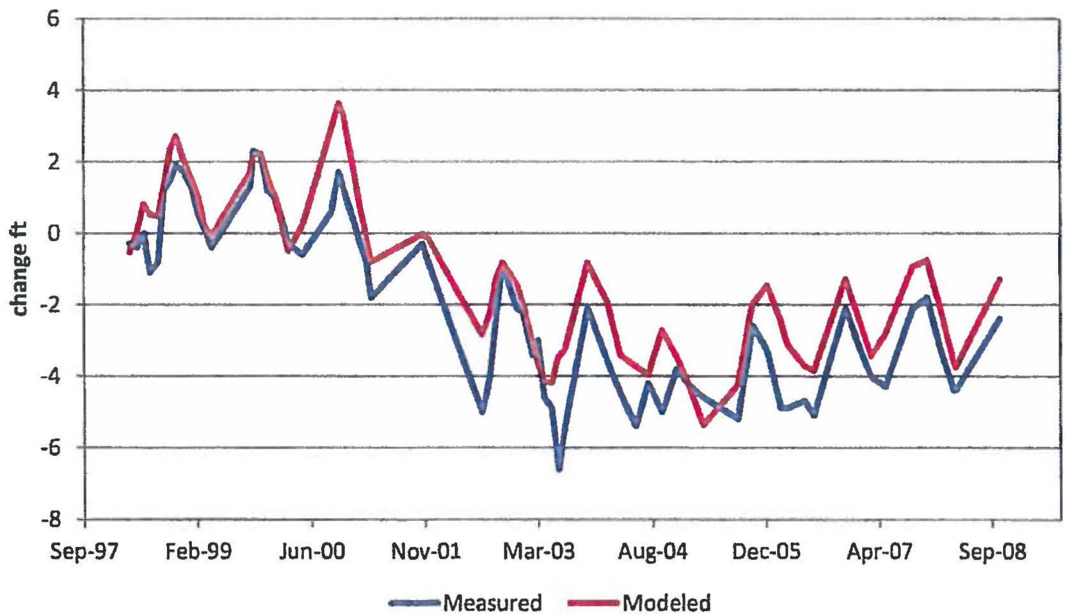

Figure 7. ESPAM2.1 calibration to water level change in IDWR Well No. 989.

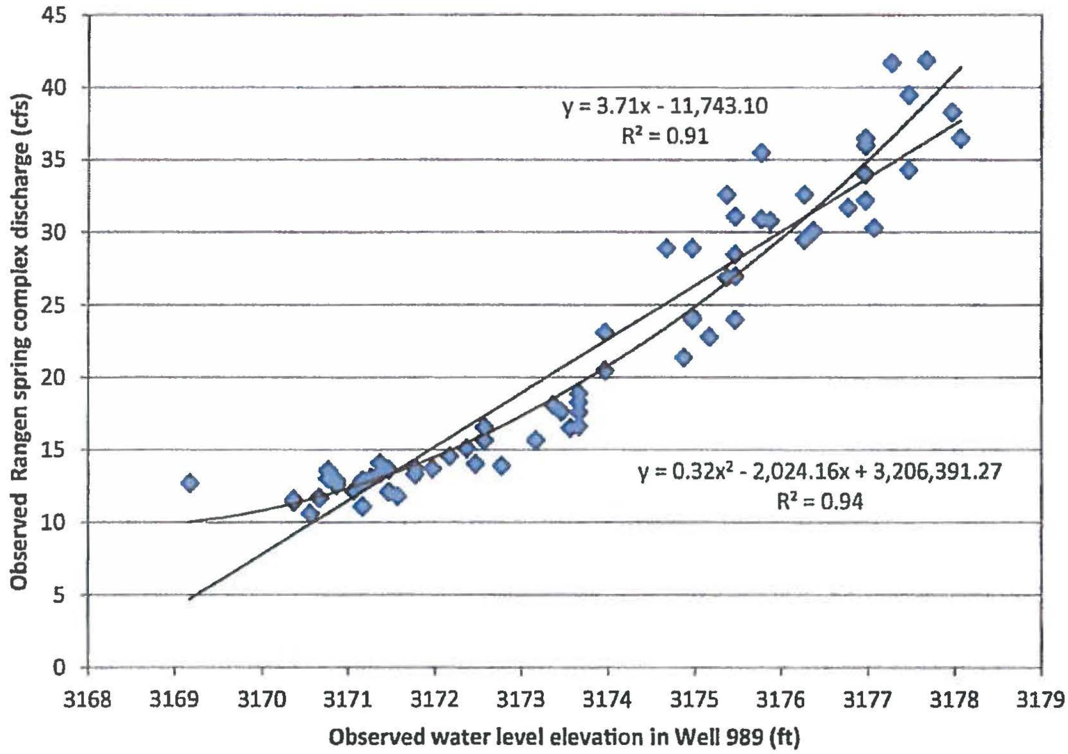

Figure 8. Relationship between Rangen spring complex discharge and aquifer head at IDWR Well No. 989.

On pages 30-45, Mr. Hinckley evaluates the ESPAM2.1 representation of the area between Thousand Springs and Malad. IDWR staff agree with some of Mr. Hinkley's points, but disagree with his conclusion that ESPAM2.1 cannot provide a reasonable prediction of the response at the Rangen spring cell to groundwater pumping in the ESPA. Because ESPAM2.1 is discretized into one-square-mile grid cells, it does not represent detailed topographic and geologic features that are smaller than one-mile in scale. However, ESPAM2.1 does represent regional topography and hydrogeologic features within the constraints of the one-square-mile model grid and the spacing of transmissivity pilot points, which is generally two to four miles in the vicinity of the Buhl to Lower Salmon Falls reach. This provides a better representation of the spatial and hydrogeologic relationships than is available in any other predictive model or method available for evaluating the effects of groundwater pumping within the ESPA on spring and river flows. On a local scale it is not possible to model the complexity of the aquifer with one-square-mile grid cells, however, on a regional scale, the response of head-dependent discharges to springs and rivers is dependent on aquifer head responses to recharge and well withdrawals. This allows responses to regional-scale stresses, such as groundwater pumping throughout the plain to be modeled with less uncertainty than responses to stresses applied in a small area located immediately adjacent to the spring or river.

IDWR staff agree with Mr. Hinckley that ESPAM2.1 is a linear approximation of a non-linear system, and does not reflect non-linear relationships between aquifer head and spring discharge. IDWR staff note that comparison of aquifer head and discharge (Figures 6 and 8) indicate that a linear regression does provide a reasonable approximation of the relationship, explaining 85 to 91% of the variability in these examples. Non-linear, polynomial regressions of these data only improve this correlation slightly, explaining only an additional 3% of the variability.

As stated by Mr. Hinckley, the model does not allow transmissivity to vary with time. Time-constant transmissivity models of unconfined systems are common in practice, because calibrating models with variable transmissivity is generally not feasible with automated parameter adjustment. Although IDWR staff agree that ESPAM2.1 is a linear approximation of a non-linear system and that this contributes to model uncertainty, IDWR staff do not agree with Mr. Hinckley's conclusion that ESPAM2.1 is not suitable for evaluating the response to aquifer stresses at the Rangen spring cell. ESPAM2.1 is the best available scientific tool for predicting responses to curtailment of groundwater pumping or other changes in regional aquifer stresses within the ESPA. The model was calibrated to spring and river responses to a range of aquifer stresses applied over a 23.5-year period, with net aquifer recharge ranging from 3.2 MAF/year to 6.3 MAF/year and measured discharge at the Rangen spring complex ranging from 11 to 58 cfs. The model calibration targets reflect geologic controls on hydrologic responses to a range of aquifer stresses. ESPAM2.1 provided reasonable approximations of measured discharge at the Rangen spring complex within this range of stresses and responses, and is expected to provide a reasonable approximation of the response to curtailment, which falls within the range of the calibration data set.

On pages 40-41, Hinckley argues, "*ESPAM2.1 is structurally incapable of modeling the relationships shown on Figures 17 and 18. Figure 28, for example, presents the data of Figure 18, expressed as deviations from an ideal linear model as required by ESPAM2.1. The average error in the predicted discharge is 20% of the average discharge, and deviations as large as 50% are not uncommon. Because Figure 28 uses well-measured, paired daily data (e.g. rather than monthly averages), and because the monitor well and discharge points are in near proximity, the relationship presented should be well controlled with respect to data-collection and location based errors.*" IDWR staff disagrees with these statements. The IWRB well referred to by Mr. Hinckley in Figure 28 is located approximately 600 feet from the Rangen spring complex. His comparison of paired daily data ignores transient timing of spring responses to changes in aquifer head, magnifies the impact of measurement error, and results in overestimation of deviations from a linear relationship. Because ESPAM2.1 calculates discharge at the Rangen spring complex to aquifer head at the Rangen spring complex, it is not appropriate to quantify deviations from linearity based on comparisons with aquifer head at a well any distance from the spring complex. As shown in Figure 6, a linear relationship explains approximately 85% of the variability between Curren Tunnel discharge and aquifer head at the IWRB well. Transient response time, measurement error, and physical non-linearity are factors in the other 15% of the variability. It is not appropriate for Mr. Hinckley to attribute all of the variability to physical non-linearity.

On page 42, Hinckley (2012) argues that the use of general head boundaries along the Hagerman rim effectively reverses the removal of the Hagerman Valley from the ESPAM2.1 model domain. IDWR staff disagree with this statement. The general head boundaries were added along the Hagerman rim to allow discharge from the ESPA to Billingsley Creek and/or the Snake River via one of several pathways that may include talus flow that does not daylight as spring discharge, discharge from the ESPA to Tertiary sediments to Billingsley Creek, or discharge from the ESPA to Tertiary basalts to the Snake River as conceptualized by Farmer, 2009 (Figure 9). The general head boundaries were added to provide an outlet for ESPA discharge that reaches Billingsley Creek or the Snake River without surfacing as springs. This does not reverse the removal of the Hagerman Valley from the ESPAM2.1 model domain, because there is no modeled aquifer recharge or discharge occurring in the Hagerman Valley, and elevations of the general head boundary were selected to be low enough that there was not any flux modeled from the Snake River into the ESPA in the reaches below Milner.

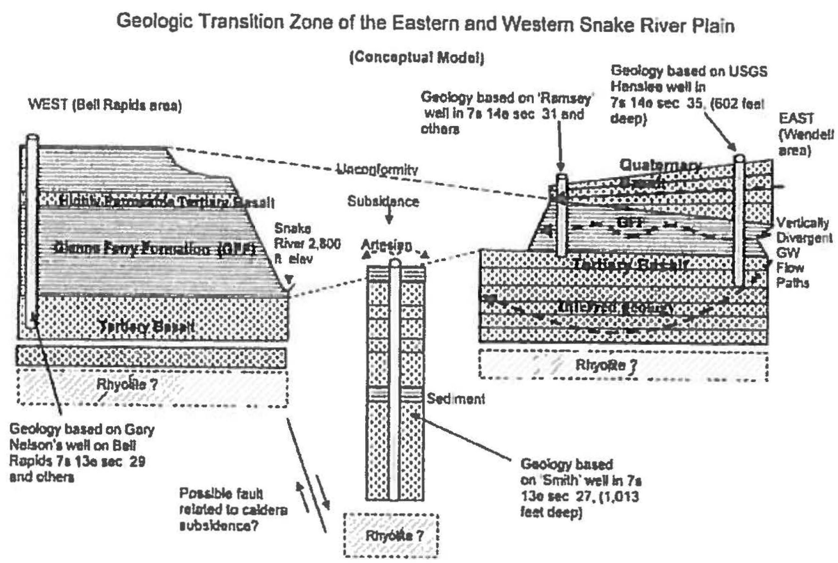

Figure 20. Conceptual model of Hagerman Valley (not to scale)

Figure 9. Farmer (2009) conceptualization of potential groundwater flow from ESPA to Tertiary sediments and basalts.

The locations of general head boundaries used to model base flow below Milner were discussed by the ESHMC, including Dr. Brendecke on December 12, 2011 and the committee agreed that a general head boundary "*would be assigned to cells with springs that butt against the river, and for cells along the edge of the Hagerman Valley*" (Raymondi, 2011). IDWR staff note that the analyses submitted by Leonard Rice Engineers, Inc. with Rangen's December 13, 2011 Petition for Delivery Call was performed using a preliminary calibration of ESPAM2 that pre-dated addition of the general head boundaries to the model. The results of their analysis (McGrane, et al., 2011) were similar to the results predicted by ESPAM2.1, suggesting that the addition of the general head boundaries along the Hagerman rim had little effect on model predictions of response at the Rangen spring complex.

On page 43, Hinckley (2012) claims that the ESPAM2.1 calibration targets for the general head boundary base flow were "*a constant, average value...despite the fact that the total gains through this reach have declined over the period, and include seasonal fluctuations of 700 cfs.*" This claim is false. In ESPAM2.1, each base flow reach was calibrated to an average value for the calibration period, not a constant value. During calibration, the average of model-calculated discharge from May 1985 through October 2008 was computed and compared to the target average value from Wylie (2012b). The model calibration is only constrained by the average value for the calibration period, and is still allowed to vary the base flow discharge with time to match fluctuations in the transient reach gain targets.

Brendecke (2012) concludes that observed flows of Billingsley Creek have not been high enough to provide any water to water right 36-7964 since October 1976, a date which precedes the water right's 4/12/1977 priority date. This is consistent with IDWR's previous review of this water right. Dreher (2005), stated "*...Rangen may be entitled to divert water under this right when such water is physically available. However, because water was not available to appropriate on the date of appropriation for right no. 36-07694, Rangen may not be entitled to have a delivery call recognized against junior priority rights.*" From a practical standpoint this is not relevant, because the predicted benefit from curtailing all groundwater users junior to the 7/13/1962 priority date of water right 36-2551 is only 17.9 cfs, and curtailment is not expected to provide more water than Rangen is entitled to divert under water right 36-2551. Between 2002 and 2011, annual average spring discharge ranged from 12 to 16 cfs, and monthly average spring discharge ranged from 11 to 22 cfs (Sullivan, 2012, Table 2-2). Based on 2002 to 2011 conditions, the predicted total annual average spring discharge would be between 30 and 34 cfs with curtailment.

Brendecke (2012) concludes that the source for water right 36-2551 is the Martin-Curren Tunnel and that flows from the tunnel have never been high enough to deliver the maximum diversion rate authorized under water right 36-2551. IDWR staff agree that the SRBA partial decree for water right 36-2551 lists the source as Martin-Curren Tunnel and describes the 10-acre tract containing the tunnel. A cursory review of the water right file indicates that the water right was licensed with the source described as "*underground springs tributary to Billingsley Creek*" and the point of diversion is located in the 40-acre tract containing both Curren Tunnel and Rangen's diversion at the head of the creek. The water right file also contains two survey drawings showing the point of diversion from the creek and the 36-inch pipe to the large raceways. The licensed priority date was July 31, 1962. The files reviewed did not indicate why the source, point of diversion, and priority date were changed in the SRBA.

Brendecke (2012) concludes that the Martin-Curren Tunnel meets the physical definition of a well contained in Idaho Code 42-230(b), which states, *"'Well' is an artificial excavation or opening in the ground more than eighteen (18) feet in vertical depth below land surface by which ground water of any temperature is sought or obtained."* The partial decree lists the source for water right 36-2551 as *"Martin-Curren Tunnel"*, not *"Ground Water"*. Whether the tunnel is considered a well or a developed spring for administration of water right 36-2551 is a legal, not a technical, question.

Brendecke (2012) concludes that much of the change in spring discharge in the Milner to King Hill reach since 1960 can be attributed to reduction in incidental recharge from surface water irrigation. IDWR staff acknowledge that reduction in incidental recharge from surface water irrigation has contributed significantly to reductions in spring discharge. Spring flows respond to changes in various types of aquifer stress, including changes in incidental recharge from surface water irrigation, well pumping, and infiltration of precipitation. ESPAM2.1 was calibrated with all of these stresses, and then the calibrated model was used to calculate the response to a change in well pumping while other stresses were held constant. ESPAM2.1 provides a method for determining the portion of the water shortage at the Rangen hatchery that can be attributed to junior groundwater pumping, rather than holding junior groundwater users accountable for the entire decrease in spring discharge. Spring discharge records indicate that the annual average spring discharge was 51 cfs in 1966 and 14 cfs in 2008 (Sullivan, 2012, Table 2-2). The steady state impact of junior groundwater pumping predicted by ESPAM2.1 is less than half of the total decrease in spring discharge between 1966 and 2008. Note that spring discharge in 1966 would have already been reduced to some extent by junior groundwater pumping developed between 1962 (the priority date for water right 36-2551) and 1966.

Brendecke (2012) states that *"The 1992 moratorium on new irrigation wells suggests that decreases in discharge after the mid-1990s are not the result of groundwater pumping."* IDWR staff note that groundwater pumping junior to July 13, 1962 has resulted in depletions to spring discharge every year since 1962. While the rate of depletion due to groundwater pumping may not have increased significantly since 1992, the depletions continue to occur. These depletions are superimposed on decreases in spring discharge resulting from changes in surface water irrigation practices and natural recharge derived from precipitation. Even if the rate of depletion due to groundwater pumping has been approximately constant since 1992, groundwater pumping continues to contribute to removal of water from aquifer storage, declines in ESPA water levels, and decreases in spring discharge.

Brendecke (2012) mentions that former Director Dreher found that curtailment of water rights junior to July 13, 1962 would not result in a meaningful increase in the quantity of water discharge from springs in the Thousand Springs to Malad Gorge spring reach, which includes the Curran Spring from which Rangen diverts surface water. Dreher (2005) indicates that this conclusion was based on simulations using ESPAM1.1. During development of ESPAM2.1, IDWR discovered that values from Covington and Weaver (1990) that were used to estimate discharge for Thousand Springs and springs in the Thousand Springs to Malad spring reach for calibration of ESPAM1.1 were inaccurate. These values were corrected in the calibration targets used for ESPAM2.1. These corrections included a significant decrease in the spring discharge target at Thousand Springs and a significant increase in spring discharge targets in the Billingsley Creek area (Table 2). ESPAM2.1 calibration targets also provided the model with information regarding transient changes in spring discharge in the Billingsley Creek area. Because ESPAM2.1 incorporates these and other improvements to ESPAM1.1, ESPAM2.1 model predictions are an improvement to analyses performed using ESPAM1.1.

ESPAM1.1 Spring Reach	ESPAM1.1 Discharge Target (cfs)	ESPAM1.1 Proportion of Milner to King Hill Discharge	Sum of Average ESPAM2.1 Discharge Targets (cfs)	ESPAM2.1 Proportion of Milner to King Hill Discharge
Devil's Washbowl to Buhl	1,002	0.18	840	0.14
Buhl to Thousand Springs	1,584	0.28	1,431	0.24
Thousand Springs	1,749	0.31	811	0.13
Thousand Springs to Malad (Billingsley Creek)	77	0.01	223	0.04
Malad	1,117	0.20	1,070	0.18
Malad to Bancroft	91	0.02	103	0.02
Baseflow, Kimberly to King Hill (ESPAM2.0 only)	--	--	1,537	0.26
Sum	5,620	1.00	6,015	1.00

Table 2. Comparison of calibration targets for springs below Milner.

Brendecke (2012) mentions that approximately 24,000 linear feet of lateral off the W-Canal in the area west of Wendell have been lined or placed in pipe since the 1990s, reducing incidental recharge. IDWR staff note that ESPAM2.1 does model this reduction in incidental recharge, because the sum of incidental recharge and canal seepage in the North Side Canal Company service area is equal to recorded diversions less crop irrigation requirement and return flow. IDWR staff also acknowledge that, while the volume of recharge reflects the canal lining/piping projects, the spatial distribution of the recharge does not reflect this change. The pre-processing tools developed for use with ESPAM2.1 have the ability to reflect changes in canal seepage rates with time, and this improvement could likely be incorporated into future versions of ESPAM2 if proposed to the ESHMC for consideration.

On page 4-4 Brendecke (2012) states that in ESPAM2.1 "*canal seepage losses are still considered to be constant throughout the model study period.*" IDWR staff would like to clarify that canal seepage rates in ESPAM2.1 were calculated as a constant percentage of diversions. Canal seepage losses vary with time, because diversions vary with time.

On page 4-6, Brendecke (2012) states that the number of adjustable parameters in ESPAM2.1 model calibration increases the likelihood that the model is not linear. Dr. Brendecke appears to misinterpret a quote from Doherty (2005). This quote refers to the linearity of the model calibration process, not the linearity of the calibrated MODFLOW model. IDWR addressed the non-linearity of the calibrated MODFLOW model in Sukow (2012c) with respect to the use of superposition to perform curtailment simulations.

On page 4-9, Brendecke (2012) states that water levels in the ESPA near Rangen vary seasonally by about 5 feet and that "*These changes are nearly 100% of the saturated thickness above the Tunnel and about 10% of the thickness above the lower springs, further indicating that the requirements for superposition are not met at Rangen.*" Dr. Brendecke appears to be referring to the guidelines for using a time-constant representation of transmissivity, not requirements for superposition. As stated in the ESPAM2.1 model documentation (IDWR, 2013), "*The generally considerable saturated thickness of the ESPA supports a time-constant representation of transmissivity, because drawdown is generally expected to be less than 10% of total saturated thickness (Anderson and Woessner, 1992).*" Note that this guideline applies to water level change as a percentage of the total saturated thickness. The portion of the saturated thickness that is above the tunnel elevation is not relevant, because the tunnel is not located at the base of the aquifer. If the lower springs are assumed to be located at the base of the aquifer, the water levels changes would be about 10% of the total saturated thickness, as acknowledged by Dr. Brendecke. Therefore, the conditions described by Dr. Brendecke are at the limit of the standard cited in IDWR (2013), but do not exceed this standard.

Brendecke (2012) indicates that ESPAM2.1 is not capable of separating the effects of groundwater pumping on flows from the Martin-Curren Tunnel from the effects on other springs in the Rangen complex. IDWR staff agree with this statement. Even in other spring cells where ESPAM2.1 has two drains, the model is calibrated to target data that reflect the total flow of all springs in the cell. Apportioning the predicted response between the tunnel and other springs in the Rangen complex, could done by applying a post-model calculation to the model prediction. The methodology should consider the amplitude of observed changes in the tunnel discharge and discharge from other springs, not the average magnitude of the discharges. Observed data (Figure 10) indicate that Curren Tunnel discharge is more responsive than discharge from other springs in the complex to changes in aquifer head. Linear regression of Curren Tunnel discharge with total Rangen spring complex discharge (Figure 11) indicates that the change in discharge at Curren Tunnel will be approximately 70% of the change in total spring complex discharge.

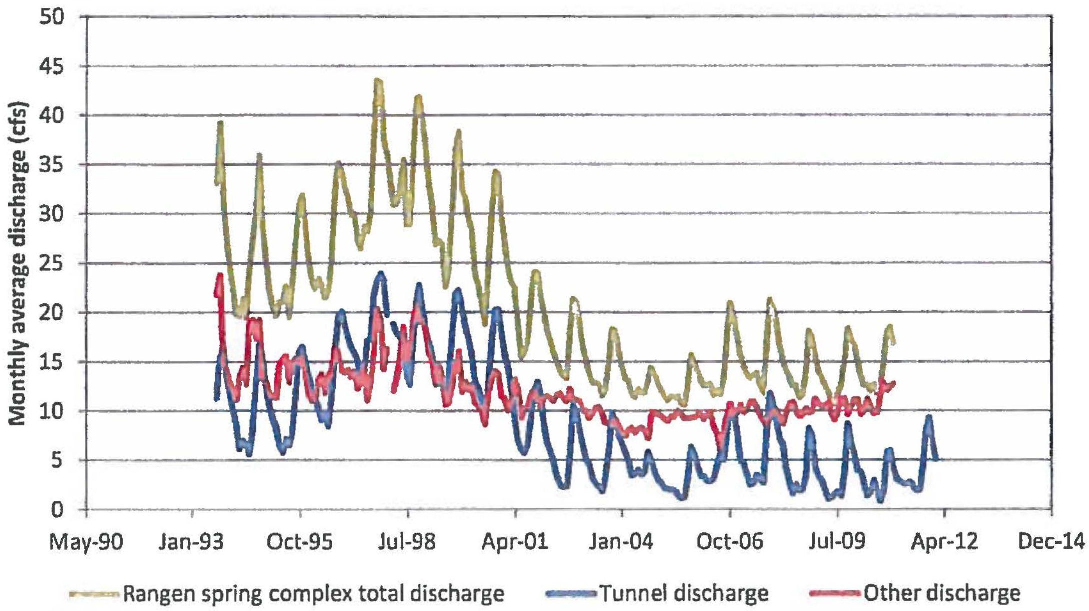

Figure 10. Observed monthly average discharge at Rangen spring complex and Curren Tunnel.

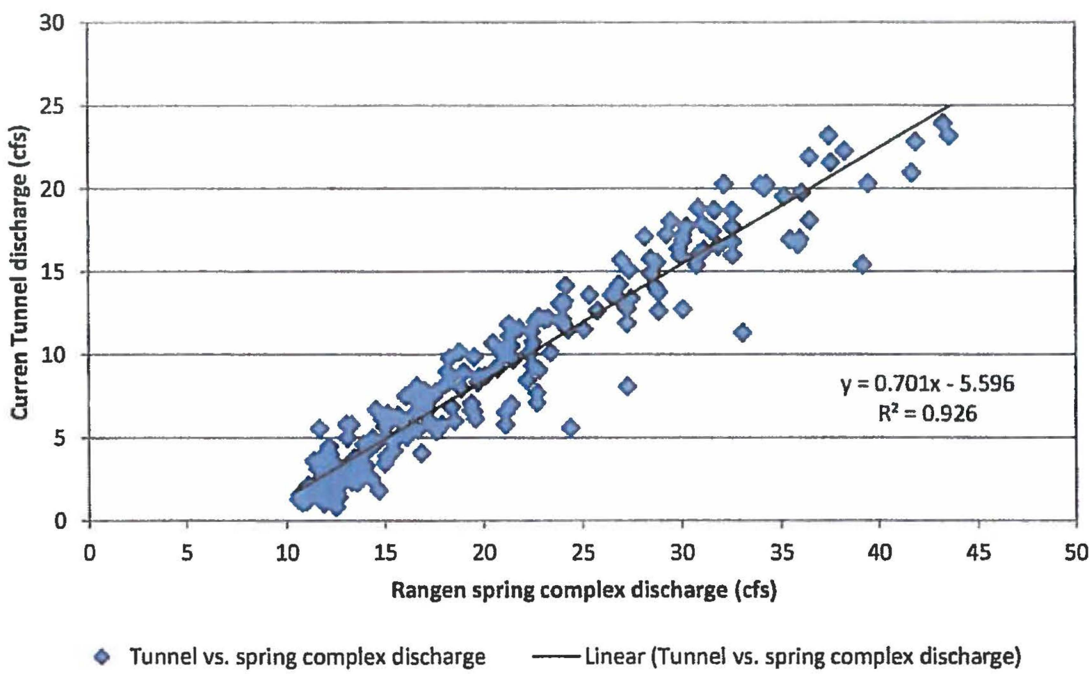

Figure 11. Relationship between Curren Tunnel discharge and total Rangen spring complex discharge, September 1993 to December 2010.

Brendecke (2012) and Hinckley (2012) suggest that ESPAM2.1 would better represent the Rangen spring complex if two drains with different elevations were assigned to the model cell. IDWR staff agree that adding a second drain to the model cell would provide PEST with an additional tool and would likely improve the match to the Rangen calibration target. This improvement has been suggested for ESPAM2.2 (for Rangen and several other spring cells), and could likely be incorporated into future versions of ESPAM if proposed to the ESHMC for consideration. Although IDWR staff agree that adding a second drain to the model cell would be appropriate, IDWR staff disagree that the drains could be used to calculate the response at Curren Tunnel separately from other springs in the Rangen complex. In ESPAM2.1, spring cells with two drains are calibrated to a single set of discharge data representing discharge occurring throughout the model cell. The use of two drain cells allows PEST to find an effective elevation (Equation 1) between the upper and lower drain elevation that allows the best linear approximation of the relationship between aquifer head and observed spring discharge. Because the elevation or range of elevations at which the spring discharge loses hydraulic connection with the aquifer are unknown, using two drain elevations provides PEST the opportunity to find the best estimate for the effective elevation (within the assigned range) based on available head and discharge data. Provided aquifer head remains above both drain elevations throughout the simulation period, total drain discharge in the model cell can be represented by Equation 2.

$z_{eff} = (C_1 z_1 + C_2 z_2)/(C_1 + C_2)$ (Equation 1)

where:
z_{eff} = effective drain elevation (ft)
C_1 = conductance of upper drain (ft^2/day)
z_1 = elevation of upper drain (ft)
C_2 = conductance of lower drain (ft^2/day)
z_2 = elevation of lower drain (ft)

$Q_d = C_1(z_1 - h_{aq}) + C_2(z_2 - h_{aq}) = (C_1 + C_2)(z_{eff} - h_{aq})$; if $h_{aq} > z_1$ and $h_{aq} > z_2$ (Equation 2)

where:
Q_d = total drain discharge (ft^3/day) in model cell, negative values indicate flux out of the aquifer
h_{aq} = aquifer head at center of cell containing the drain (ft)

Hinckley (2012) and Brendecke (2012) argue that representing the Rangen spring discharge with a single drain at elevation 3,138 feet in ESPAM2.1 resulted in a drain conductance that is unrealistically high. Brendecke (2012) explored the effects of representing the Rangen spring discharge with two drains in his alternative models, AMEC Model 1 and AMEC Model 2. Dr. Brendecke's drain file for AMEC Model 1 show that his model has a drain conductance of 11,307 ft^2/day at an elevation of 3,100 feet and a drain conductance of 363,270 ft^2/day at an elevation of 3,152 feet. In this model, the Rangen spring discharge is represented by an effective conductance of 374,577 ft^2/day at an effective elevation of 3,150.4 feet. AMEC Model 2 has a drain conductance of 23,862 ft^2/day at an elevation of 3,100 feet and a drain conductance of 357,756 ft^2/day at an elevation of 3,148 feet. In this model, the Rangen spring discharge is represented by an effective conductance of 381,618 ft^2/day at an effective elevation of 3,145.0 feet. The effective response to a unit change in head in Dr. Brendecke's alternative models is only 9-11% lower than in ESPAM2.1, contradicting Mr. Hinckley and Dr. Brendecke's assumptions that the ESPAM2.1 drain conductance value is unreasonable.

Brendecke (2012) said that the predictive uncertainty analysis of ESPAM2.1 carried out by IDWR explores only a limited aspect of model uncertainty, and that conceptual model uncertainty is fundamental to overall model uncertainty. Dr. Brendecke presents two alternative conceptual models, AMEC Model 1 and AMEC Model 2, which he uses to explore conceptual model uncertainty. Dr. Brendecke asserts that these alternative models better represent local conditions in the vicinity of Rangen through the following modifications to ESPAM2.1:

1. A horizontal flow barrier was added to represent a geologic discontinuity between the Rangen spring complex and the Tucker spring complex.
2. The Rangen spring complex was represented by two drains. The lower drain was assigned an elevation of 3,100 feet in both alternative models. The upper drain was assigned an elevation of 3,152 in AMEC Model 1 and 3,148 feet in AMEC Model 2.
3. General Head Boundaries assigned to four cells along the Hagerman rim were removed.
4. In AMEC Model 2, the calibration weights for Rangen spring discharge observations after the year 2000 were increased to encourage the model to concentrate on matching those observations at the expense of earlier observations.
5. Water level data from an additional well were added to the calibration targets.

IDWR staff note that several of the conceptual model decisions implemented in ESPAM2.1, including the use of a single drain with an elevation based on Covington and Weaver (1990), the assignment of General Head Boundaries to model cells along the Hagerman Rim, and calibration weights were discussed with the ESHMC. Items 2 and 5 could likely be implemented in calibration of future versions of ESPAM if proposed to the ESHMC for consideration. Item 4 is an inappropriate change. Encouraging the model to match observations during a particular time period at the expense of other time periods results in a poorer representation of physical conditions. Items 1 and 3 are based on subjective geologic interpretations that would need to be presented to the ESHMC for review and discussion.

Dr. Brendecke evaluates the calibration quality of his alternative models by comparing the model and observed values for only three calibration targets, the Rangen spring complex discharge and aquifer head elevation in two wells. IDWR staff did not perform an extensive review of the alternative models, but did note that the contributions to the objective function shown in Dr. Brendecke's calibration files indicate both AMEC models had a poorer match to observed discharges at the nearby Three/Weatherby springs complex. These files and Dr. Brendecke's Figure 6.4b indicate that the improved match to the last eight years of observed Rangen complex discharge in AMEC Model 2 was achieved at the expense of the overall match to discharge observed during the other 20 years of the ESPAM2.1 simulation period. The contribution of residuals at the Rangen spring complex to the objective function is approximately 60% larger in AMEC Model 2 than in ESPAM2.1.

On pages 6-7 and 6-8, Dr. Brendecke explores the conceptual model uncertainty by performing analyses of curtailment of junior groundwater use within an area defined by a 10% trimline using AMEC Model 1 and AMEC Model 2. IDWR staff analyses indicate that Dr. Brendecke overstates the uncertainty illustrated by these alternative models for several reasons:

1. It appears that Dr. Brendecke did not use the correct 10% trimline in his analysis performed with ESPAM2.1. AMEC's model files show that pumping was applied in model cells 1041014 and 1043013, which both have steady state response functions of 9.53% with respect to the Rangen spring complex. IDWR analysis using ESPAM2.1 indicates that the response to curtailment within the 10% trimline, which only consists of four model cells (a four-square-mile area), is negligible (0.01 cfs) because the simulated curtailment volume is negligible.
2. It appears that Dr. Brendecke did not use the correct 10% trimline in his analysis performed with AMEC Model 1. AMEC's model files show that pumping was applied in model cell 1041014, which has a steady state response function of 9.74% in AMEC Model 1.
3. An analysis of model uncertainty should be performed by comparing responses to the same stress. Dr. Brendecke uses a different stress file in each of his three simulations, with total stress applied ranging from 0.1 to 2.0 cfs. This comparison does not illustrate uncertainty in the ESPAM2.1 MODFLOW model; it illustrates uncertainty in delineating the area subject to curtailment. In Dr. Brendecke's example, mistakes in delineating the 10% trimline appear to be the primary source of the uncertainty cited by Dr. Brendecke on pages 6-7 and 6-8.
4. IDWR compared model predictions made by AMEC's alternative models with ESPAM2.1 predictions applying consistent stress files. Table 3 shows the results of these comparisons, which indicate that the predictions made by AMEC's alternative models are very similar to predictions made by ESPAM2.1.

Curtailed area	ESPAM2.1 prediction (cfs)	AMEC Model 1 prediction (cfs)	AMEC Model 2 prediction (cfs)
Model extent	17.9	18.5	18.0
Four cells in ESPAM2.1 10% trimline for Rangen	0.01	0.01	0.01

Table 3. IDWR comparison of predicted responses at the Rangen spring cell to curtailment junior to July 13, 1962 using ESPAM2.1 and AMEC's alternative models.

The results shown in Table 3 indicate that the conceptual model changes implemented by Dr. Brendecke in AMEC Model 1 and AMEC Model 2 did not significantly affect the prediction of responses to curtailment within a given area. For the model extent, the responses predicted by AMEC's alternative models were slightly (0.6% to 3.5%) larger than those predicted by ESPAM2.1. For the area delineated by the four cells in the ESPAM2.1 10% trimline for the Rangen spring cell, the response is negligible using all three models.

Brendecke (2012) said that ESPAM2.1 mischaracterizes the physical relationship between water levels and flows at Rangen, resulting in over-sensitivity of the change in drain flow to a simulated change in water level due to curtailment. Dr. Brendecke asserts that changes in spring flows are over-predicted by nearly a factor of 4 (page 1-6 and 4-9). IDWR staff disagree with this conclusion. Dr. Brendecke compares the calibrated drain conductance in ESPAM2.1 with the relationship between the discharge of Curren Tunnel and water level in a monitoring well located about 600 feet east of the Rangen spring complex (Hinckley, 2012, Figure 18). This is not a valid comparison because the ESPAM2.1 drain conductance is calibrated to the total discharge of the Rangen spring complex, not the discharge from Curren Tunnel, and because the data available for the comparison in Hinckley (2012) only represent a limited time period between August 2008 and January 2012. These data do not represent the range of responses included in the calibration data set for ESPAM2.1, which extended from May 1985 to October 2008. Further, simulations performed with Dr. Brendecke's alternative models, which he asserts better characterize the physical relationship between water levels and flows at Rangen, provide similar predictions to ESPAM2.1 (Table 3).

Dr. Brendecke also concludes that the representation of the Rangen spring complex as a single drain with an elevation of 3,138 feet and ESPAM2.1's over-prediction of spring complex discharge in recent years result in over-prediction of responses to curtailment. Dr. Brendecke explored these issues in his alternative models AMEC Model 1 and AMEC Model 2. As shown previously in Table 3, analyses performed using these alternative models predict responses similar to ESPAM2.1. In simulations of curtailment of junior groundwater pumping over the model extent, Dr. Brendecke's alternative models predict slightly larger responses, even in AMEC Model 2, which concentrated on matching Rangen spring discharge observations after the year 2000. These results contradict Dr. Brendecke's conclusion.

Brendecke (2012) compares the area encompassed by a 5% trimline to the Rangen spring complex in ESPAM2.1 to ESPAM2.0, and concludes that the ESPAM2.1 5% trimline has expanded to include areas *"on the opposite side of the Malad Gorge from Rangen, which are hydrogeologically disconnected from Rangen Spring."* IDWR disagrees with Dr. Brendecke's assertion that this is *"evidence of unexpectedly large changes in ESPAM2.1"* for two reasons. First, the changes in the delineation of a 5% trimline are the result of response functions in cells changing from slightly less than 5% (4.822% to 4.997%) in ESPAM2.0 to slightly greater than 5% (5.0004% to 5.118%) in ESPAM2.1. Stresses applied in areas outside the 5% trimline will still result in a response at the Rangen spring complex; the response will be less than 5%, but will not be zero. Second, the area on the opposite side of the Malad Gorge is hydraulically connected to the Rangen spring complex via the ESPA aquifer to the east of Malad Gorge. This is acknowledged by Hinckley (2012), who notes that, *"If the aquifer is severed by the gorge...any impacts to groundwater levels on the north side can only be communicated to the south side via the continuously saturated portions of the primary aquifer further east, or through the lower aquifer..."* IDWR staff analyses also indicate that the predicted response at the Rangen spring complex to curtailment within the area delineated by the ESPAM2.1 5% trimline is 3.35 cfs, nearly identical to the prediction calculated using ESPAM2.0.

On page 4-11, Brendecke (2012) states that ESPAM2.1 is "*called upon to represent highly localized conditions such as those governing discharge from specific outlets of a specific spring complex.*" IDWR staff would like to clarify that ESPAM2.1 does not represent specific spring outlets. In no case does it represent or predict discharge at a scale smaller than a one-square-mile model cell. In the case of the Rangen spring complex, which is the only spring complex in its model cell, ESPAM2.1 is calibrated to the total discharge of the spring complex. It is not calibrated to, and cannot predict discharge from specific outlets within the spring complex.

Brendecke (2012) concludes that ESPAM2.1 is a linear representation of a non-linear physical system. IDWR staff agree with this conclusion and acknowledge that ESPAM2.1, like all models, is an approximation of the physical system. Although there is uncertainty associated with using a model to approximate a physical system, it is the opinion of IDWR staff that ESPAM2.1 is the best available scientific tool for predicting the response at the Rangen spring complex to regional curtailment of groundwater. Based on IDWR's analyses, ESPAM2.1 predicts a response of 17.9 cfs to curtailment within the model boundary, 16.9 cfs to curtailment within the area of common groundwater supply, and 0.01 cfs to curtailment within the area delineated by a 10% response function. While there is uncertainty in these predictions, it is likely that the response to curtailment within the model boundary or the common groundwater area will be a measurable amount of water, and that the response to curtailment in an area delineated by a 10% response function will be a negligible amount of water.

Brendecke (2012) concludes that ESPAM2.1 predicts a benefit of 0.19 cfs will accrue to the Rangen spring complex if a 10% trimline is applied. IDWR analyses indicate that Dr. Brendecke did not use the correct area for the 10% trimline, and that the predicted benefit using ESPAM2.1 is 0.01 cfs if a 10% trimline is applied. Review of Dr. Brendecke's model files also indicates that he applied a stress equal to total pumping, rather than applying a stress equal to the crop irrigation requirement or net pumping. Total pumping includes some water that is pumped from wells, but is returned to the aquifer as recharge. IDWR staff recommend modeling a stress equal to the crop irrigation requirement to represent the long term effects of groundwater use. IDWR staff also note that delineation of a trimline based on response functions for the Rangen spring complex is a direct application of ESPAM2.1-predicted responses at the Rangen spring cell, which Dr. Brendecke argues are unreliable predictions. If, as argued by Dr. Brendecke, ESPAM2.1 "*cannot be relied upon to accurately predict changes in flow at Rangen*" because it is a regional model then it would be more appropriate to use predictions of steady state response functions for the Buhl to Lower Salmon Falls reach, as suggested by Contor (2012a).

On pages 1-2, Table 5.2 and Table 6.1, Brendecke (2012) asserts that less than 3% of the curtailed groundwater rights within a 10% trimline would accrue to the Rangen spring complex. IDWR staff disagree with this statement. By definition, a 10% trimline is the area within which 10% or greater of the effect of an applied stress will accrue to the Rangen spring complex. In Tables 5.2 and 6.1, Dr. Brendecke compares the change in flow at the Rangen complex to a typical maximum water right diversion rate of 0.02 cfs per irrigated acres. The maximum diversion rate is considerably greater than the actual curtailed groundwater use. Dr. Brendecke should have compared the change in flow at the Rangen complex to the curtailed groundwater use in the fourth column of Table 5.2 and fifth column of Table 6.1. The resulting increase as a percentage of the curtailed groundwater use for Dr. Brendecke's simulations is 10.5% for his ESPAM2.1 simulation, 10.8% for his Alternative Model #1 simulation, and 11.6% for his Alternative Model#2 simulation. IDWR's analysis performed using ESPAM2.1 with the correct 10% trimline indicates that the response at Rangen is 12.8% of the curtailed groundwater use.

On page 1-7, Dr. Brendecke quantifies the effects of curtailing all junior groundwater irrigation within the model domain as modeled by ESPAM2.0. Dr. Brendecke provides an incorrect value for the volume of curtailed consumptive use and did not update the results using ESPAM2.1. IDWR's analyses with ESPAM2.1 indicate that there are approximately 565,026 acres within the model domain irrigated with groundwater rights junior to July 13, 1962. The estimated consumptive use (net withdrawal from the aquifer) associated with this irrigation is 1.24 MAF per year. At steady state, ESPAM2.1 predicts curtailment will result in an increase of 17.9 cfs at the Rangen spring complex. The model predicts that it will take approximately 13 years for the response to reach 90% of the steady state increase.

On page 4-10, Brendecke (2012) states that the comparison of ESPAM2.1 with ESPAM1.1 performed by IDWR "*highlights the sensitivity of ESPAM2 results to conditions in particular years.*" This is not a valid interpretation of the results. Changes in estimates of irrigated acreage between ESPAM1.1 and 2.1 are the result of improvements in GIS technology and methodology used to delineate irrigated lands, not sensitivity to conditions in particular years. Changes in estimates of crop irrigation requirements result largely from changing from 1971-2000 average precipitation used with ESPAM1.1 to a November 1998 to October 2008 average precipitation with ESPAM2.1. The ~~1971-2000~~ 1961-1990 gs period used to estimate precipitation with ESPAM1.1 curtailment simulations resulted in estimates of precipitation higher than the long term average from 1934 through 2008. Average precipitation from the 1998-2008 period used with ESPAM2.1 curtailment simulations is closer to the long term average.

On page 4-13, Brendecke (2012) claims that the IDWR predictive uncertainty analysis "*assumed that pumping stress for entire Water Districts could be applied at the centroids of each District without loss of accuracy.*" IDWR staff would like to clarify that IDWR did not make such an assumption. The predictive uncertainty analysis was not intended to model the impacts of Water Districts on spring discharge or reach gains. The centroids of Water Districts were used to select representative points for the analyses that were distributed throughout the model domain in areas where irrigated lands are present.

On page 4-14, Brendecke (2012) states "*While it is clearly an improvement over its predecessor, several important features are the same in ESPAM1.1 and ESPAM2.1. The two are still conceptually the same regional model. Differences between them are largely the result of differences in input data and in values of calibration parameters resulting from use of that input data. Both models represent the details of the Rangen spring complex and the surrounding geology in highly simplified form, omitting several key features that would make significant differences in predicted benefits of curtailment.*" IDWR staff note the differences between these models' predictions of response to curtailment at springs tributary to Billingsley Creek are largely the result of the use of calibration targets in ESPAM1.1 that were not representative of discharge at springs tributary to Billingsley Creek and at Thousand Springs. The ESPAM2.1 calibration targets were a significant improvement over ESPAM1.1. ESPAM2.1 was also calibrated with more closely spaced transmissivity pilot points than ESPAM1.1, allowing more local-scale variation in transmissivity than ESPAM1.1. IDWR staff also note that Dr. Brendecke assumes that details not included in the ESPAM2.1 representation of the Rangen spring complex and surrounding geology *"would make significant differences in predicted benefits of curtailment,"* but does not provide evidence supporting this statement. Dr. Brendecke's exploration of conceptual model uncertainty shows that the predicted benefits of curtailment at Rangen made by his alternative models are less than 3.5% different than the prediction made by ESPAM2.1.

On page 4-14, Brendecke (2012) states that curtailment of large amounts of junior groundwater pumping would results in water use conditions *"that are radically different from those extant in the model calibration period."* IDWR staff disagree with this statement. As shown in Figure 12, when the simulated curtailment volume is added to the 2002-2007 average annual net recharge, the net ESPA recharge is within the range of net recharge during the model calibration period and is closest to conditions that occurred in the late 1990s.

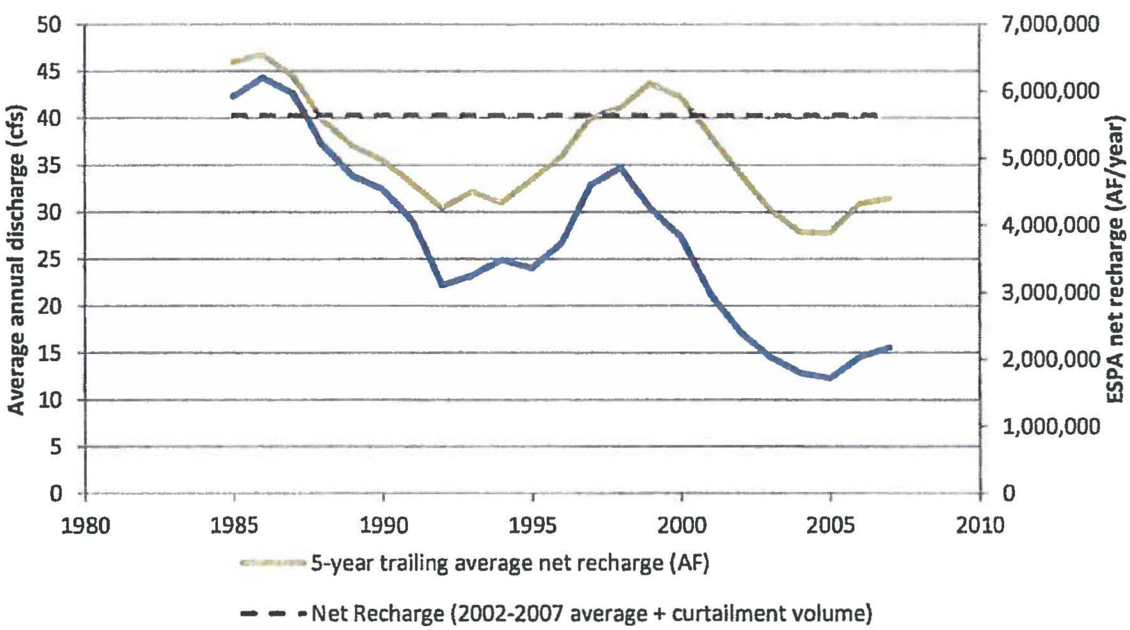

Figure 12. Comparison of net ESPA recharge during model calibration period and simulation of curtailment to July 13, 1962.

On page 5-1, Brendecke (2012) mentions that IDWR provided a superposition version of ESPAM2.1 and states that *"a superposition model can introduce significant error into the analysis of effects of stress changes."* IDWR staff note that the fully populated model files are also available to Dr. Brendecke and the public[5]. Dr. Brendecke could have simulated the curtailment using the fully populated version of the model to explore any potential difference in the prediction at the Rangen spring complex. IDWR staff explored the difference between predictions made using fully populated and superposition versions of ESPAM2.0 and found that there was not a significant difference in predicted responses to curtailment at the Rangen spring cell (Sukow, 2012c). Because the model structure and degree of model linearity did not change between ESPAM2.0 and ESPAM2.1, the conclusions of Sukow (2012c) apply to ESPAM2.1. IDWR staff did not perform the curtailment simulation for this water delivery call with the fully populated version, because IDWR staff are confident the predicted response would not be significantly different from the results of the superposition version.

On page 9, Church (2012) states, "*assuming a diversion rate of 0.02 cfs per acre, the curtailment of 479,200 groundwater irrigated acres would immediately eliminate beneficial use of 9,584 cfs. By this comparison, Rangen would receive less than two-tenths of 1% (0.0018) of the curtailed water.*" IDWR staff disagree with Mr. Church's assumption that the curtailed use will be 0.02 cfs per acre, because this is the typical maximum authorized diversion rate. Mr. Church assumes that irrigators would be diverting the maximum diversion rate 24 hours per day, 7 days a week, 365 days per year and significantly overestimates their water use. The actual curtailed use would be significantly less. Attachment A shows IDWR's analysis of curtailment of 479,200 acres of junior groundwater irrigation within the current area of common groundwater supply. The volume of curtailed consumptive use would be approximately 1.09 MAF/year, an average rate of 1,509 cfs. ESPAM2.1 predicts that 16.9 cfs, which is approximately 1.1% of the curtailed use, would accrue to the Rangen spring cell.

IDWR staff comments regarding expert reports submitted on behalf of FMID

Contor (2012a, p. 5) states, "*The determination and application of a Deminimus* (sic) *effect is a policy question that will not be addressed in this report. The concept of uncertainty may be considered in making this policy determination, and uncertainty will be addressed. A Deminimus* (sic) *policy could be defined in terms of Capture Fraction, specifying a threshold fraction below which propagating effects are considered Deminimus* (sic). *This is essentially the definition of a Trim Line which has been applied in administration of water calls using ESPAM1.1. The policy could also specify a threshold total volume or volume per time, below which effects are considered Deminimus* (sic). *This is the concept that has been applied in use of ESPAM1.1 for water-right transfers. ESPAM2.0 can be operated to calculate either of these potential Deminimus* (sic) *thresholds.*" IDWR staff agree that ESPAM2.1 can be used to calculate either of these types of de minimis thresholds, but do not recommend attempting to quantify model uncertainty to make a de minimis policy determination. As noted by Contor (2012a), model uncertainty is generally greater when smaller areas of the regional ESPA model are considered. Therefore, the uncertainty associated with predicting the response to curtailment within a small area defined by a trimline is likely to be greater than the uncertainty associated with predicting the response to curtailment throughout the ESPA. Further, uncertainty does not mean that it is uncertain whether or not there will be a response to curtailment, it means there is uncertainty in the magnitude of the

[5] http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/meetings/2012_ESHMC/11_9_2012/E121025A001_spresdsheets.zip/mudflow (last visited February 20, 2013.

response. As shown in the IDWR predictive uncertainty analysis (Wylie, 2012) and the alternative conceptual models developed by Brendecke (2012), ESPAM2.1 appears to do a good job of predicting whether or not curtailment will result in a measurable amount of water at a given spring or river reach.

On page 24, Contor (2012a) states "*The IDWR Predictive Uncertainty work indicates that the difference between two Calibrated ESPAM2.1-framework models can exceed 500% for some questions, though it is generally much smaller.*" IDWR staff disagree with this statement. The IDWR Predictive Uncertainty work does not indicate predictive uncertainty exceeding 500%. Further, high percentage differences in predictive uncertainty are misleading in cases where the predicted response is small. For example, if ESPAM2.1 predicts a response of 0.02 cfs at a given location, and the alternative model calibration predicts a response of 0.04 cfs at the same location, the percentage difference would be 100%, but both models indicate that the response at that location is insignificant.

On page 24, Contor (2012a) state, "*For any particular questions, quantity uncertainty is probably at least in the range of the 17% result obtained from the water-budget analysis.*" IDWR staff have not conducted a detailed review of Mr. Contor's analysis, but note that this range of uncertainty does not prevent the model from providing a useful prediction of whether or not curtailment will result in a measurable amount of water at a given spring or river reach. For example, if a range of ±20% is applied to the ESPAM2.1 predicted responses to curtailment within the model domain, a response between 14.3 and 21.5 cfs would be expected at the Rangen spring cell and a response between 194 and 291 cfs would be expected at the Buhl to Lower Salmon Falls reach. Even with this range of uncertainity, the model tells us that a model-wide curtailment would result in a measurable amount of water at the Rangen spring complex and the Buhl to Lower Salmon Falls reach. The model also tells us that only a very small fraction (approximately 1%) of the benefit of a model-wide curtailment would accrue to the Rangen spring complex. The majority of the curtailed water use would benefit other springs and reaches of the Snake River.

On pages 5-6, Contor (2012a) presents results of simulating curtailment of groundwater use junior to July 13, 1962 within the Egin Bench area of the Freemont Madison Irrigation District. Mr. Contor used ESPAM2.0 to perform this analysis and did not update the analysis with ESPAM2.1. Mr. Contor estimated that curtailment of groundwater use within the Egin Bench would reduce pumping by 4,730 acre feet per year and that after 150 years, the cumulative benefit to the Buhl to Lower Salmon Falls reach would be 1.90 acre feet (0.04% of the curtailed use), in response to a single year of curtailment. It is not clear how Mr. Contor estimated the volume of curtailed use. Mr. Contor did not simulate continuous curtailment, thus this simulation does not represent conditions that would occur if these groundwater users were curtailed for multiple years in response to an ongoing spring delivery call. IDWR staff review indicates that steady state response functions in model cells containing points of diversion for FMID groundwater irrigation rights range from 0.004% to 0.05% with respect to the Rangen spring cell, and 0.05% to 0.78% with respect to the Buhl to Lower Salmon Falls springs. The average response function, weighted by irrigation diversion rate, is 0.04% with respect to the Rangen spring cell and 0.55% with respect to the Buhl to Lower Salmon Falls springs. This indicates that Mr. Contor's methods underestimate the fractional response to a continuous curtailment at the Buhl to Lower Salmon Falls reach by an order of magnitude. Although the steady state response predicted by

ESPAM2.1 at the Buhl to Lower Salmon Falls springs is not as small as indicated by Mr. Contor's analysis, it is still a small fraction of the curtailed use, with greater than 99% of the curtail use accruing to other reaches of the Snake River.

On pages 8 and 23, Contor (2012a) recommends that ESPAM2.1 not be used to predict responses at reaches smaller than the distances between nearby transmissivity pilot points. Figure 13 shows the ESPAM2.1 transmissivity pilot points in the vicinity of the Rangen spring cell and Buhl to Lower Salmon Falls reach. The Rangen spring cell is a one-square-mile model cell. The Buhl to Lower Salmon Falls reach is comprised of 24 model cells. The spacing between pilot points in the vicinity of the Buhl to Lower Salmon Falls reach is generally between two and four miles. If Mr. Contor's recommendation is applied, ESPAM2.1 would be used to predict the response at the Buhl to Lower Salmon Falls reach, because it is the smallest calibration reach that is greater than four miles in length.

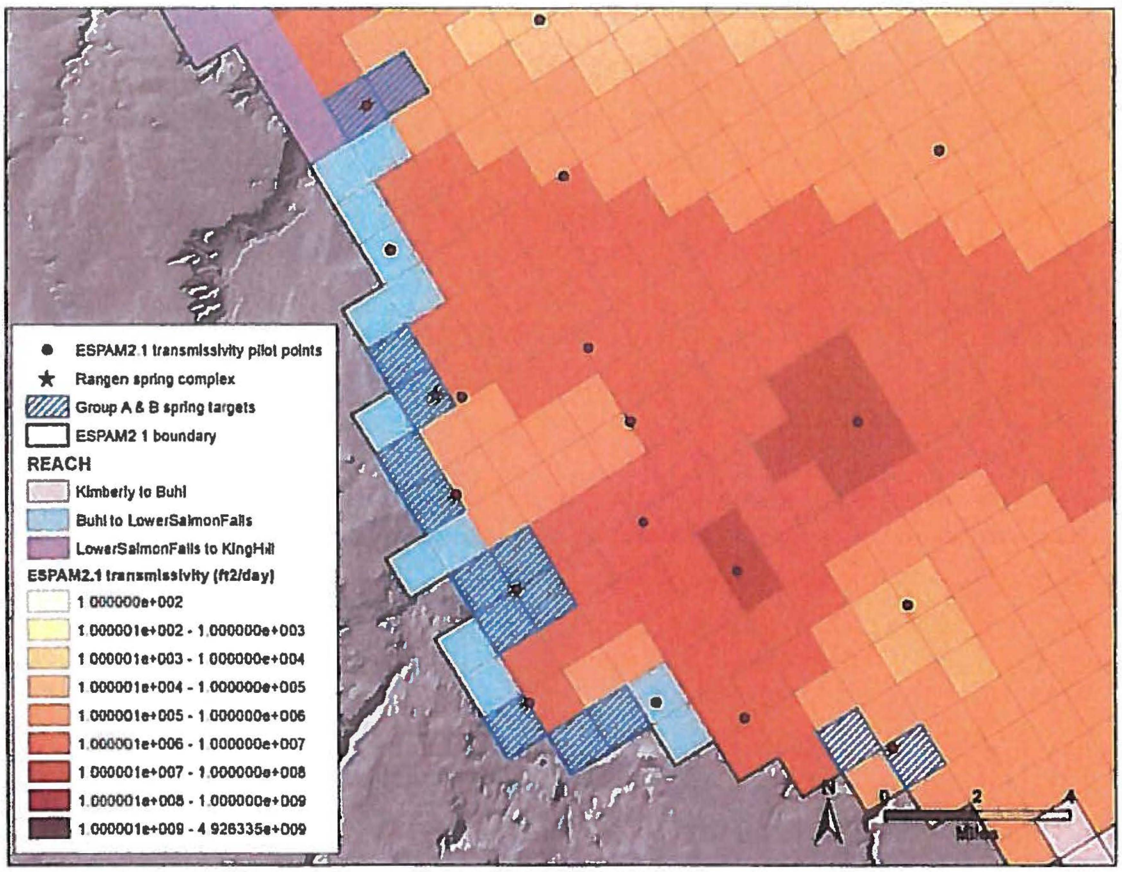

Figure 13. ESPAM2.1 transmissivity pilot points in the vicinity of the Buhl to Lower Salmon Falls reach.

Mr. Contor does not recommend a method for apportioning the ESPAM2.1-predicted response at the Buhl to Lower Salmon Falls reach to the Rangen spring cell, stating on page 6, "*However, no attempt has been made to apportion these benefits to individual diversions.*" If Mr. Contor's recommendation is applied, a method for apportioning the reach benefit to spring cells would be needed to predict the response at the Rangen spring cell. In response to Mr. Contor's recommendation, IDWR staff performed analyses using ESPAM2.1 to predict the response at the Buhl to Lower Salmon Falls reach to curtailment of groundwater irrigation junior to July 13, 1962. IDWR analyses indicate that the response at the reach would be 242 cfs in response to curtailment within the entire model domain, 229 cfs in response to curtailment within the current area of common groundwater supply, and 198 cfs in response to curtailment within the area delineated by a 10% steady state response (Figure 14) and the area of common groundwater supply. Model results are provided in Attachment B.

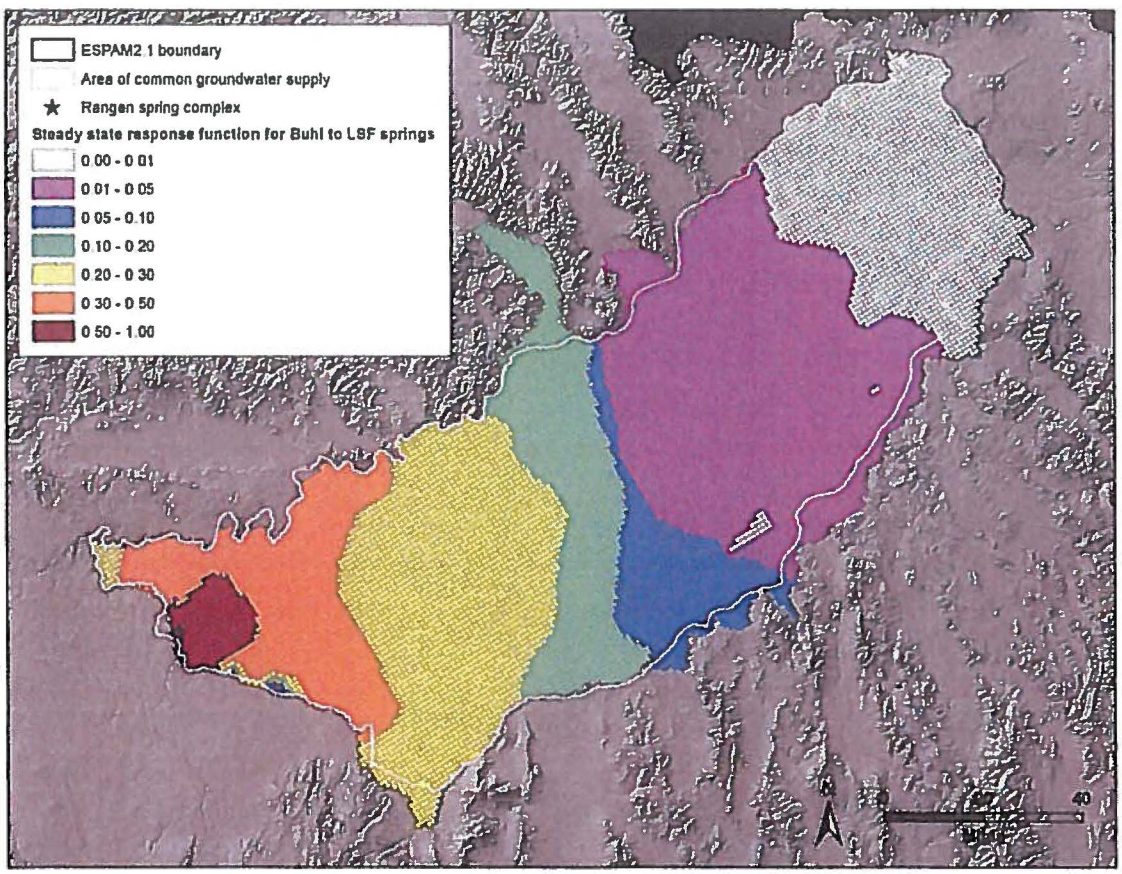

Figure 14. Steady state response functions indicating portion of curtailed use that would accrue to springs in the Buhl to Lower Salmon Falls reach.

IDWR staff considered two methods for apportioning the response at the reach to the Rangen spring cell. IDWR staff consider both of these methods to be inferior to using ESPAM2.1 directly to predict the response at the Rangen spring cell.

1. Use the Covington and Weaver ratio method previously used with ESPAM1.1 to apportion discharge to the Rangen spring complex. This method is identical to the method used with ESPAM1.1 except that the Covington and Weaver discharge values for Thousand Spring and the Three/Weatherby spring complex were updated[6]. Based on the Covington and Weaver discharge estimates of 35.5 cfs for the Rangen spring complex and 2,852 cfs for all spring in the reach, a ratio of 0.0124 was multiplied by the ESPAM2.1-predicted response at springs within the reach. This method results in a predicted accrual of 2.9 cfs at the Rangen spring complex in response to model-wide curtailment and 2.4 cfs in response to curtailment within a 10% trimline for the reach. This method is inferior to using the ESPAM2.1 prediction for the Rangen spring cell, because it considers fewer data than ESPAM2.1, neglects regional hydrogeologic conditions that are modeled in ESPAM2.1 at a scale smaller than the 24 cell reach, neglects the spatial distribution of aquifer recharge and discharge, and neglects the sensitivity of higher elevation springs to changes in aquifer head. Figure 15 illustrates how this method provides a poorer prediction of discharge at the Rangen spring complex than ESPAM2.1. Use of this method with ESPAM1.1 was necessary because the discharge data compiled for calibration of ESPAM2.1 were not available for use with ESPAM1.1. The additional data currently available allow development of better methods for predicting the response at the Rangen spring cell.

[6] See attribute field ESPAM2_cfs in http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/monitoring_data/Springs/Covington_Weaver_Spgs.zip/Covington_Weaver_Spgs.shp (last visited February 20, 2013).

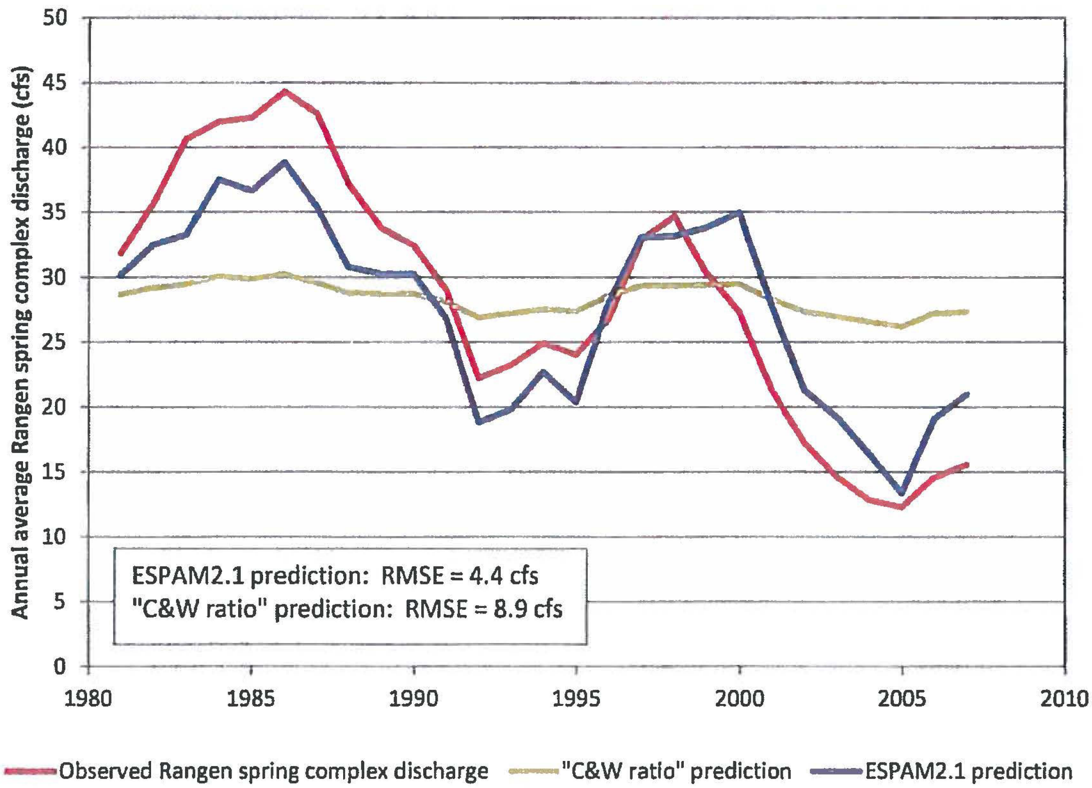

Figure 15. Comparison of Covington and Weaver ratio prediction method and ESPAM2.1 prediction of discharge at Rangen spring cell.

2. Use a linear regression of Rangen spring complex discharge with reach gain to predict change in Rangen spring discharge corresponding to the modeled change in reach gain (Figure 16). This method predicts a 0.028 cfs change in Rangen spring complex discharge per unit cfs change in reach gain, resulting in a predicted accrual of 6.8 cfs at the Rangen spring complex in response to model-wide curtailment and 5.5 cfs in response to curtailment within a 10% trimline for the reach. This method is inferior to using the ESPAM2.1 prediction for the Rangen spring cell, because it considers fewer data than ESPAM2.1, neglects regional hydrogeologic conditions that are modeled in ESPAM2.1 at a scale smaller than the 24 cell reach, and neglects the spatial distribution of aquifer recharge and discharge. This method is a slight improvement over the Covington and Weaver ratio method, because it incorporates some consideration of the sensitivity of higher elevation springs to changes in aquifer head. Figure 17 illustrates how this method provides a poorer prediction of discharge at the Rangen spring complex than ESPAM2.1, but a better prediction than the Covington and Weaver ratio method.

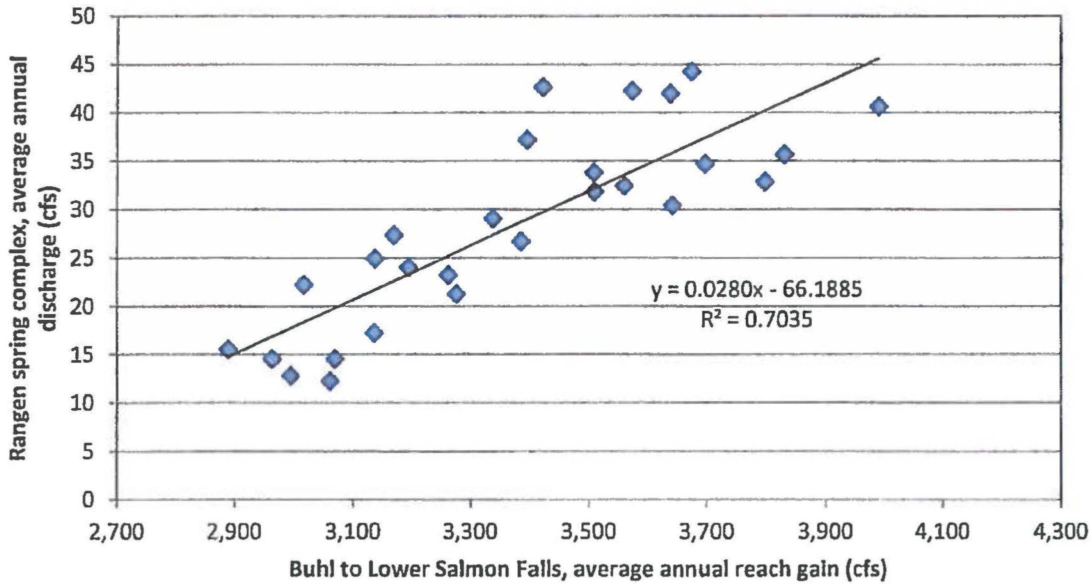

Figure 16. Linear regression of Rangen spring complex discharge with reach gain.

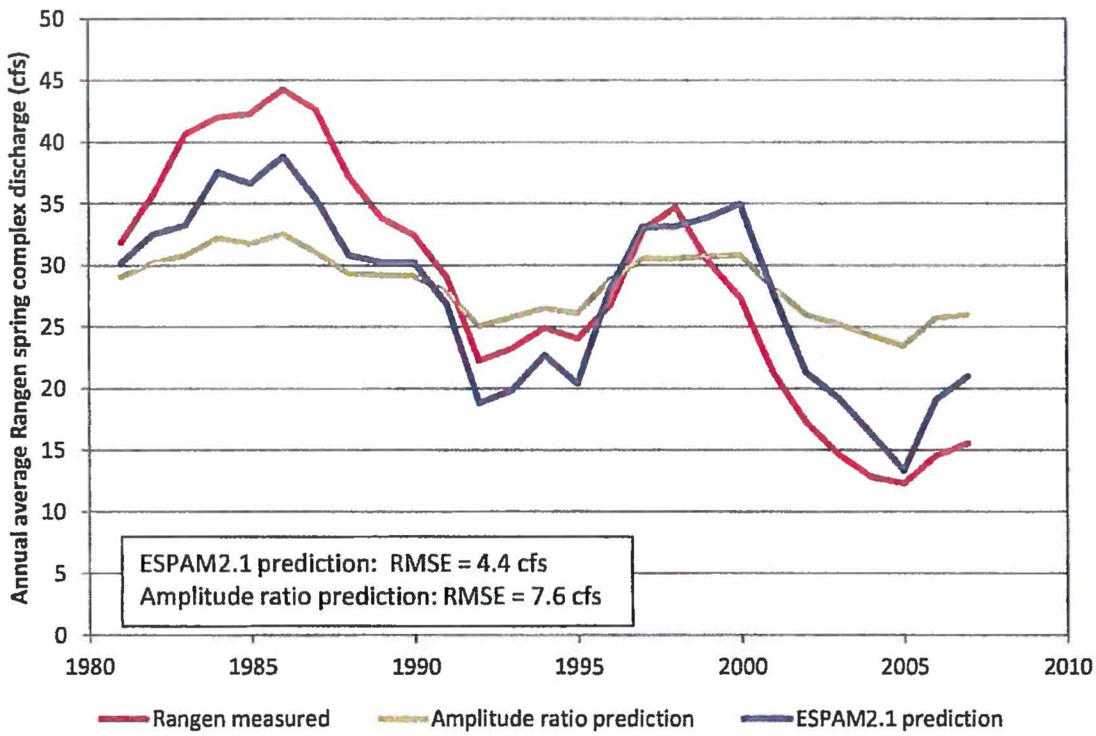

Figure 17. Comparison of amplitude ratio prediction method and ESPAM2.1 prediction of discharge at Rangen spring cell.

IDWR staff comments regarding expert reports submitted on behalf of the City of Pocatello

IDWR staff review indicates that ESPAM2.1 steady state response functions for model cells containing groundwater points of diversion for the City of Pocatello range from 0.37% to 0.47% with respect to the Rangen spring cell. Based on the response functions, IDWR staff agrees with Sullivan (2012) that curtailment of the City of Pocatello's groundwater use will result in a negligible increase in discharge at the Rangen spring complex. ESPAM2.1 predicts that more than 99.5% of the curtailed use would benefit other springs and reaches of the Snake River.

Sullivan (2012) provided a copy of the results of an IDWR analysis of the response at the Rangen spring cell to curtailment within various areas defined by steady state response functions. These analyses limited the area of curtailment to areas where the fraction of curtailed use accruing to the Rangen spring cell exceed values ranging from 0.2% to 10%. The results of the analyses performed by IDWR and submitted by Mr. Sullivan were calculated with ESPAM2.0 and were not updated using ESPAM2.1. IDWR staff updated these analyses with ESPAM2.1 in response to Mr. Sullivan's submittal. The results are provided in Table 4 and Figure 18. These results supersede the results presented by Mr. Sullivan in his Figure 8-4.

Area of curtailment[7]	Curtailed groundwater irrigation (ac)	ESPAM2.1 predicted response at Rangen spring cell (cfs)	Acres curtailed per cfs of benefit at Rangen spring cell (ac/cfs)
Model Boundary	565,026	17.89	31,591
Area Common Ground Water Supply (CGW)	479,203	16.94	28,296
CGW 0.2% trim line	257,673	16.15	15,956
CGW 1% trim line	160,389	14.55	11,022
CGW 1.5% trim line	154,270	14.32	10,774
CGW 1.7% trim line	108,543	11.84	9,167
CGW 2% trim line	67,093	9.31	7,210
CGW 3.5% trim line	26,694	5.71	4,678
CGW 5% trim line	12,346	3.35	3,689
CGW 10% trim line	24	0.01	1,868

Table 4. IDWR analysis of response to curtailment within various areas. (ESPAM2.1)

[7] Trim lines used to define the area of curtailment were delineated to include model cells where greater than a given percentage of the curtailed use will accrue to the Rangen spring cell. This method relies on ESPAM2.1 predictions of response at the Rangen spring cell. The area within the trim line was also clipped to exclude areas outside of the current area of common groundwater supply.

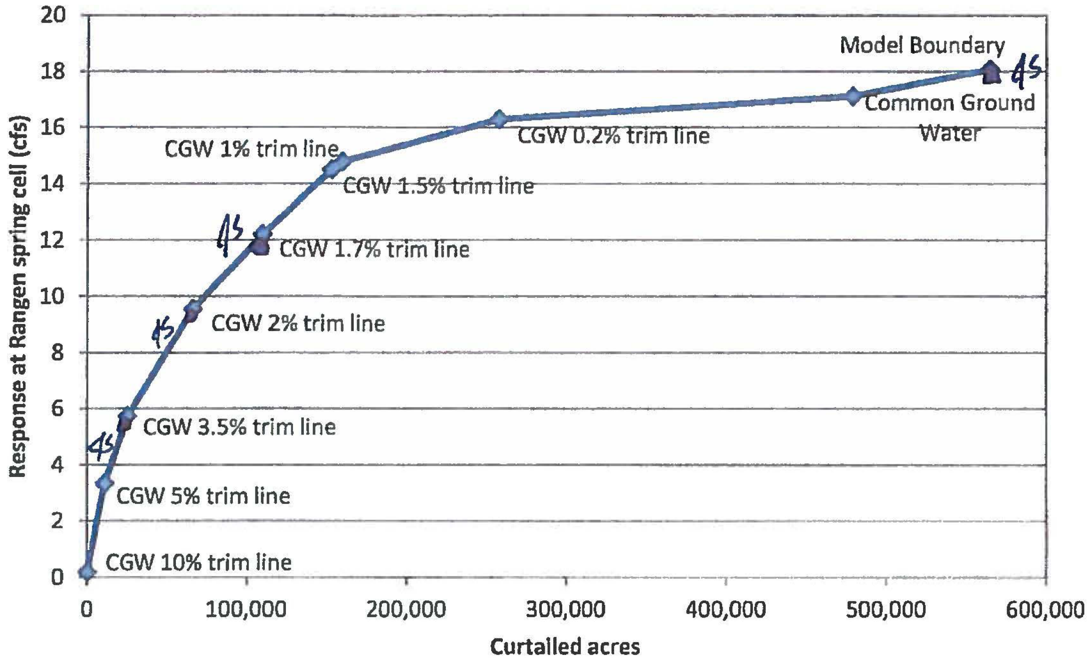

Figure 18. Comparison of predicted response and acres curtailed. (ESPAM2.0 values corrected to ESPAM2.1 values)

Summary of expert rebuttal reports

This section summarizes and responds to the following expert rebuttal reports submitted in the Rangen Delivery Call. No expert rebuttal reports were submitted on behalf of FMID.

1. Brockway, C.E., D. Colvin, and J. Brannon, 2013a. *Rebuttal Report in the Matter of Rangen, Inc. – Availability of Spring Flow and Injury to Water Rights*, prepared for Rangen, Inc., February 8, 2013.
2. Brockway, C.E., D. Colvin, and J. Brannon, 2013b. *Rebuttal Report by Bryce Contor in the Matter of Rangen, Inc. – Availability of Spring Flow and Injury to Water Rights*, prepared for Rangen, Inc., February 8, 2013.
3. Smith, C. E., 2013. *Rebuttal Expert Report in the Matter of Distribution of Water to Rangen, Inc's Water Right Nos. 36-02551 and 36-07694*, prepared for Rangen, Inc.
4. Green, G., 2013. *Rebuttal Report in the Matter of Distribution to Water Right Nos. 36-02551 and 36-07694*, prepared for Brody Law Offices, PLLC.
5. Brendecke, C.M., 2013. *Review of Expert Report in the Matter of Rangen, Inc. – Availability of Spring Flow and Injury to Water Rights by Charles E. Brockway, David Colvin, JimBrannon*, prepared for Racine, Olson, Nye, Budge, and Bailey, Chartered, February 8, 2013.

6. Hinckley, B., 2013. *Review of "Expert Report in the Matter of Rangen, Inc. – Availability of Spring Flow and Injury to Water Rights", December 20, 2012 by Charles E. Brockway, David Colvin, and Jim Brannon*, prepared for Racine, Olson, Nye, Budge, and Bailey, Chartered, February 8, 2013.
7. Rogers, T.L., 2013. *Rebuttal Report by Thomas L. Rogers,* prepared on behalf of the Idaho Ground Water Appropriators, Inc., February 8, 2013.
8. Sullivan, G.K., 2013. *Spronk Water Engineers, Inc. Expert Rebuttal Report in the Matter of Distribution of Water to Water Right Nos. 36-02551 and 36-07694 (Rangen, Inc.)*, prepared for the City of Pocatello, February 8, 2013.
9. Woodling, J.D., 2013. *Expert Rebuttal Report in the Matter of Distribution of Water to Water Right Nos. 36-02551 and 36-07694*, prepared on behalf of the City of Pocatello.

Summary of rebuttals on behalf of Rangen

Brockway et al. (2013a) respond to the expert reports submitted on behalf of IGWA by Brendecke (2012), Hinckley (2012), Rogers (2012) and the expert report submitted on behalf of the City of Pocatello by Sullivan (2012). Brockway et al. (2013a) *"assert that the water rights issued by IDWR for the Rangen facility and the administration of those define and treat the entire Range Spring as a single source."* Brockway et al. (2013a) reiterate their opinions that ESPAM2.1 is the best available scientific tool for evaluation of responses to changes is ESPA water use and that uncertainty analyses performed on ESPAM2.1 and other ESPA groundwater models do not support the use of the trimline proposed by Brendecke (2012).

Brockway et al. (2013a, p. 2) criticize the alternative conceptual models presented by Brendecke (2012), stating, *"Hypothetical interpretations of the Rangen Spring geology offered by IGWA consultants Hinckley and Brendecke are not justified and different conceptual models, as proposed by IGWA consultants, are incorrect,"* and *"These expert reports can be characterized as a sudden reversal of a decade of open and collaborative ESPAM model development led by IDWR and with the cooperation and oversight of the members of the ESHMC, including Brendecke and Sullivan."* Brockway et al. (2013a, p. 17) also note that Dr. Brendecke's alternative models predict similar responses to curtailment at the Rangen spring complex and state, *"The similarities between the results from alternative models presented by Brendecke and results from ESPAM2.1 prove that ESPAM2.1 is a robust model. Even when inappropriate changes are made to the conceptualization of the model, it predicts virtually the same Rangen Spring response to full ESPA curtailment of junior ground water pumping."*

Brockway et al. (2013a) provide additional discussion of Rangen's water measurement methods and reiterates their opinion that historic flow measurements at the Rangen facility are accurate and adequate for the purposes for which they have been used, including calibration of ESPAM2.1. Brockway et al. (2013a) criticizes the Sullivan (2012, p. 6) analysis of Rangen's beneficial use and efficiency of water use, stating, *"This assumption reflects an un-familiarity with the operation of aquaculture facilities which require periodic harvesting and movement of stock within the facility which results in temporary non-use of specific raceways or rearing facilities.*

Brockway et al. (2013b) respond to the expert reports submitted on behalf of FMID by Contor (2012a, 2012b). Brockway et al. (2013b) criticize the Contor (2012a) analysis of model uncertainty, and disagree with Mr. Contor's conclusion that transmissivity uncertainty is approximately equal to water budget uncertainty. They also question how Mr. Contor calculated the 17% estimate of water budget uncertainty, and criticize statements made by Mr. Contor regarding the results of IDWR's uncertainty analysis.

Smith (2013) responds to expert reports submitted on behalf of IGWA by Church (2012) and Rogers (2012) and on behalf of the City of Pocatello by Sullivan (2012). Mr. Smith states that pumped water and reused water are less desirable than first use spring water because of dissolved oxygen concentrations, concentration of waste, and potential failure due to loss of power. Mr. Smith asserts that the hatcheries using pumped water and recycled water mentioned by Rogers (2012) are federal or state hatcheries that do not have to make a profit to operate. Mr. Smith asserts that pumped water is too unreliable for large commercial hatcheries and that recirculation hatcheries are subject to catastrophic losses of fish to pumping failures, nitrite toxicity and disease outbreaks such as infectious hematopoietic necrosis (IHN). Mr. Smith submitted a copy of an expert report submitted by John R. MacMillan on behalf of Clear Springs Foods in a previous proceeding and stated that he is in general agreement with Dr. MacMillan's report. Smith (2013) also discusses errors in calculations presented by Rogers (2012).

Smith (2013) reiterates his conclusions that the flow indices and density indices used by Rangen for the purpose of raising fish for Idaho Power Co. are reasonable, the Rangen hatchery is currently beneficially using all available water and not wasting water, and that the hatchery could use more water to raise fish if it was available.

Green (2013) responds to Church (2012) and states, "*My opinion of Mr. Church's analysis is that his analysis is incomplete and inaccurate.*" Mr. Green states that Idaho farm raised trout is a multi-million dollar business and that Idaho trout production capacity is a substantial portion of the U.S. total trout production, and that the U.S. trout producing industry is not in decline. Mr. Green criticizes Mr. Church's assertion that Rangen should use their own money to make efforts to remedy a problem caused by junior groundwater pumping. Mr. Green concludes, "*Ronald Coase, a Nobel Prize winning economist, suggests the persons' imposing an externality, ground water farmers, on other property owners, Rangen, can and should compensate the damaged party, Rangen.*"

Summary of rebuttals on behalf of IGWA

Hinckley (2013) responds to Brockway et al. (2012). Mr. Hinckley reiterates his opinion that ESPAM2.1 does not adequately represent aquifer geometry and hydrogeologic conditions in the area of the Rangen spring complex. Mr. Hinckley also reiterates his opinion that Rangen should obtain additional water by constructing a vertical well in the ESPA, or by developing another horizontal tunnel below Curren Tunnel.

Brendecke (2013) responds to Brockway et al. (2012) and reiterates his opinions that ESPAM2.1 is a regional model that cannot be relied upon to accurately predict effects at Rangen from curtailment of junior groundwater rights, that Rangen consistently underestimates available flows, that Rangen could pump additional water to its small raceways, and that Rangen should make improvements to Curren Tunnel or construct a vertical well. Dr. Brendecke states that the Brockway et al. (2012) simulation of curtailment throughout the model domain ignores the statutory definition of the area of common groundwater supply, and that *"delivery of less than 1% of the curtailed use to the calling water right constitutes a waste of water by any reasonable definition."*

Rogers (2013) responds to Smith (2012), Brockway et al. (2012), and Sullivan (2012) and reiterates his opinions that Rangen does not maximize fish production, is not using water efficiently, and is wasting water currently available to the hatchery. Mr. Rogers also reiterates his opinion that Rangen should consider pumping systems, reuse of water, and developing new wells to enhance flows.

Summary of rebuttals on behalf of the City of Pocatello

Sullivan (2013) responds to Brockway et al. (2012) and Smith (2012). Mr. Sullivan provides a detailed discussion regarding the accuracy of Rangen flow measurement procedures and concludes that *"significant under-measurement of the flows during the calibration period calls into question the model calibration to the Curren spring flows, and would likely require that the model be re-calibrated."* Mr. Sullivan points out that he and Chuck Brendecke qualified the ESHMC recommendation for ESPAM2.1 with *"although other tools or models may be more appropriate in certain circumstances."* Mr. Sullivan argues that Rangen has not shown material injury and states, *"No data or analyses were provided to support the opinion that Rangen would increase fish production with additional flow,"* and, *"An overarching implication in the Brockway Report is that depletions predicted by the ESPAM2.1 model from junior ground water users equals injury. This is not how the prior versions of the ESPAM have been used in delivery calls. Only after it has been proven that a senior water user is suffering material impacts due to water shortages...has the Department used the ESPAM to assess the magnitude of the shortage..."*

IDWR staff comments regarding rebuttals on behalf of Rangen

On page 4, Brockway et al. (2013a) state *"The best estimate of the impact of junior groundwater pumping on Rangen spring is the unmodified output from ESPAM2.1. Utilization of a trimline of any percentage magnitude, justified by an unsubstantiated estimate of ground water model uncertainty, arbitrarily limits the true hydraulic impact of junior pumping and is not hydraulically or statistically supported. There has never been an uncertainty analysis performed on ESPAM2.1 or any ESPA ground water model to support the use of a trimline as currently configured."* IDWR staff agree that ESPAM2.1 provides the best prediction of the impact of junior groundwater pumping on spring discharge in the Rangen spring cell. This conclusion applies both to the ESPAM2.1-predicted response to model-wide curtailment and to the ESPAM2.1-predicted steady state response functions. These response functions provide the best prediction of the percentage of curtailed groundwater use that would accrue to the Rangen spring cell, and the percentage of curtailed use that would accrue to other springs and reaches of the Snake River. This information can be used to delineate a trimline, if the Director finds it is not appropriate to curtail groundwater users if less than a certain percentage of their curtailed use would accrue to the Rangen spring cell.

On page 14, Brockway et al. (2013a) provide results of curtailment simulations performed using the alternative models presented by Brendecke (2012). Their results are identical to those obtained by IDWR and presented previously in the section "IDWR staff comments regarding submittals on behalf of IGWA".

On page 15, Brockway et al. (2013a) provide a table of response functions for seven model cells in the Rangen area. Their results are identical to those obtained by IDWR and discussed previously in the section "IDWR staff comments regarding submittals on behalf of IGWA".

IDWR staff comments regarding rebuttals on behalf of IGWA

On page 1, Hinckley (2013) asserts that ESPAM2.1 represents the aquifer *"as a single, 4,000-ft. thick layer"*. IDWR staff disagree with this comment. ESPAM2.1 represents the aquifer using time-constant transmissivity. Transmissivity, which is the product of hydraulic conductivity and saturated thickness, is adjusted during model calibration to obtain the best fit to observed data. Neither hydraulic conductivity nor saturated thickness is explicitly represented in the ESPAM2.1, and their individual contributions to transmissivity are not relevant in a time-constant transmissivity model.

On page 1, Hinckley (2013) asserts that *"characterization of aquifer geometry is important"* and that ESPAM2.1 *"models the aquifer as being laterally continuous in all directions from the Rangen discharge points."* IDWR staff disagree with Mr. Hinckley's assertions that ESPAM2.1 ignores aquifer geometry and represents the aquifer as laterally continuous in all directions. ESPAM2.1 models the aquifer geometry and the geometry of spring discharge locations along the Snake River and Hagerman rims within the constraints of a one-square-mile model grid. While the ESPAM2.1 representation does not allow delineation of details smaller than one mile, it does provide a better representation of aquifer geometry than other available models or predictive methods.

Hinckley (2013) discusses water levels in Well No. 797 on pages 5-6 and in Figure 2. He inappropriately compares the slope of a linear regression of data collected only in the 2000s with the linear slope of water levels modeled by ESPAM2.1. It is not appropriate to use data collected only in the 2000s to evaluate ESPAM2.1, which was calibrated to data collected between 1985 and 2008. The data collected in the 2000s represents a period of relatively low net ESPA recharge, and do not reflect the range of conditions that occurred between 1985 and 2008 or the volume of net ESPA recharge that would occur if groundwater pumping junior to 1962 was curtailed. As shown previously in Figure 12, curtailment of groundwater pumping junior to 1962 would result in net ESPA recharge similar to the late 1990s. Further, IDWR staff disagree with the use of Well No. 797 by both Brockway et al. (2012) and Hinckley (2013) for prediction of impacts at the Rangen spring complex. This well is located approximately 6.5 miles north of the Rangen spring complex and has a significantly different spatial relationship to junior irrigated lands in this area. Well No. 989 would be a more appropriate well to use for prediction of impacts at the Rangen spring complex, as discussed previously in the section "IDWR staff comments regarding submittals on behalf of IGWA."

Hinckley (2013) discusses water levels in Well No. 991 on page 6 and in Figures 3a and 3b. This well was not used to calibrate ESPAM2.1, because water levels and the well driller's report indicate that it is not completed in the ESPA. The maximum water level elevation in this well is approximately 3,007 feet, more than 80 feet lower than the elevation of Spring Creek Spring, which is the lowest elevation spring in the same model cell. This well is not included in the shapefile, Wells.shp[8], which shows the wells used as calibration targets. Water level measurements for this well are included in the spreadsheet ESPAM2_ESPAM21.xlsm[9], but all measurements are weighted zero, indicating that they were not used to calibrate the model.

On page 2-2, Brendecke (2013) compares historic measurements of 50 cfs in April 1902 and 96 cfs in September 1917 and suggests the difference between these measurements may be seasonal variation in discharge from the Rangen spring complex. As previously discussed in response to Brockway et al. (2012), IDWR staff review of these historic records indicates that these measurements were likely collected at two different locations along Billingsley Creek, and it is likely both measurements include more than just the discharge from the Rangen spring complex.

On page 4-1, Brendecke (2013) states, *"There is nothing in the Department's report on this comparison that attributes the increase in curtailed consumptive use to 'increased confidence in model inputs and calibration targets'. Most changes in model inputs were associated with extension of the model period and disaggregation to monthly stress periods. The curtailment difference is largely due to the use of different time periods to represent current conditions."* This statement does not reflect the conclusions presented by IDWR in Sukow (2012a), which stated that most of the increase in junior irrigated land area resulted from improvements in GIS methods used to delineate irrigation lands. Sukow (2012a) also stated that changes in estimates of crop irrigation requirements result largely from changing from ~~1971-2000~~ 1961-1990 average precipitation used with ESPAM1.1 to a November 1998 to October 2008 average precipitation with ESPAM2.1. The 1971-2000 period used to estimate precipitation with ESPAM1.1 curtailment simulations resulted in estimates of precipitation higher than the long term average from 1934 through 2008. Average precipitation from the 1998-2008 period used with ESPAM2.1 curtailment simulations is closer to the long term average. 45

On page 4-2 and Table 4.1, Brendecke (2013) states that differences between ESPAM2.0 and ESPAM2.1 predictions of responses to curtailment differed by up to 30%. IDWR staff note that the prediction which changed by up to 30% was the prediction of the response at the Ellison spring cell, which is a Group C spring and had an insignificant response (0.115 cfs in ESPAM2.0 and 0.162 cfs in ESPAM2.1).

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[8] Available at
http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/meetings/2012_ESHMC/11_9_2012/E121025A001_spresdsheets.zip in the gis folder (last visited February 20, 2013).

[9] Available at
http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/meetings/2012_ESHMC/11_9_2012/E121025A001_spresdsheets.zip (last visited February 20, 2013).

Model calibration with respect to Group C springs is not well constrained, because the Group C springs do not have transient calibration targets. The difference between the ESPAM2.0 and ESPAM2.1 predictions of response at the Rangen spring cell was only approximately 1%, suggesting that the Group B transient target for the Rangen spring cell adequately constrains model calibration with respect to the Rangen spring cell.

On page 4-3, Brendecke (2013) states, *"seasonal water level fluctuations and predicted water level changes (due to curtailment) are nearly 100% of the saturated thickness above the Tunnel and about 10% of the thickness above the lower springs at Rangen."* He states that the use of time-constant transmissivity in ESPAM2.1 was not justified. As stated in the ESPAM2.1 final report (IDWR, 2013), *"The generally considerable saturated thickness of the ESPA supports a time-constant representation of transmissivity, because drawdown is generally expected to be less than 10% of total saturated thickness (Anderson and Woessner, 1992)."* Note that this guideline applies to water level change as a percentage of the total saturated thickness, which Dr. Brendecke acknowledges is about 10%. The portion of the saturated thickness that is above the tunnel elevation is not relevant, because the tunnel is not located at the base of the aquifer. The conditions described by Dr. Brendecke are at the limit of the standard cited in IDWR (2013), but do not exceed this standard.

On page 4-3, Dr. Brendecke asserts, *"The curtailment scenario discussed by Rangen represents a 'new distribution of stress' as described by Reilly (1987)."* As shown previously in Figure 12, curtailment of groundwater use junior to 1962 would result in net ESPA recharge within the range that occurred during the model calibration period. Because the model is calibrated using net recharge, not the groundwater pumping portion of net recharge, the comparison made by Dr. Brendecke in Figure 4-1 is not relevant.

On page 4-6, Dr. Brendecke states, *"The consistent over-prediction of low flow values in recent years is problematic because this is the starting point for any changes due to curtailment."* Dr. Brendecke again overstates the importance of conditions during recent drought conditions. The best modeled representation of a system is obtained with calibration to a range of conditions. This was accomplished with ESPAM2.1 by calibration during a 23.5-year period that included both wet and dry years. Low flow values in recent years are not more important than flow values in the 1980s or 1990s. For predicting the response to curtailment, it is the difference between low flow values and historic values that is most important. Over-prediction of low flow values in recent years and under-prediction of flows in the 1980s likely results in slightly lower predictions of the response to curtailment. This is illustrated by Dr. Brendecke's alternative model (AMEC Model 2), which Brendecke (2012) states *"appears to resolve the overprediction problem noted for ESPAM2.1 in recent years."* AMEC Model 2 predicts a response of 18.0 cfs in response to curtailment within the model domain, which is slightly higher than the ESPAM2.1-predicted response of 17.9 cfs.

On page 4-7, Brendecke (2013) states, *"...the inability to quantify uncertainty does not disprove its existence or demonstrate that it should be ignored."* IDWR staff agree that model uncertainty exists and do not suggest that it should be ignored. However, there is no evidence to support Dr. Brendecke's assumption that model uncertainty is so high that ESPAM2.1 cannot reliably predict whether or not the response to curtailment at the Rangen spring complex would be a measurable amount of water.

Accepting the predictions made by ESPAM2.1 as the best available prediction is not ignoring model uncertainty. Actual responses may be higher or lower than the prediction, so adjusting a model prediction in one direction would favor one party over another. IDWR staff also note that delineation of a trimline using ESPAM2.1-predicted response functions is not a *"modification of the output"* as stated in the Brockway et al. (2012) quote that Brendecke (2013) is responding to on page 4-7. Delineation of a trimline using ESPAM2.1-predicted response functions is a direct application of unmodified ESPAM2.1 predictions of response at the Rangen spring complex. The steady state response functions are subject to the same types of uncertainty as the predicted response to model-wide curtailment. Use of the steady state response functions to delineate a trimline requires accepting that the ESPAM2.1 provides the best available prediction of response at the Rangen spring cell.

On page 4-7, Brendecke (2013) states regarding the 2009-2010 validation scenario, *"This is important since curtailment would begin with present, rather than historical, aquifer conditions."* IDWR staff disagree with this statement. Curtailment of groundwater use would increase the net ESPA recharge to historic conditions reflected during the calibration period in the 1990s (Figure 12). Present conditions are not more relevant than historic conditions.

On page 7-1, Brendecke (2013) states, *"Relatively modest changes to the model demonstrate quite different model results."* IDWR staff review of Dr. Brendecke's modified alternative models indicates that his models actually demonstrate quite similar results, as presented previously in the section "IDWR staff comments regarding expert reports on behalf of IGWA".

On page 7-3, Brendecke (2013) states, *"Good model calibration is a necessary but not sufficient condition for reliable model prediction. Reliable prediction also requires accurate model representation of hydrologic and hydrogeologic conditions in the area of the prediction. ESPAM2.1 does not contain this detailed representation."* In the opinion of IDWR staff, ESPAM2.1 is capable of providing a reasonable prediction of the response at the Rangen spring cell to regional stresses in the ESPA, such as curtailment of groundwater use. ESPAM2.1 does represent the aquifer geometry and regional hydrogeologic conditions within the constraints of a one-square-mile model grid and the transmissivity pilot point spacing, which is generally two to four miles in the vicinity of the Buhl to Lower Salmon Falls reach. ESPAM2.1 considers more hydrologic and hydrogeologic data than any other method available for predicting the response at the Rangen spring cell.

IDWR staff comments regarding rebuttals on behalf of the City of Pocatello

On pages 5-14, Sullivan (2013) discusses the accuracy of Rangen's flow measurements and rebuts statements made by Brockway et al. (2012). IDWR staff have reviewed Rangen's flow measurement methods during previous proceedings and have a number of comments in response to Sullivan (2013) and Brockway et al. (2012, 2013).

Rangen submitted annual water measurement reports directly to IDWR from 1995 through 2009, and to Water District 36A from 2010 to 2012. IDWR has accepted these annual water measurement reports during this period of record understanding that Rangen estimates hatchery diversions or flows using fish raceway check boards as non-standard weir measuring devices.

Based on the IDWR memorandum dated December 4, 2003 from Jennifer Berkey to Tim Luke (Berkey, 2003), reported measurement data submitted to IDWR by Rangen from 1995 through 2002 for the hatchery diversion (IDWR diversion number 410089) are the sum of the CTR raceway measurements and the measurement at the dam on Billingsley Creek (also known as the "Lodge dam"). IDWR understands that the Rangen measurement reports submitted to IDWR after 2002 are also based on the sum of the CTR raceways and the Lodge dam. The CTR raceway measurements include all water flowing through the hatchery, including the water diverted from Billingsley Creek and water diverted from the Curren Tunnel to the hatchery lab and upper raceways. Water diverted from the Curren Tunnel to the lab and upper raceways is re-diverted to the lower raceways (Large and CTR raceways). Water measured over the Lodge dam in the creek is water that bypasses the hatchery. The hatchery diversions and layout are described in the IDWR memo from Cindy Yenter to Director Karl Dreher, dated December 15, 2003 (Yenter, 2003).

Measurement of flow through the hatchery using 2-inch rectangular stop logs or check dam boards[10] (check boards) is not considered a standard methodology of measurement because the check board weirs are not considered standard measurement devices. IDWR's *Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices* specify that construction, installation and operation of open channel measuring devices, including contracted rectangular weirs and suppressed rectangular weirs, should follow published guidelines such as those published by the United States Bureau of Reclamation (USBR, 1997).

Although the raceway check boards are not considered standard measuring devices, IDWR accepts measurements using these structures at many hatcheries in the area given that IDWR's standards allow an accuracy of +/-10 percent for open channel measuring devices when compared to measurements using standard portable measuring devices. Many of the area hatcheries have long used raceway check board structures for measuring devices out of convenience and lack of any other installed standard type devices. Some hatchery operators have not installed standard measuring devices due to lack of suitable measurement locations and added costs associated with installing standard devices. IDWR has not calibrated or compared the Rangen raceway check board measurements against standard portable measuring device measurements due to the lack of suitable locations within the hatchery where flows can be measured with portable measuring equipment. However, IDWR staff has compared portable discharge measurements against check board structures at other hatchery and irrigation diversions in both the Hagerman area and other locations in Idaho. IDWR has found those check board measurements, when used with the standard suppressed rectangular weir equation[11] and acceptable

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[10] IDWR has observed that the check boards used at the Rangen Hatchery and other area hatcheries are standard 2" x 4" boards in which the actual thickness measures 1-1/2 inches, or 0.125 ft.

[11] The Francis equation for a standard suppressed rectangular weir is $Q = 3.33\ L\ H^{1.5}$ where Q = discharge, L = weir crest length, and H = head of water above the weir crest, and the value 3.33 is a constant coefficient (US BOR, 1997, p 7-19)

head measurements are typically within +/- 10 percent of standard portable flow meter measurements. In her memo dated December 15, 2003, Cindy Yenter, Water District 130 watermaster, states the following:

> *"My experience has been that measurements taken at flat-crested dam boards are generally less accurate than those taken at sharp crested weirs, and that flat crested dam measurements return indications of flow which are typically 5-10% lower than actual flow, when checked against other methods of measurement."*

The Yenter memo further states that the sum of the IDWR staff measurements of the CTR raceways and Lodge dam on November 25, 2003 was 10 percent higher than the measurements taken by the Rangen staff a day earlier[12]. The memo was the basis for of Finding of Fact No. 76 in the May 19, 2005 Second Amended Order issued by Director Dreher which states in part that "*...measurement of flows through hatchery raceways reported by Rangen may be systematically about 10 percent lower than actual flows.*" The Yenter memo suggests that the difference may be due largely to methods in measuring the head above the weir crest between IDWR and hatchery staff. Yenter notes that the proper location for measurement of head is upstream from the weir crest. Sullivan (2013, p. 11-12) correctly states that the head measurement for a standard weir should be upstream of the weir crest a distance of at least four times the maximum head on the crest. Yenter (2003) states that if it is not possible to obtain a proper upstream head measurement, "*the proper technique for using a hand held staff gage directly on the crest is to turn the surface of the gauge into the flow slightly, to overcome the drawdown (over the crest) and simulate a true head reading.*" This method of measuring head on a weir is described in more detail in Brockway (2013) on pages 4-5. The description provided by Brockway is consistent with the methodology used by IDWR staff. IDWR rarely finds that staff gages are installed in the proper location for either standard or non-standard weirs. The method described by Yenter and Brockway therefore is used extensively by IDWR staff when measuring head at weirs found in the field where no staff gage is installed or gages are not installed in the proper location.

The other source of discrepancy between the IDWR and Rangen staff measurements noted in Yenter (2003) is the use of different weir equations or rating tables. IDWR used the standard suppressed weir equation (Francis equation), $Q = 3.33\ L\ H^{1.5}$, where Rangen used a rating table based on a modified weir equation. The table used by Rangen is found in Appendix A of the Brockway report dated December 20, 2012. This same table was also found in IDWR's records (attached) and appears to have been faxed to the IDWR Southern Region office on December 18, 2003 by Rangen staff. The table includes a rating for the Large raceways, the CTR raceways and the Lodge dam. The Large and CTR raceway ratings employ a fixed length weir crest even though the crest lengths at individual raceways vary slightly in size.

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[12] IDWR staff measured a total of 18.97 cfs at the Rangen hatchery based on sum of the Large raceways + Lodge Dam, or a total of 18.69 cfs based on sum of CTR raceways and Lodge dam. The 2003 measurement report submitted to IDWR by Rangen reports a total of 17.51 cfs on November 24, 2003, which is a difference of either 1.46 or 1.18 cfs, or a difference of -7.7% and -6.31% respectively. IDWR measured 0.48 cfs at the Lodge dam on November 25, 2003.

When using the IDWR head measurements from November 25, 2003 with the Rangen discharge table, the flow at the Large raceways is 16.9 cfs and the flow at the CTR raceways is 16.2 cfs. The Yenter memo states that Rangen staff measured 16.6 cfs and 15.9 cfs at the Large and CTR raceways respectively on November 24, 2003, a difference of only 0.3 cfs between IDWR and Rangen when using the Rangen discharge table, or a difference of less than 2 percent at each set of raceways. The relatively minor differences between the IDWR and Rangen measurements when using the Rangen discharge tables indicates that the differences in flow measurements between IDWR and Rangen on November 25th and 24th, 2003, was due mostly to the use of different weir equations or rating tables, rather than differences in head measurements.

Page 9 of Brockway (2012) indicates that the Rangen rating table "appears to match most closely with a standard rectangular contracted weir formula with a coefficient of 3.09 rather than the typical 3.33 coefficient." IDWR staff note that use of this formula with the 3.09 coefficient yields values that are slightly different than the values in the Rangen table. Columns 5 and 6 of Tables 1-3 through 1-5 in the SWE rebuttal report show the coefficients derived from both the suppressed weir and contracted weir equations using the Rangen rating table. As seen in Tables 1-3 through 1-5 the coefficients used in the Rangen rating table range from 2.85 to 3.20.

Brockway (2012) states that the Rangen rating tables *"are likely to be more accurate"* than a standard rectangular weir discharge using USBR weir flow calculations, but the report does not provide an explanation for the improved accuracy. Brockway (2013) on page 5 states the following:

> *"Studies conducted on flow over check boards at the ends of raceways on aquaculture facilities indicate that the weir coefficient that should be used for flow over check boards, is near 3.09 as compared to the standard Francis formula, which assumes a sharp crested weir with a coefficient of 3.33 (USBR Water Measurement Manual, 1967). King and Brater, (Appendix A), 1967 compiled research on broad crested weir coefficients which shows a weir coefficient for use on a broad crested weir of approximately 2-inch width of 3.08. This would be applicable to flow over check boards with heads between 3 and 4.5 inches (0.25 to 0.38 ft.)"*

Sullivan (2013, p. 7) cites King and Brater, 1976, whereby the standard suppressed rectangular weir equation with a coefficient of 3.09 is used as the standard broad crested weir equation.

The statements from Dr. Brockway above with respect to use of a standard contracted weir equation with a 3.08 coefficient that is more appropriate for a broad crested weir raise the following concerns:

1) IDWR's review of the 1984, 1997 and 2001 editions of the USBR Water Measurement Manual confirm that a coefficient of 3.33 is used for standard sharp crested thin plate weirs. However, IDWR's review of the USBR manuals found no mention or reference to studies conducted on flow over check boards in aquaculture raceways and the recommended use of a coefficient of either 3.09 or 3.08 when using 2-inch thick check boards.

2) As shown in Table 1-1 of Sullivan (2013), which is taken from King and Brater, 1976, a broad crested weir coefficient of 3.08 corresponds to a crest breadth (or width) of 0.5 ft. and head of 0.6 ft., as well as a crest breadth of 1.0 ft. and head of 1.2 ft. The 2-inch thick check boards used at the Rangen facility represents a crest width of about 0.17 ft. As stated on page 7-2 of the USBR Water Measurement Manual, 1997, "true broad crested weir flow occurs when upstream head above the crest is between the limits of 1/20 and 1/2 the crest length in the direction of flow" (between 0.05 and .50). Additionally, Bos (1989) states that for use of broad crested weirs, the length of the weir crest in the direction of flow (L) should be related to the total energy head (H) over the weir crest as: $0.07 \leq H/L \leq 0.50$. A crest width of 2 inches (0.17 ft) and a head of 4.5 inches (0.38 ft.) referenced by Dr. Brockway results in the ratio H/L being equal to 2.24, thereby exceeding the recommended ratio provided in both Bos (1989) and the USBR (1997). Moreover, a description of a broad crested weir provided in Sullivan (2013, p. 9) notes that *"a weir will function as broad crested when the width (aka breadth) exceeds twice the measured head."* Using a 2-inch check board as a broad crested weir provides a crest width of only 1.5 inches, which is less than one-half the typical measured head of 4.5 inches cited by Dr. Brockway, not two times the measured head.

3) Bos (1989) states that where a broad crested weir with ratio of $H/L > 1.5$, *"the nappe may separate completely from the crest and the weir in fact acts as a sharp crested weir. If H/L becomes larger than 1.5 the flow pattern becomes unstable and is very sensitive to the 'sharpness' of the upstream weir edge"*. Column 7 of Tables 1-3 through 1-5 in Sullivan (2013) show that H/L (or H/B) for the Large, CTR and Lodge weirs is 1.5 or greater starting at a head of 3 inches. Mr. Sullivan also notes in his rebuttal report on page 9 that "when the measured head exceeds 1 to 2 times the width of the crest, the nappe will ordinarily spring clear and the weir will hydraulically operate as sharp-crested (Chow, 1964, King, 1976)."

4) Although Rangen has apparently used a rating table that more closely approximates a broad crested weir equation and coefficient, IDWR staff note that every annual measurement report submitted by Rangen to IDWR from 1995 through 2009 states that standard suppressed rectangular weirs are used (see Section III A of the IDWR annual report forms). Section III C of the IDWR annual report forms asks that copies of measuring device rating tables be attached to the report unless previously supplied to IDWR. None of the annual reports submitted to IDWR by Rangen include copies of rating tables used by Rangen. IDWR records do not show that the rating table identified in Appendix A of the December, 2012 Brockway report was received by IDWR until December 18, 2003. IDWR had assumed that Rangen was using standard rectangular suppressed weir tables from 1995 through 2002.

Tables 1-3 through 1-5 in Sullivan (2013) show computed discharges at the Large raceways, CTR raceways and the Lodge dam for what Mr. Sullivan calls *"'Hybrid Weirs' based on their function as broad crested weirs at low heads and sharp crested weirs at higher flows."* Also included in column 1 of Tables 1-3 through 1-5 are the corresponding discharges from the Rangen rating tables. As seen on page 11 of Sullivan (2013), the range of differences between the Hybrid Weir discharges and the Rangen rating table discharges is +0.8% to 10.2% for the Large Raceways, +1.1% to 10.9% for the CTR Raceways, and -6.4% to 20.2% for the Lodge Dam. Other than the Lodge Dam, the range of differences is within +/- 10 percent except for several head measurements on the Large Raceways with heads between 0.28 and 0.31 ft., where the differences are between 10.2% and 10.9%.

Column 8 of Tables 1-3 through 1-5 in Sullivan (2013) show the discharge coefficients used in Mr. Sullivan's Hybrid Weir equation. It is noted that for heads greater than 0.25 ft (3 inches), the coefficient is 3.32, or essentially the same as the coefficient used in the standard rectangular contracted and suppressed weir equations. Mr. Sullivan uses lower Hybrid Weir coefficients which approximate coefficients used for broad crested weirs for heads at 0.25 ft and less. It is important to note that head measurements above weir crests should exceed 0.2 ft. for sharp crested weirs as per USBR published guidelines (USBR, 1997). Use of a broad crested weir equation with coefficients of about 3.08 or 3.09 may be more appropriate for heads that measure 0.2 ft or less. At such heads, the ratio H/L is less than 1.50.

Based on review of the expert reports, IDWR staff provides the following opinions:

1. IDWR concurs with the Brockway (2013, p. 5) that the difference in weir coefficients between the standard suppressed rectangular weir with C=3.33 and use of the contracted rectangular weir with C=3.09 results in a difference of about 8%. IDWR also agrees with the statement on p. 9 of Brockway (2012), that *"the standard rectangular weir discharge using USBR weir flow calculations were within 8% of the Rangen staff reported flows."* (Note: The Rangen staff reported flows were -8% as compared to the same measurements using the USBR rating table for a standard contracted rectangular weir).

2. IDWR concurs with the Brockway rebuttal (2013, p. 5) that "standard weir formulas assume a sharp crested weir is in place and not a 2-inch board." However, the typical measured head at the Rangen raceways exceeds one to two times the 2-inch width weir crest such that the nappe separates from the crest and the weir more closely approximates a sharp crested weir where C = 3.33, which is the coefficient used with standard rectangular and suppressed weir equations.

3. IDWR concurs with both the Brockway (2013) and Sullivan (2013) rebuttal reports that the raceway check boards do not constitute standard suppressed rectangular weirs because the check boards are not sharp crested. It should also be noted that *"suppressed weirs must have proper ventilation of the cavity underneath their nappes. This ventilation is commonly done by installing properly sized pipes in the walls to vent the cavity under the nappe. Standard equations and tables are valid only when sufficient ventilation is provided. The weir will deliver more water than indicated by the tables and equations when ventilation is inadequate."* (USBR, 1997, p. 7-41).

4. IDWR concurs with the Brockway (2013, p. 5) that the differences in measurements between IDWR staff and Rangen staff are not due to differences in measurements of head at the weirs.

IDWR concludes that the differences are due mostly to the use of different rating tables and weir coefficients.

5. IDWR does not concur with Brockway (2013, p. 5) that finds concern with IDWR's comparison of IDWR staff measurements with Rangen staff measurements *"because IDWR staff utilized the discharge rating curve for a standard sharp crested weir when in fact the flow was over dam boards, which is best represented by a modified weir coefficient resulting in a discharge rating similar to that utilized by Rangen personnel."* IDWR disagrees with this statement because the discharge rating used by Rangen uses coefficients that more closely approximate the standard coefficient used with a broad crested weir. As stated in item 2 above, the typical flow conditions for the Rangen check boards do not approximate conditions for a broad crested weir. Rather, typical flow conditions more closely resemble those for a rectangular sharp crested weir. IDWR maintains that without the installation of a standard measuring device, it is more appropriate to use the USBR sharp crested weir formula with a coefficient of 3.33 for estimating flows over the Rangen raceway check boards.

6. IDWR concurs with Sullivan (2013, p. 8) that the Rangen check boards do not conform to specifications of sharp crested weirs, contracted rectangular weirs, suppressed rectangular weirs or broad crested weirs. IDWR further concurs with Mr. Sullivan that use of the standard weir equation to compute flow does not result in the most accurate measurement of raceway discharges and that "it is appropriate to calibrate the weirs based on flow measurements to establish empirical rating tables that describe the relationship between discharge and measured head." However, IDWR continues to recommend the use of the standard suppressed weir equation at raceway check board dams with a coefficient of 3.33 since neither weir calibrations nor standard measurement devices exist at the Rangen Hatchery. If Mr. Sullivan recommends use of the Hybrid weir equation and coefficients, then IDWR notes that there is no difference in discharges between the Hybrid and standard suppressed weir equations for heads greater than 0.25 ft. Similarly, there is very little difference in discharge between the Hybrid Weir and the Rangen discharge tables for heads less than 0.25 ft (differences are between +0.8 to -6.8 % for CTR and Large Raceways).

7. IDWR does not concur with Sullivan (2013, p. 13) that the extent of under-measurement at the Rangen hatchery may be as high as 30 to 40 percent or more. SWE has not explained how or why the error may be this large unless they are merely adding the largest percent errors found in column 11 of Tables 1-3 through 1-5 for the CTR and Large Raceways, and the Lodge Dam, or they are merely relying on the example cited by the USBR in which a 0.1 ft. error in head measurement for a head of 0.45 ft. over a 6 ft. long rectangular weir results in an under-measurement of 2 cfs or 35 percent (USBR, 1997, p. 5-9). As described in these comments, the difference in head measurements between IDWR and Rangen staff on November 24 and November 25, 2003 appear to be relatively minor, and IDWR measured heads in a manner that minimized error.

8. IDWR accepted the measurements submitted by Rangen that are based on head measurements over raceway check boards and use of the Rangen rating tables because such measurements should be within a +/- 10 percent range of accuracy. The measurements likely under-measure actual flows, but an error up to -10% is acceptable pursuant to IDWR's *Minimum Acceptable Standards for Open Channel and Closed Conduit Measuring Devices.*

On page 13, Sullivan (2013) argues, *"The actual amount of any under-measurement of flow can be determined by conducting discharge measurements in the raceways and in Billingsley Creek using a current meter at various discharges to establish a calibrated rating table for each structure."* In the opinion of IDWR staff, it is difficult to obtain good, accurate measurements of discharge at or near the Rangen facility for calibrating the check board measurements, because flow and/or cross-sectional conditions are less than ideal. The USGS periodically measures the discharge in Billingsley Creek just downstream of the Rangen hatchery, but subjectively rates most of the measurements "fair" or "poor" indicating that USGS water measurement experts also found that flow and/or cross-sectional conditions in Billingsley Creek are not ideal and contribute to measurement error.

On page 14, Sullivan (2013) argues that *"under-measurement of the flows during the calibration period calls into question the model calibration to the Curren Spring flows, and would likely require that the model be re-calibrated."* The calibration target used for ESPAM2.1 was submitted to the ESHMC for review and comment in the fall of 2009. ESHMC members, including Mr. Sullivan and Dr. Brendecke, had more than two years to review the proposed calibration target and did not object to its use in ESPAM2.1. IDWR staff note that systematic under-measurement of discharge at the Rangen spring complex would be expected to result in lower model predictions of discharge and response to curtailment at the Rangen spring cell. This would favor the groundwater users, not Rangen.

On page 16, Sullivan (2013) points out that the ESHMC recommendation, *"The Eastern Snake Hydrologic Modeling Committee recommends that the Department begin using ESPAM Version 2.1 rather than ESPAM Version 1.1 for groundwater modeling,"* was qualified by Mr. Sullivan and Dr. Brendecke with, *"although other tools or models may be more appropriate in certain circumstances."* IDWR staff note that neither Mr. Sullivan nor Dr. Brendecke proposed other tools or models that would be more appropriate for making a prediction in this circumstance.

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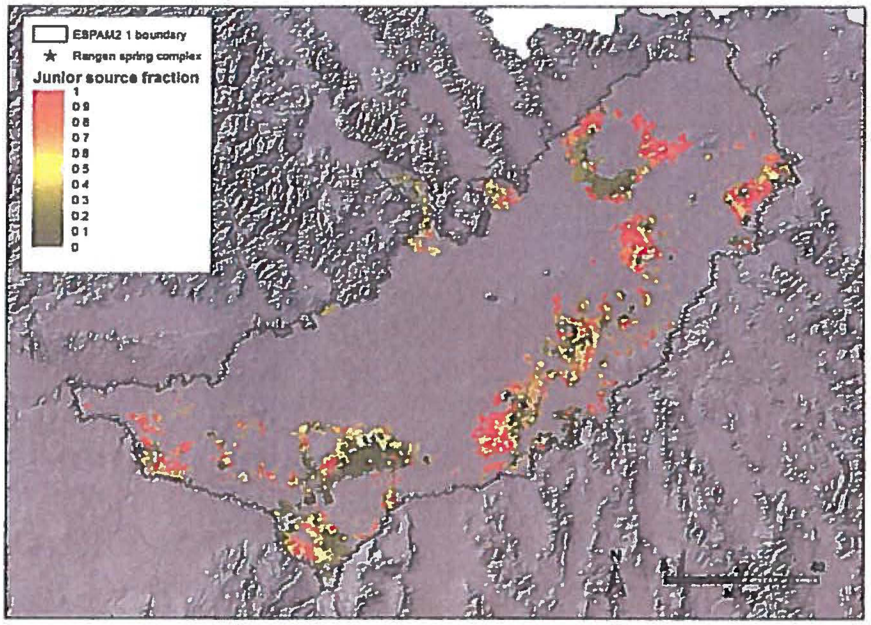
ATTACHMENT A. IDWR SIMULATIONS OF CURTAILMENT JUNIOR TO JULY 13, 1962

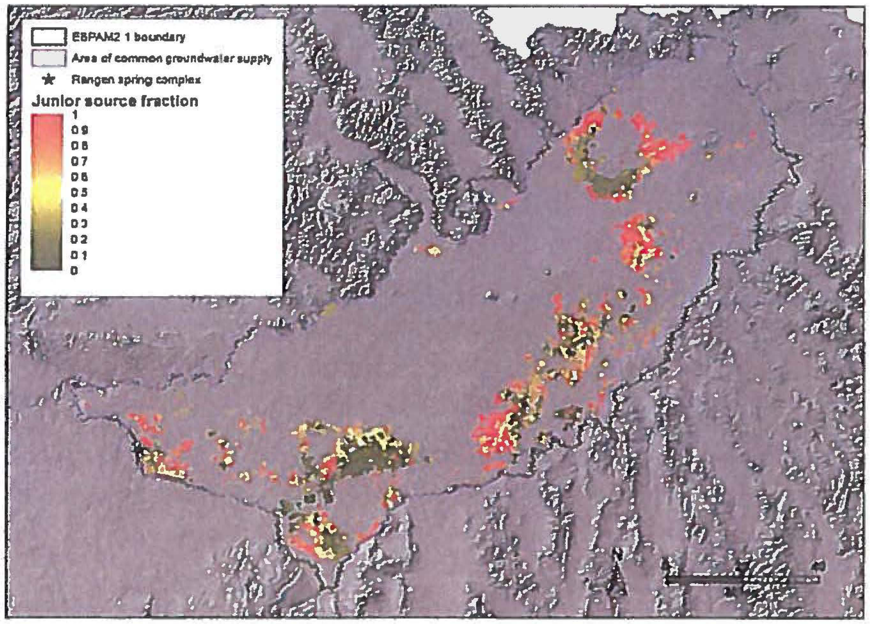
Simulated curtailment junior to July 13, 1962 within ESPAM2.1 model boundary



Simulated curtailment:	565,026	acres	
	1,235,157	AF/yr	crop irrigation requirement
	1,704.93	cfs	crop irrigation requirement
	2.19	AF/ac/yr	crop irrigation requirement

	Reach	Response (cfs)	Response (AF/yr)
Predicted response:	Ashton to Rexburg	157.79	114,312
	Heise to Shelley	206.50	149,598
	Shelley to Near Blackfoot	229.60	166,335
	Near Blackfoot to Minidoka	695.22	503,664
	Kimberly to Buhl	121.67	88,148
	Buhl to Lower Salmon Falls	242.40	175,610
	Lower Salmon Falls to King Hill	51.75	37,492
	Total	1,704.93	1,235,158
	Group A&B Spring Reaches		
	Devil's Washbowl	5.67	4,107
	Devil's Corral	7.39	5,354
	Blue Lakes	20.02	14,501
	Crystal	45.75	33,141
	Niagara	31.98	23,167
	Clear Lake	41.84	30,310
	Briggs	1.14	822
	Box Canyon	68.74	49,801
	Sand	18.33	13,281
	Thousand	50.06	36,269
	National Fish Hatchery	11.37	8,237
	Rangen	17.89	12,957
	Three	13.03	9,439
	Malad	43.95	31,839
Reach of interest:	Rangen	17.89	12,957
	Response/simulated stress	1.0%	
	Time to reach 90% steady state	13 years	
Response at other reaches:		1,687.04	1,222,200
	Response/simulated stress	99.0%	

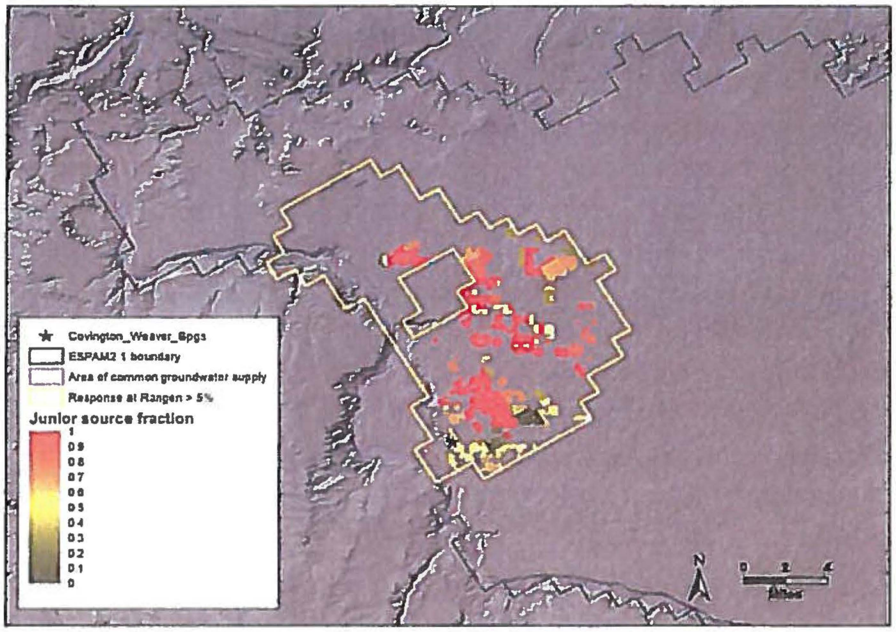
Simulated curtailment junior to July 13, 1962 within area of common groundwater supply



Simulated curtailment:		479,203 acres	
		1,092,938 AF/yr	crop irrigation requirement
		1,508.62 cfs	crop irrigation requirement
		2.28 AF/ac/yr	crop irrigation requirement

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	111.43	80,730
	Heise to Shelley	160.20	116,056
	Shelley to Near Blackfoot	209.31	151,636
	Near Blackfoot to Minidoka	635.93	460,705
	Kimberly to Buhl	113.33	82,100
	Buhl to Lower Salmon Falls	228.90	165,829
	Lower Salmon Falls to King Hill	49.53	35,882
	Total	1,508.62	1,092,938
	Group A&B Spring Reaches		
	Devil's Washbowl	5.15	3,732
	Devil's Corral	6.72	4,869
	Blue Lakes	18.39	13,326
	Crystal	42.99	31,148
	Niagara	30.13	21,827
	Clear Lake	39.44	28,572
	Briggs	1.07	775
	Box Canyon	64.78	46,934
	Sand	17.29	12,523
	Thousand	47.35	34,304
	National Fish Hatchery	10.76	7,798
	Rangen	16.94	12,269
	Three	12.34	8,940
	Malad	42.00	30,431
Reach of interest:	Rangen	16.94	12,269
	Response/simulated stress	1.1%	
	Time to reach 90% steady state	11 years	
Response at other reaches:		1,491.68	1,080,669
	Response/simulated stress	98.9%	

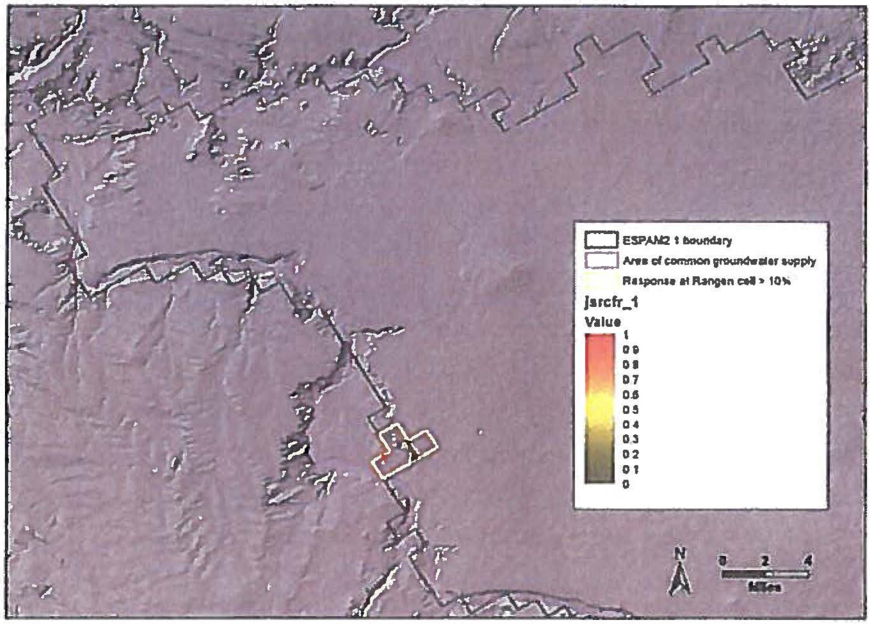
Simulated steady state curtailment junior to July 13, 1962 within area where response at Rangen cell is greater than 5%



Simulated curtailment:		12,346 acres		
		35,957 AF/yr		crop irrigation requirement
		49.63 cfs		crop irrigation requirement
		2.91 AF/ac/yr		crop irrigation requirement

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	0.0599	43.38
	Heise to Shelley	0.1754	127.07
	Shelley to Near Blackfoot	0.5253	380.58
	Near Blackfoot to Minidoka	1.7553	1,271.65
	Kimberly to Buhl	5.0987	3,693.79
	Buhl to Lower Salmon Falls	29.1239	21,099.16
	Lower Salmon Falls to King Hill	12.8946	9,341.65
	Total	49.6330	35,957.28
	Group A&B Spring Reaches		
	Devil's Washbowl	0.0558	40.43
	Devil's Corral	0.0758	54.94
	Blue Lakes	0.3567	258.41
	Crystal	2.2504	1,630.34
	Niagara	2.1947	1,589.96
	Clear Lake	3.1098	2,252.92
	Briggs	0.0861	62.35
	Box Canyon	5.6407	4,086.47
	Sand	1.6911	1,225.13
	Thousand	7.4121	5,369.78
	National Fish Hatchery	2.0780	1,505.42
	Rangen	3.3467	2,424.56
	Three	2.4990	1,810.42
	Malad	11.0826	8,028.93
Reach of interest:	Rangen	3.35	2,424.6
	Response/simulated stress	6.7%	
Response at other reaches:		46.29	33,532.7
	Response/simulated stress	93.3%	

Simulated steady state curtailment junior to July 13, 1962 within area where response at Rangen cell is greater than 10%

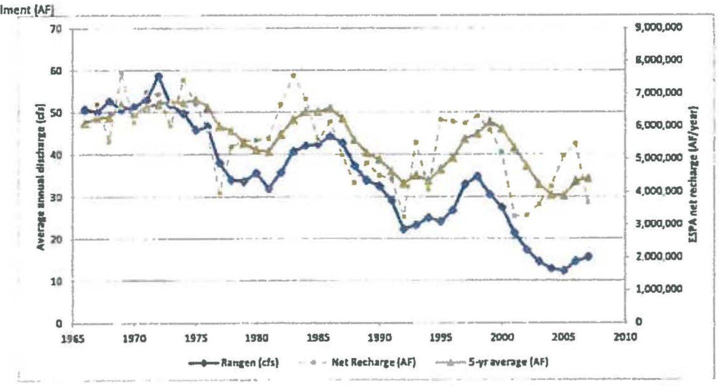


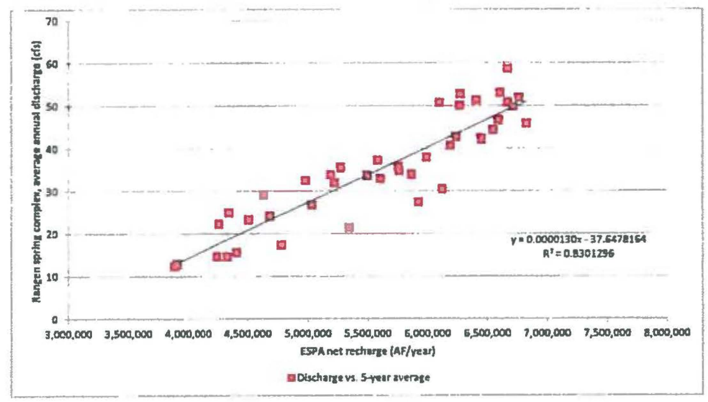
Simulated curtailment:		24 acres	
		73 AF/yr	crop irrigation requirement
		0.10 cfs	crop irrigation requirement
		3.03 AF/ac/yr	crop irrigation requirement

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	0.0001	0.04
	Heise to Shelley	0.0002	0.12
	Shelley to Near Blackfoot	0.0005	0.37
	Near Blackfoot to Minidoka	0.0017	1.24
	Kimberly to Buhl	0.0055	4.00
	Buhl to Lower Salmon Falls	0.0814	58.95
	Lower Salmon Falls to King Hill	0.0111	8.02
	Total	0.1004	72.75
	Group A&B Spring Reaches		
	Devil's Washbowl	0.0001	0.04
	Devil's Corral	0.0001	0.05
	Blue Lakes	0.0004	0.26
	Crystal	0.0024	1.76
	Niagara	0.0024	1.76
	Clear Lake	0.0036	2.62
	Briggs	0.0001	0.07
	Box Canyon	0.0072	5.22
	Sand	0.0024	1.73
	Thousand	0.0291	21.07
	National Fish Hatchery	0.0129	9.33
	Rangen	0.0128	9.31
	Three	0.0050	3.63
	Malad	0.0097	7.03
Reach of interest:	Rangen	0.01	9.3
	Response/simulated stress	12.8%	
	Time to reach 90% steady state	5 months	
Response at other reaches:		0.09	63.4
	Response/simulated stress	87.2%	

ATTACHMENT B. ALTERNATIVE PREDICTIVE METHODS

Year	Rangen (cfs)	Net Recharge (AF)	5-year average net re	Net Recharge with Curtailment (AF)
1962		5,830,000		
1963		5,510,000		
1964		5,690,000		
1965		7,410,000		
1966	50.65	6,060,000	6,100,000	5,642,712
1967	50.01	6,670,000	6,268,000	5,642,712
1968	52.67	5,540,000	6,274,000	5,642,712
1969	50.70	7,640,000	6,664,000	5,642,712
1970	51.21	6,110,000	6,404,000	5,642,712
1971	52.93	7,060,000	6,604,000	5,642,712
1972	58.67	6,980,000	6,666,000	5,642,712
1973	51.77	6,000,000	6,758,000	5,642,712
1974	49.74	7,410,000	6,712,000	5,642,712
1975	45.76	6,670,000	6,824,000	5,642,712
1976	46.57	5,890,000	6,590,000	5,642,712
1977	37.89	3,980,000	5,990,000	5,642,712
1978	33.92	5,370,000	5,864,000	5,642,712
1979	33.62	5,550,000	5,492,000	5,642,712
1980	35.55	5,570,000	5,272,000	5,642,712
1981	31.87	5,616,920	5,217,384	5,642,712
1982	35.69	6,660,929	5,753,570	5,642,712
1983	40.65	7,555,369	6,190,644	5,642,712
1984	42 00	6,829,733	6,446,590	5,642,712
1985	42.29	5,562,063	6,445,003	5,642,712
1986	44.28	6,131,979	6,548,015	5,642,712
1987	42.66	5,108,736	6,237,576	5,642,712
1988	37.22	4,273,605	5,581,223	5,642,712
1989	33.82	4,876,753	5,190,627	5,642,712
1990	32 47	4,495,566	4,977,328	5,642,712
1991	29 04	4,398,489	4,630,630	5,642,712
1992	22.25	3,243,850	4,257,653	5,642,712
1993	23.23	5,506,157	4,504,163	5,642,712
1994	24.93	4,072,345	4,343,281	5,642,712
1995	24.05	6,194,348	4,683,038	5,642,712
1996	26.73	6,139,823	5,031,305	5,642,712
1997	32.87	6,095,010	5,601,537	5,642,712
1998	34 73	6,305,636	5,761,432	5,642,712
1999	30.42	5,883,367	6,123,637	5,642,712
2000	27.35	5,189,381	5,922,643	5,642,712
2001	21.27	3,256,481	5,345,975	5,642,712
2002	17.26	3,270,479	4,781,069	5,642,712
2003	14.59	3,620,557	4,244,053	5,642,712
2004	12.82	4,174,080	3,902,196	5,642,712
2005	12.29	5,096,649	3,883,649	5,642,712
2006	14.57	5,466,940	4,325,741	5,642,712
2007	15.57	3,679,551	4,407,555	5,642,712

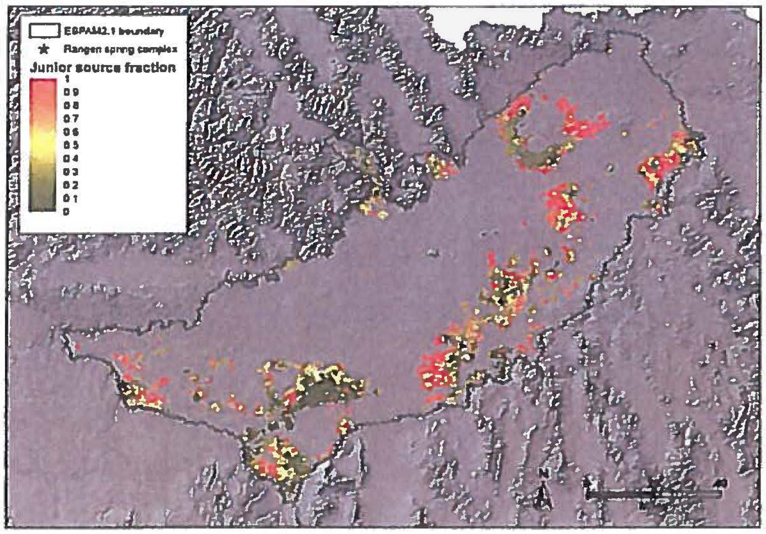




Curtailment volume	1,235,157 AF/yr
Change in discharge/change in recharge	0.0000130 cfs/AF
Predicted change in discharge	16 1 cfs

IDWR staff consider this prediction inferior to the ESPAM2.1-predicted response at the Rangen spring complex. This prediction method neglects the spatial distribution of all components of historic net recharge and of junior groundwater irrigated lands.

Simulated curtailment junior to July 13, 1962 within ESPAM2.1 model boundary



Simulated curtailment:	565,026 acres		
	1,235,157 AF/yr	crop irrigation requirement	
	1,704.93 cfs	crop irrigation requirement	
	2.19 AF/ac/yr	crop irrigation requirement	

	Reach	Response (cfs)	Response (AF/yr)
Predicted response:	Ashton to Rexburg	157.79	114,312
	Heise to Shelley	206.50	149,598
	Shelley to Near Blackfoot	229.60	166,335
	Near Blackfoot to Minidoka	695.22	503,664
	Kimberly to Buhl	121.67	88,148
	Buhl to Lower Salmon Falls	242.40	175,610
	Lower Salmon Falls to King Hill	51.75	37,492
	Total	1,704.93	1,235,158
Reach of interest:	Buhl to Lower Salmon Falls	242.40	175,610
	Response/simulated stress	14.2%	
Response at other reaches:		1,462.53	1,059,548
	Response/simulated stress	85.8%	

Apportionment of reach gains:

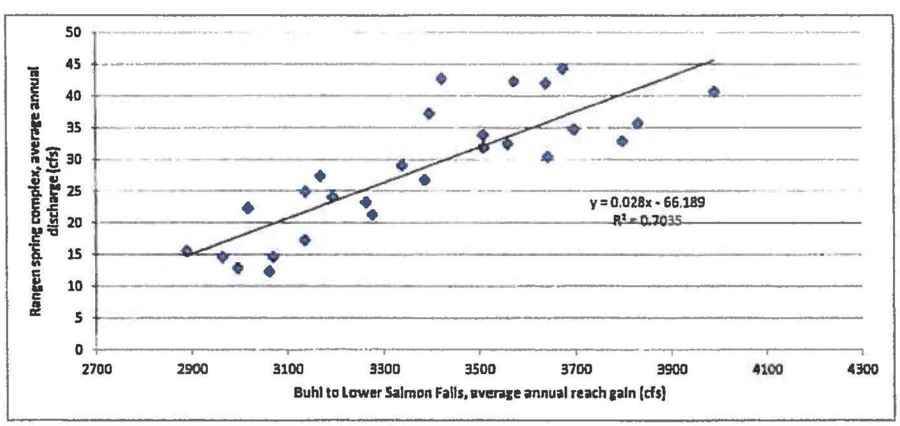
Observed Amplitude Ratio 2.80%

Portion of reach response assigned to Rangen spring complex 6.8 cfs

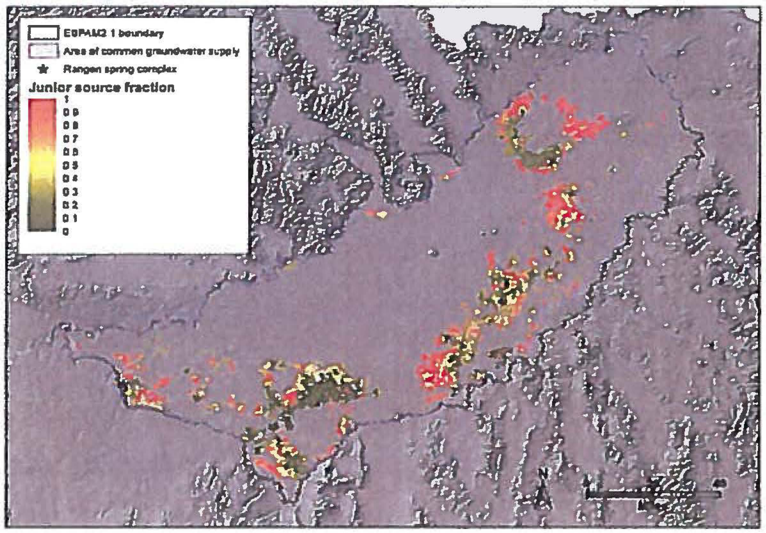
IDWR staff consider this prediction inferior to the model-predicted response at the Rangen spring complex.

This prediction method neglects spatial relationships between the springs within the reach and junior irrigation lands, and numerous other data used to calibrate ESPAM2.1.

ESPAM2.1 predicts a response of 17.9 cfs at the Rangen spring complex for this simulation.



Simulated curtailment junior to July 13, 1962 within area of common groundwater supply



Simulated curtailment:	479,203 acres		
	1,092,938 AF/yr	crop irrigation requirement	
	1,508.62 cfs	crop irrigation requirement	
	2.28 AF/ac/yr	crop irrigation requirement	

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	111.43	80,730
	Heise to Shelley	160.20	116,056
	Shelley to Near Blackfoot	209.31	151,636
	Near Blackfoot to Minidoka	635.93	460,705
	Kimberly to Buhl	113.33	82,100
	Buhl to Lower Salmon Falls	228.90	165,829
	Lower Salmon Falls to King Hill	49.53	35,882
	Total	1,508.62	1,092,938
Reach of interest:	Buhl to Lower Salmon Falls	228.90	165,829
	Response/simulated stress	15.2%	
Response at other reaches:		1,279.72	927,109
	Response/simulated stress	84.8%	

Apportionment of reach gains:

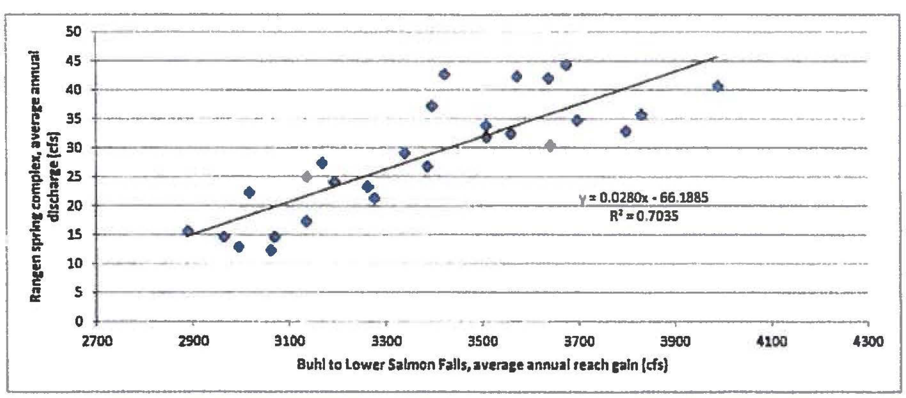
Observed Amplitude Ratio 2.8%

Portion of reach response assigned to Rangen spring complex 6.4 cfs

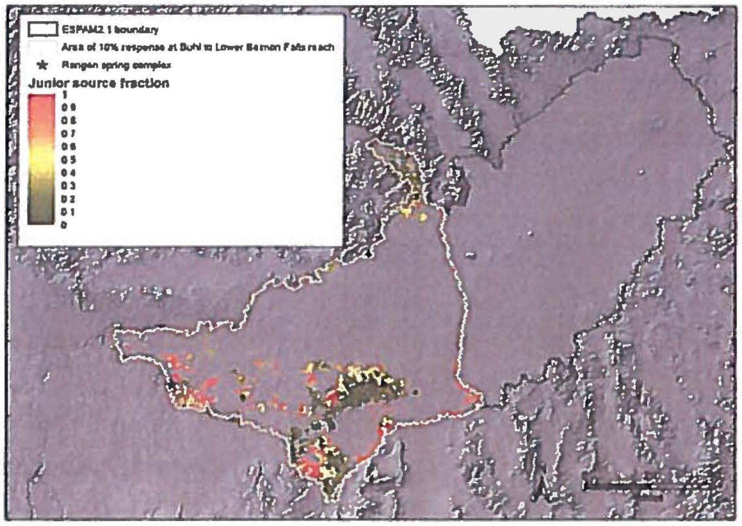
IDWR staff consider this prediction inferior to the model-predicted response at the Rangen spring complex.

This prediction method neglects spatial relationships between the springs within the reach and junior irrigation lands, and numerous other data used to calibrate ESPAM2.1.

ESPAM2.1 predicts a response of 16.9 cfs at the Rangen spring complex for this simulation.



Simulated curtailment junior to July 13, 1962 within area of 10% response at Buhl to Lower Salmon Falls Reach



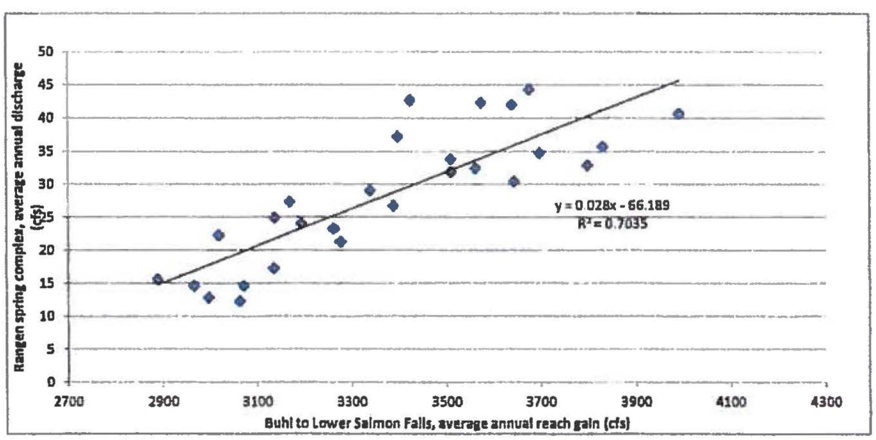
Simulated curtailment:	184,941 acres		
	454,737 AF/yr	crop irrigation requirement	
	627.69 cfs	crop irrigation requirement	
	2.46 AF/ac/yr	crop irrigation requirement	

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	6.33	4,588
	Heise to Shelley	18.52	13,419
	Shelley to Near Blackfoot	55.40	40,135
	Near Blackfoot to Minidoka	189.38	137,195
	Kimberly to Buhl	102.89	74,538
	Buhl to Lower Salmon Falls	209.08	151,472
	Lower Salmon Falls to King Hill	46.09	33,390
	Total	627.69	454,737
Reach of interest:	Buhl to Lower Salmon Falls	209.08	151,472
	Response/simulated stress	33.3%	
Response at other reaches:		418.61	303,265
	Response/simulated stress	66.7%	

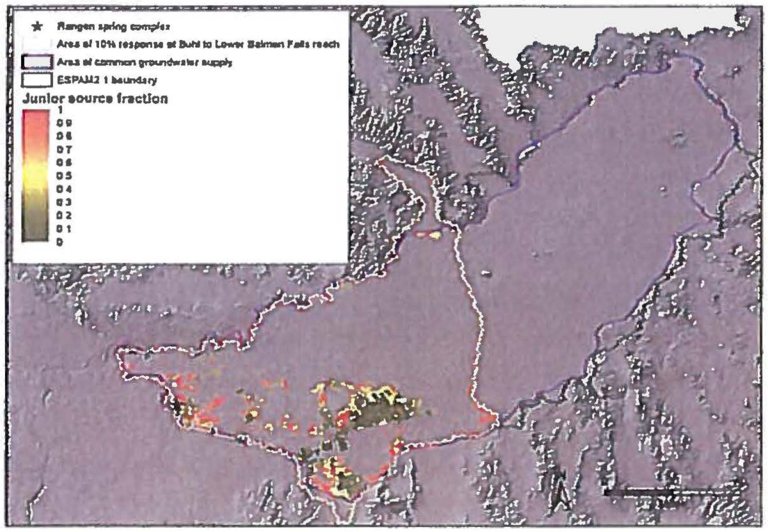
Apportionment of reach gains:

Observed Amplitude Ratio	2.8%
Portion of reach response assigned to Rangen spring complex	5.9 cfs

IDWR staff consider this prediction inferior to the model-predicted response at the Rangen spring complex.
This prediction method neglects spatial relationships between the springs within the reach and junior irrigation lands, and numerous other data used to calibrate ESPAM2.1.
ESPAM2.1 predicts a response of 15.5 cfs at the Rangen spring complex for this simulation.



Simulated curtailment junior to July 13, 1962 within area of 10% response at Buhl to Lower Salmon Falls Reach and area of common groundwater supply



Simulated curtailment:		168,559 acres	
		418,575 AF/yr	crop irrigation requirement
		577.77 cfs	crop irrigation requirement
		2.48 AF/ac/yr	crop irrigation requirement

Predicted response:	Reach	Response (cfs)	Response (AF/yr)
	Ashton to Rexburg	5.60	4,055
	Heise to Shelley	16.40	11,881
	Shelley to Near Blackfoot	49.12	35,587
	Near Blackfoot to Minidoka	168.68	122,201
	Kimberly to Buhl	95.80	69,406
	Buhl to Lower Salmon Falls	197.92	143,384
	Lower Salmon Falls to King Hill	44.26	32,062
	Total	577.77	418,575
Reach of interest:	Buhl to Lower Salmon Falls	197.92	143,384
	Response/simulated stress	34.3%	
Response at other reaches:		379.86	275,191
	Response/simulated stress	65.7%	

Apportionment of reach gains:

Observed Amplitude Ratio 2.8%

Portion of reach response assigned to Rangen spring complex 5.5 cfs

IDWR staff consider this prediction inferior to the model-predicted response at the Rangen spring complex.

This prediction method neglects spatial relationships between the springs within the reach and junior irrigation lands, and numerous other data used to calibrate ESPAM2.1.

ESPAM2.1 predicts a response of 14.7 cfs at the Rangen spring complex for this simulation.