No. 141, Original

IN THE
SUPREME COURT OF THE UNITED STATES

♦

STATE OF TEXAS,

Plaintiff,

v.

STATE OF NEW MEXICO and
STATE OF COLORADO,

Defendants.

♦

OFFICE OF THE SPECIAL MASTER

♦

STATE OF NEW MEXICO'S *DAUBERT* MOTION *IN LIMINE* TO EXCLUDE OPINIONS OFFERED BY DR. WILLIAM HUTCHISON

♦

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July 20, 2021

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COMES NOW the State of New Mexico ("New Mexico") and respectfully moves the Special Master to exclude Dr. Hutchison's opinions and testimony concerning the Texas groundwater model under Rule 702 of the Federal Rules of Evidence and *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993) and its progeny.

BACKGROUND

1. The Special Master has recently emphasized "the programmatic nature of the Compact's downstream apportionment[s]" to New Mexico and Texas. May 21, 2021 Order of the Special Master at 5. The Compact "fundamentally relied on the Project" to make its apportionment to New Mexico and Texas, and it was Project operations that "resulted in a de facto division of Project deliveries between the states . . . ." *Id*. at 6.

2. Now, among the primary issues to be determined at trial is the extent to which New Mexico and Texas actions, including groundwater pumping, may have affected those Project deliveries and, therefore, the states' respective Compact entitlements.

3. Dr. William Hutchison developed Texas's groundwater model in this case ("Dr. Hutchison's Model"). Exhibit A, *Expert Report of Dr. William Hutchison* (May 31, 2019) ("*Hutchison Expert Report*") (cover and table of contents). Dr. Hutchison's Model estimates flows in the Rio Grande at a river gage near El Paso; it does not simulate the entire Project area. *See* Exhibit B, *Expert Report of Gregory Sullivan & Heidi Welsh* at 112, 141 (Oct. 31, 2019) ("*Sullivan Expert Report*") (excerpts).

4. Additionally, Dr. Hutchison's Model was developed only to answer the simple question of quantifying changes in flows at the El Paso gage due to groundwater pumping in New Mexico and the Texas Mesilla valley below Elephant Butte Reservoir. *See id*. at 111, 141. Dr. Hutchison's Model does not consider such other critical variables as Project allocations and

operations, well pumping in the Texas and Mexico Hueco Bolson, changes in reservoir releases, and implementation of the 2008 Operating Agreement. *See id*.

5. Dr. Hutchison's Model also uses an annual time step, which does not allow it to represent the seasonal Project releases and substantial seasonal variations in groundwater levels and surface flows in the system. *See* Exhibit C, *Expert Report of Gilbert Barth* at 9-6 (Oct. 28, 2019) ("*Barth Expert Report*") (excerpts).

6. As a result of these critical shortcomings of his model, Dr. Hutchison's opinions lack relevancy and reliability and should be excluded from the evidence at trial.

LEGAL STANDARD

A party may use a motion *in limine* to exclude inadmissible or prejudicial evidence before it is actually introduced at trial. *See Luce v. United States*, 469 U.S. 38, 40 n.2 (1984). "[A] motion in limine is an important tool available to the trial judge to ensure the expeditious and evenhanded management of the trial proceedings." *Jonasson v. Lutheran Child and Family Services*, 115 F.3d 436,440 (7th Cir. 1997).

Under Rule 702 of the Federal Rules of Evidence, which serves as a guide here, "the trial judge acts as a 'gatekeeper' screening evidence for relevance and reliability." *Polski v. Quigley Corp.*, 538 F.3d 836, 838 (8th Cir. 2008) (citing *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 589 (1993)). This gatekeeping role under Rule 702 applies regardless of "whether the trier of fact is a judge or a jury." *UGI Sunbury LLC v. A Permanent Easement for 1.7575 Acres*, 949 F.3d 825, 832 (3d Cir. 2020). The party offering expert testimony has the burden to show, among other things, that (1) it will help the trier of fact understand the evidence or determine a fact in issue; (2) it is based on sufficient facts or data; (3) it is the product of reliable principles and methods; and (4) it is the product of a reliable application of the principles and methods to the facts of the case. Fed. R. Evid. 702.

The importance of the trial court's "gatekeeping" responsibility under Rule 702 and *Daubert* cannot be overstated. As the Supreme Court has characterized it, "[T]he objective of that requirement is to ensure the reliability and relevancy of expert testimony. It is to make certain that an expert, whether basing testimony upon professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field." *Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 152 (1999).

ARGUMENT

I. Dr. Hutchison's Testimony Should be Excluded Because His Model is Irrelevant and Unreliable

A. Dr. Hutchison's Model is Not Relevant Because it Cannot Account for the Physical Realities of the Project and Rio Grande Basin.

Under Rule 702(a), a witness qualified as an expert may "testify in the form of an opinion" if the "expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue." Fed. R. Evid. 702(a). This "condition goes primarily to relevance" or what has been called "fit" because "[e]xpert testimony which does not relate to any issue in the case is not relevant and, ergo, non-helpful." *Daubert*, 509 U.S. at 591, (quotations omitted). The court must determine whether the expert's "reasoning or methodology properly can be applied to the facts in issue." *Cooper v. Smith & Nephew, Inc.*, 259 F.3d 194, 199 (2001) (quoting *Daubert*, 509 U.S. at 592–93).

Courts have routinely excluded expert testimony relying on models that did not accurately represent the real-world environment being modeled or that overlooked important variables that should have been considered. In *Concord Boat Corp. v. Brunswick Corp.*, 207 F.3d 1039, 1056

(8th Cir. 2000), the court excluded an expert's opinion in an antitrust suit because the model the expert used "to construct a hypothetical market . . . was not grounded in the economic reality of the [subject product's] market, for it ignored inconvenient evidence." *Id*.

Similarly, in *El Aguila Food Prods., Inc. v. Gruma Corp*., another antitrust suit, the court upheld the trial court's exclusion of an expert's opinions under Rule 702 because "his opinions amounted to abstract conclusions not adequately grounded in the facts of the case." 131 F. App'x 450, 454 (5th Cir. 2005). The record showed the expert did not examine relevant facts and data and did not quantify the extent of the defendant's anti-competitive behavior. *Id*.

Models have also been excluded because they did not accurately represent or account for real-world facts. *Reali v. Mazda Motor of Am., Inc.*, concerned a plaintiff who suffered a form of mild traumatic brain injury after a traffic accident. 106 F.Supp.2d 75, 76 (D. Me. 2000). The court found certain expert testimony irrelevant because the expert used a computer application that did not model the design defects identified by plaintiff's design expert. *Id*. at 79.

Finally, the court in *In re TMI Litig*., excluded expert testimony based on a water model that could not simulate radiation flows at the time of a faulty nuclear reactor accident. 193 F.3d 613, 670 (3d Cir. 1999). The Third Circuit concluded that the expert's testimony based on a water model that was a "tool for visualization" only, was not intended to simulate flows at the time of the nuclear accident, and therefore did not assist the trier of fact. *Id*.

Here, Dr. Hutchison's groundwater model cannot address alleged injury from groundwater pumping because Dr. Hutchison's Model does not evaluate—and is not capable of evaluating—how *Project deliveries* are impacted by that pumping. Dr. Hutchison's Model cannot analyze this impact because (1) it was created to estimate flows in the Rio Grande at a river gage near El Paso, which is not a measure of Compact compliance; (2) it cannot make accurate estimations of reduced

Project deliveries to Texas because it does not account for crucial variables such as Project operations, including reservoir releases; and (3) its annual timescale makes it further incapable of disaggregating alleged impacts on Project deliveries during the irrigation (release) season from alleged impacts during the non-irrigation (non-release) season.

1. Dr. Hutchison's Model Simulates the Incorrect Measure of Compact Compliance.

First, Dr. Hutchison's Model estimates a measure that is irrelevant to Compact compliance. Dr. Hutchison's Model estimates flows in the Rio Grande at a river gage near El Paso; yet the El Paso gage is not a Project delivery point or a Compact delivery point and is therefore irrelevant to alleged injury. *See Sullivan Expert Report* at 112, 141.

Any modeling that evaluates impacts to Project deliveries must represent accurate historical deliveries and operations. The Project has always operated as a unit, and prior to the 2008 Operating Agreement, operated to allocate equal amounts of water to each farm acre under the Project. Prior to the early 1980s, the Bureau of Reclamation ("Reclamation") was responsible for delivering the reservoir releases directly to the farmers. Exhibit D, *Disclosure of Expert Rebuttal Witness Dr. Ian Ferguson* at 7 (Dec. 30, 2019). After the early 1980s, Reclamation used the historical releases and deliveries from 1951 to 1978 to estimate the releases necessary to make deliveries to the major diversion structures in the Project area. Exhibit E, *Supplemental Disclosure of Expert Witness Dr. Ian Ferguson* at 3 (Sep. 16, 2019). This post-1980 delivery procedure was an allocation procedure developed by Reclamation (known as the "D1/D2 Allocation"). *Id*.

To understand whether groundwater pumping within the Project area has impacted historical Project deliveries, it is necessary to develop and apply a robust simulation model of the entire Project. *Sullivan Expert Report* at 112, 141. Simply estimating annual flows in the river at the El Paso gage does not indicate whether Project deliveries were made and therefore whether Compact compliance was achieved. *Id*.

Further, as the Special Master has acknowledged, return flows have made up a significant portion of Project supply and historically were an increasing source of Project supply in the southern reaches of Texas below the El Paso gage. *See* May 21, 2021 Order of the Special Master at 27 ("In the early 1930s, return flow comprised approximately 35 percent of the water diverted by Reclamation near El Paso and approached 60 percent at the southern reaches of the Project.") (citations omitted); *see also id*. at 33. Yet Dr. Hutchison has expressed an unawareness and indifference to Project supply and Project deliveries below the El Paso gage, stating that he did not know where the Project delivery points were located in Texas and that he did not believe they were relevant to his investigations in this case. Exhibit F, *Deposition of Dr. William Hutchison*, *Vol. 2* at 235:21-236:3 (Oct. 1, 2019) ("*Hutchison Depo. Tr. Vol. 2*") (excerpts).

In sum, Dr. Hutchison's Model cannot estimate Project deliveries at their delivery locations or simulate the Project reach below the El Paso gage. For this reason, Dr. Hutchison's testimony based on his groundwater model should be excluded because it is not "fit" to answer the issues of Compact compliance in this case.

2. Dr. Hutchison's Model Cannot Evaluate Project Operations.

Like the deficient models in *Concord Boat Corp*. and *Reali* that failed to accurately represent real-world conditions, Dr. Hutchison's Model does not account for crucial variables such as Project operations, how those operations change when hydrologic conditions change, and how Texas and Mexico groundwater pumping impacts the amount of water released from the Project reservoirs.

The assumption in Dr. Hutchison's Model that all increases in drain flows and river flows under reduced groundwater pumping scenarios would translate into like increases in the flow at the El Paso gage ignores that reservoir releases are continually adjusted to consider downstream river gains and losses so that downstream deliveries do not exceed Project water orders. *Sullivan Expert Report* at 142. It also ignores that Reclamation would allocate 57% of any increased supply to EBID. Dr. Hutchison's Model simply eliminates groundwater pumping in the Rincon and Mesilla valleys and then delivers all simulated increases in surface flow to Texas without adjustment of reservoir releases or allocation of any additional flows to EBID. *Id*. at 142-43. The Project has never operated in this manner. In fact, Dr. Hutchison's Model simulates deliveries to Texas that exceed demands and are therefore wasteful.

As the Special Master has acknowledged, Project operations are inherently interconnected with the flows observed in the Rio Grande River below Elephant Butte. *See* Special Master's May 21, 2021 Order at 3, 5, 11, 22, 24 (noting the Compact's "programmatic" division of water below Elephant Butte to the states via the Project); *id*. at 15 ("Through Article VI, upstream rights and duties are defined by reference to Project storage conditions which, in turn, are at least partially the result of cumulative Project releases for downstream water deliveries."); *id*. at 29 ("In operation, Reclamation played a large role in the actual delivery of water. From the beginning of Project deliveries until approximately 1980, Reclamation delivered water directly to farm headgates."); *Id*. at 29-30 ("Individual water users would place water orders directly with Reclamation, and Reclamation would adjust Reservoir releases as well as downstream control dam and canal headgate releases to attain the desired delivery of water at farm headgates.") (citations omitted). Dr. Hutchison too, has acknowledged the connection between reservoir releases and flows in the Rio Grande below the reservoir. Exhibit G, *Deposition of Dr. William Hutchison*, *Vol. 1* at 218:24-219:4 (Sep. 30, 2019) (excerpts) ("Clearly if you change the reservoir operations, you change the outflow, that would cause a change . . . ."). However, Dr. Hutchison's Model simply cannot represent the real-world facts at issue in this case. *Hutchison Depo. Tr. Vol. 2* at 230:17-20 (agreeing that his model assumes "that the reservoir releases would remain the exact same as they did historically"); *id*. at 240:15-241:2 (stating that his model "was based on the physical system, not the institutional system").

Because Dr. Hutchison's Model does not model Project operations and therefore cannot represent real-world circumstances, Dr. Hutchison's testimony and opinions regarding the Texas Model are neither helpful to the Court nor reliable and should be excluded.

3. Dr. Hutchison's Model Improperly Uses an Annual Time Step

Finally, Dr. Hutchison's Model uses an annual time step, precluding the model's ability to differentiate between Project deliveries during the irrigation season versus winter flows. *See Barth Expert Report* at 9-6. Without seasonality, Dr. Hutchison's Model also cannot represent groundwater elevation fluctuations, which vary several feet during the course of the year, and does not predict the seasonal rise in groundwater that contributes to Project drains, which then results in underestimation of drain flows. *Id*. at 9-7. The decision to implement an annual time step renders Dr. Hutchison's Model incapable of accurately representing anything other than Rio Grande flows at the El Paso gage for the entire year, again ignoring that Project deliveries occur only during the irrigation season and making it impossible to separate these deliveries from non-Project flows that occur in winter. *Id*.

Dr. Hutchison acknowledged that drain flows and canal seepage in the Rio Grande below Elephant Butte are dependent on seasonal gradients, *see Hutchison Depo. Tr. Vol. 2* at 266:2-5, but he justified the decision to develop a model on an annual time-step because of its simplicity and because it addressed the questions posed by Texas's counsel at the time, *see id*. at 260:14-20. This oversimplification, however, left Dr. Hutchison's Model unable to accurately represent Project deliveries.

Dr. Hutchison's testimony based on his groundwater model must be excluded because the model cannot evaluate how *Project deliveries* to Texas are impacted by that pumping.

B. Dr. Hutchison's Model Is Unreliable Because It Does Not Account for Important Circumstances of this Case.

Expert testimony is admissible only if the witness applies his or her principles and methods reliably to the facts of the case. Fed. R. Evid. 702(d). Thus, even if the expert employs reliable general principles developed by reliable methods, evidence may be excluded under Rule 702(d) if the specific application of those principles to the facts of the case is suspect. *General Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997) ("[N]othing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence that is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered."). Under Rule 702, courts should consider, among other factors, whether "the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion" and whether "the expert has adequately accounted for obvious alternative explanations" in reaching the expert's conclusion. *See* Fed. R. Evid. 702, Advisory Committee Notes, 2000 Amendment (citing *Claar v. Burlington N.R.R.*, 29 F.3d 499 (9th Cir. 1994).

Courts have been willing to exclude expert testimony as unreliable when the expert fails to explain how he or she applied the methodology or reason through alternative explanations and nuances. *Claar*, the decision cited approvingly by Rule 702's advisory committee, concerned an action by former employees of a railroad alleging ailments stemming from exposure to chemicals at their workplace. 29 F.3d at 502. The Ninth Circuit held that the district court properly refused to admit expert affidavits when those experts did not rule out other possible causes for injuries the plaintiffs complained of. *Id*.

Similarly, in *In re Live Concert Antitrust Litigation*, the court excluded an expert economist's damages analysis in an antitrust suit brought against promoters of live rock concerts. 863 F.Supp.2d 966, 986–987 (C.D. Cal. 2012). The expert's "yardstick" damages analysis assumed, without further examination, that the difference in average ticket prices the expert observed were due entirely to promoters' allegedly anticompetitive conduct and did not account for any other possible explanations for the disparity such as differences in artist quality or popularity. *Id*.

And in a law firm's defamation claim alleging that an adversary posted on an electronic bulletin board claiming to be an unhappy client, the firm's proffered expert testimony claimed that the post originated from an IP address registered to the adversary. *Wendler & Ezra, P.C. v. American Intern. Group, Inc.*, 521 F.3d 790, 791 (7th Cir. 2008). The court excluded the testimony, however, because the expert did not explain what software he used, what data he fed it, what results it produced, or how alternative explanations were ruled out. *Id*.

For the same reasons Dr. Hutchison's Model does not "fit" the facts of this case, it also produces unreliable conclusions because it fails to account or adjust for critical real-world circumstances. Most significantly, and much more deficient than the proposed expert evidence in *Wendler* and *In re Live Concert Antitrust Litigation* that failed to account for alternative explanations and nuances, Dr. Hutchison's Model completely disregards crucial variables such as Project operations, how those operations change when hydrologic conditions change, and even how Texas and Mexico actions, including groundwater pumping, impact the amount of water released from the Project. Dr. Hutchison's Model cannot supply meaningful or reliable conclusions on the issues in this case from its analysis, in isolation, of how groundwater pumping in the Rincon and Mesilla basins impacts flows in the river. *See Fuesting v. Zimmer, Inc.*, 421 F.3d 528, 536 (7th Cir. 2005), *opinion vacated in part on reh'g*, 448 F.3d 936 (7th Cir. 2006) (admonishing expert testimony that is merely an "unjustifiable extrapolation from an accepted premise to an unfounded conclusion").

Nor did Dr. Hutchison accumulate the knowledge required to understand these critical shortcomings in his model. Dr. Hutchison admitted to having only a "superficial understanding" of how Reclamation determines Project releases, *Hutchison Depo. Tr. Vol. 2* at 231:23-232:2, did not know how Reclamation considers gains or losses in the river from Project releases, *id*. 232:23-233:2, did not discuss reservoir releases with any Reclamation personnel, *id*. at 233:21-24, and did not know any details of the Project delivery points in Texas, *id*. at 234:16-22. Without this background understanding, Dr. Hutchison developed a model that focused solely on the physical responses in the river to groundwater pumping, without any attempt to incorporate the institutional operations critical to those same flows:

> Q. Is it your opinion that if in the what-if scenario, no pumping, that reservoir releases would have remained the same?
>
> A. I don't know. Simulating a physical response is a different problem, a different issue, than simulating the effects of alternative operations, and the work that I completed was limited to looking at just the physical changes associated with changes in pumping.

Id. at 231:7-15.

Without accounting for these important considerations, the conclusions from Dr. Hutchison's Model are purely speculative, and "[e]xpert testimony that is speculative is not competent proof and contributes nothing to a legally sufficient evidentiary basis." *Concord Boat Corp. v. Brunswick Corp.*, 207 F.3d at 1057.

CONCLUSION

For the foregoing reasons, New Mexico respectfully moves the Special Master to enter an order excluding Dr. Hutchison's opinions on the Texas groundwater model.

Respectfully submitted,

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OFFICE OF THE SPECIAL MASTER

♦

STATE OF NEW MEXICO'S CERTIFICATE OF SERVICE

♦

This is to certify that on July 20, 2021, I caused a true and correct copy of the **State of New Mexico's *Daubert* Motion *in Limine* to Exclude Opinions Offered by Dr. William Hutchison** to be served by e-mail and U.S. Mail upon the Special Master and by e-mail upon all counsel of record and interested parties on the Service List, attached hereto.

Respectfully submitted this 20th day of July, 2021.

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Exhibit A

May 31, 2019

EXPERT REPORT OF:
William R. Hutchison

In the matter of:

No. 141, Original
In the Supreme Court of the United States
State of Texas v. State of New Mexico and State of Colorado

Prepared for:

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Prepared by:

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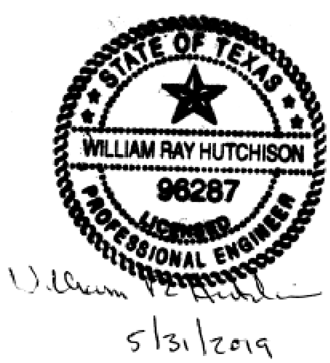

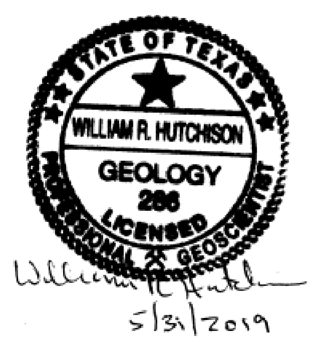

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3 – El Paso Water Utilities Letter to Transboundary Aquifer Assessment Coordinators (July 11, 2008)

Associated Technical Memoranda – Model Development

1 – Model Grid, Service Areas, Zones
2 – Gridded Acres CU
3 – Adjusted CU – Double Cropping and Match GoldSim Output
4 – Monthly Zonal Estimates of Agricultural Supply and Deep Infiltration
5 – Agricultural Groundwater Pumping and Deep Infiltration of Irrigation Water (WEL)
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Exhibit B

No. 141, Original

IN THE

SUPREME COURT OF THE UNITED STATES

TEXAS V. NEW MEXICO AND COLORADO

EXPERT REPORT OF
GREGORY K. SULLIVAN, P.E.
AND
HEIDI M. WELSH

Prepared for:

STATE OF NEW MEXICO

Prepared by:

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Adelheid M. Welsh

October 31, 2019

Spronk Water Engineers, Inc.

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LIST OF ABBREVIATIONS

2008 OA	2008 Operating Agreement
ACE	American Canal Extension
AF	Acre-feet
Reclamation	Bureau of Reclamation
CFB Model	Canal and Farm Budget Model
cfs	Cubic feet per second
CIR	Crop irrigation requirement
cms	Cubic meters per second
Compact	Rio Grande Compact
DCMI	Domestic, commercial, municipal, and industrial
DE	David's Engineering
DP	Deep percolation
EBID	Elephant Butte Irrigation District
EPA	Environmental Protection Agency
EPCWID	El Paso County Water Improvement District No. 1
EPW	El Paso Water
ET	Evapotranspiration
FHG	Farm headgate
Ft. Quitman	Fort Quitman, Texas
gpm	Gallons per minute
GPS	Global positioning system
HCCRD	Hudspeth County Conservation and Reclamation District No. 1
Hueco Model	Hueco Ground Water Model
Hydros	Hydros Consulting
IBWC	International Boundary and Water Commission
ILRG Model	Integrated Lower Rio Grande Model
JID	Juarez Irrigation District
JMAS	Junta Municipal de Aqua y Saneamiento (water utility for Ciudad Juarez)
LRG	Lower Rio Grande
LRG Area	Area of irrigation and non-irrigation water use in the Rincon, Mesilla, El Paso, and Juarez Valleys between Caballo Reservoir and Ft. Quitman Texas
M&A	Montgomery & Associates
MAD	Management allowable depletion
MFE	Maximum farm irrigation efficiency
MMA	McDonald-Morrisey Associates, LLC
MX-IBWC	Mexican section of the International Boundary and Water Commission
NMAGO	New Mexico Office of the Attorney General
NMISC	New Mexico Interstate Stream Commission
NMOSE	New Mexico Office of the State Engineer
NMR-M Model	New Mexico Rincon-Mesilla Ground Water Model
NPDES	National Pollutant Discharge Elimination System

PET	Potential evapotranspiration
QA/QC	Quality assurance and quality control
RGCC	Rio Grande Compact Commission
RGJI	Rio Grande Joint Investigation
RiverWare	RiverWare simulation model
RHG	River headgate
SSPA	S.S. Papadopulos & Associates
SWDataSet	Surface Water Dataset prepared by SWE
SWE	Spronk Water Engineers, Inc.
URGWOM	Upper Rio Grande Water Operations Model
USGS	United States Geological Survey
US-IBWC	United States section of the International Boundary and Water Commission
WDR	Water Distribution Report
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

11.0 RESPONSE TO BRANDES REPORT

Robert J. Brandes, Ph.D., P.E. prepared a May 31, 2019 expert report on behalf of the State of Texas ("Brandes Report"). The subjects of the Brandes Report generally included the following:

- New Mexico Ground Water Development
- Historical Changes in Rio Grande Flows
- Project Operations
- Effect of Ground Water Pumping on Project Deliveries

SWE was asked by legal counsel for New Mexico to review the Brandes Report to identify information or opinions with which we disagreed, and to prepare expert opinions to respond to these issues. We attempted to identify and respond to all substantive issues in which there appeared to be differences of opinion, however a lack of response to a particular issue should not be interpreted as tacit agreement with Dr. Brandes' opinion(s).

Brandes Opinion 1 – *Extensive ground water development in the Rincon and Mesilla basins of New Mexico that began in the 1950s has depleted drain flows and river flows, and this has altered the Project water budget by reducing flows in the Rio Grande that would reach water users in Texas. (Page 10 paragraph 1).*

Response:

The conceptual discussion of the impacts of pumping on Texas water users in Section 4 implies that New Mexico pumping has caused continuous and unrelenting impacts on Texas water users since the early 1950s. The discussion exaggerates the impacts for the following reasons:

1. Pumping in New Mexico varied substantially since it developed in the early 1950s with higher pumping amounts in low Project supply years and lower pumping amounts in full supply years.
2. In full supply years, Reclamation delivered all water ordered by EPCWID and EBID up to their total allocations. To the extent there were varying Project delivery efficiencies (i.e., diversion ratio), Reclamation could adjust releases from storage to deliver the water that was ordered. Therefore, there would not be shortages of delivered water to EPCWID as a result of New Mexico (or Texas) pumping on Project water deliveries in full supply years.

3. There were full supply years from 1979 through 2002, and Dr. Brandes ignores the full deliveries to Texas during all of these years.
4. Additionally, if ground water pumping caused any reductions in the diversion ratio within the Project areas, this would apply to New Mexico, Texas, and Mexico pumping. Dr. Brandes ignores the impacts of Texas and Mexico pumping on Project operations.
5. Dr. Brandes also ignores that Reclamation operated the Project releases and deliveries, encouraged conjunctive use of ground water by all Project participants to meet the full irrigation demands from 1951 - 1978, and then formalized the needed conjunctive use of surface water and ground water by implementing the D1/D2 allocation procedure in 1980 and operating thereunder until major changes in the operating procedures were initiated in 2006 and then adopted in the 2008 OA. Instead, Dr. Brandes blames all changes in Project water deliveries and Rio Grande flows on New Mexico pumping.
6. The foregoing criticisms apply to all of the analyses of historical river flows, drain flows, and Project water deliveries that are presented in the Brandes Report.

Brandes Opinion 2 – *The estimated annual withdrawals for irrigation in the Rincon and Mesilla basins since 1940 are presented on the bar chart in Figure 4.3. As shown by the bars on the chart in Figure 4.3, annual groundwater withdrawals for irrigation has varied considerably, likely in response to wet/dry conditions, and the annual volume of groundwater pumpage for irrigation was substantial even in the early 1950s, indicating that the groundwater well pumping capacity, and likely the total number of irrigation wells, at that time were significant. The demands for additional supplies of irrigation water during the severe drought of the 1950s and during other dry periods, particularly in the mid-2000s and after 2010, are illustrated by the higher levels of groundwater withdrawals on the chart. (Page 11 paragraph 2).*

Response:

The ground water withdrawals for irrigation in Figure 4.3 in the Brandes Report include a significant amount of pumping in the Texas portion of the Mesilla basin. Since roughly 10% of the total Project irrigated area in the Mesilla basin is in Texas, it is reasonable to assume that roughly 10% of the estimated Mesilla basin irrigation pumping in Figure 4.3 would also be in Texas.

The high pumping in the early 1950s is unrealistic given that significant irrigation well development began in New Mexico in the late 1940s and was not complete until about 1955. The pumping estimates shown in Figure 4.3 indicate that almost all of the pumping capacity developed in a single year, with pumping increased from about 10,000 AF in 1950 to about 200,000 AF in 1951. It is unrealistic to assume that all of the irrigation wells would have been constructed in a single year.

As described in the responses to the M&A Report, the total irrigation water demands are overstated because the crop irrigation water requirements are too high beginning in the mid-1980s. Since the irrigation pumping is estimated based on the unmet irrigation demand, this leads to the irrigation pumping also being overstated.

The estimated irrigation pumping during the full supply years of the 1980s and early 1990s averaging nearly 100,000 AF/y is unrealistically high given the full allocation of surface water during those years.

Brandes Opinion 3 *–The plot in Figure 4.5 shows the total combined groundwater withdrawals for both irrigation and urban uses in the Rincon and Mesilla basins [5]. As indicated, since 1950, the total annual groundwater withdrawals consistently have been above 100,000 AF per year, with peak pumpage in recent dry years in the range of 300,000 to over 400,000 AF. (Page 12 paragraph 2).*

Response:

A substantial portion the annual pumping in Figure 4.5 of the Brandes Report is from irrigation wells in the Texas portion of the Mesilla Valley, from EPW's Canutillo wellfield, and from the Juarez Conejos-Medanos wellfield. Pumping from these non-New Mexico wells contributes to the depletions of Rio Grande flow for which Texas is claiming damages. **Figure 11-1** disaggregates the Texas estimates of the total annual pumping in the Rincon and Mesilla basins between the amounts from wells in New Mexico, Texas, and Mexico.

Brandes Opinion 4 *– A report by an unknown author reportedly prepared in 1982 is cited as evidence of the following impacts from ground water development in the Rincon and Mesilla basins:*

> *This groundwater development has changed the flow regime established prior to 1951 such that a greater release is required from Elephant Butte Reservoir to achieve the same flow at El Paso. This new trend, which was established after the end of the drought of the 1950's, has continued to the present (1982).*
>
> *In conclusion, all four figures used in this analysis show that the effects of the groundwater development below Elephant Butte Dam induced by the drought of the 1950's have significantly affected the amount of water reaching El Paso. The*

new relationship is well defined and has been continuous to the present (1982). (Page 14 paragraph 2 and 4).

Response:

The reliability of conclusions from a 1982 report by an unknown author with unknown affiliation using unsourced data is questionable. Dr. Brandes presents analyses similar to those in his report, and my responses are therefore focused on review of his analyses.

***Brandes Opinion 5** – A 1986 report by Tipton and Kalmbach prepared for the IBWC is described and the following conclusions are cited from the report*

1) Depletions of the Rio Grande upstream of the El Paso Narrows have increased. The annual depletions from 1922 through 1950 averaged 237,000 acre-feet per year, from 1951 through 1984 averaged 260,000 acre-feet per year, and from 1980 through 1984 averaged 305,000 acre-feet per year.

5) The use of wells in the Rincon Valley and Mesilla Basin for supplemental irrigation water and for municipal, industrial, and domestic uses since 1951 is the principal cause for the increased depletion upstream of the El Paso Narrows. (Page 15 paragraph 1 and 2).

Response:

The Rio Grande depletions upstream of the El Paso Narrows were reportedly computed as the annual flow at El Paso minus the releases from Project storage. Based on this calculation, the 1986 report concluded that annual Rio Grande depletions increased by an average of 23,000 AF/y after 1950 based on comparison of average depletions during 1922 - 1950 (237,000 AF/y) to average depletions during 1951 - 1984 (260,000 AF)/y).

The 1986 report does not describe the specific sources for the data that were used in the analyses described in the report. Also, the attachments to the report that are the basis for some of the conclusions in the report were not provided. This makes it difficult to review and assess the validity of the report analyses and conclusions.

The report text indicates that the releases from Project storage were a combination of releases from Elephant Reservoir and releases from Caballo Reservoir. Since Caballo Reservoir began operating in 1938, it is assumed that Elephant Butte Reservoir releases were used before 1938. As described previously in Section 5, on average, there was an average gain of about 20,000 AF/y between the Elephant Butte Reservoir outlet and the approximately location of the Caballo Reservoir outlet between 1930 and 1938. Therefore, depletions computed from Elephant Butte Reservoir releases would be expected to be lower than depletions computed from Caballo Reservoir releases before 1938. Using Elephant Butte Reservoir releases for more than half of the 1922 - 1950 period would have depressed the average computed depletions during this period. Comparison of this figure to average depletions after 1950 that are computed entirely based on Caballo Reservoir releases would result in misleading conclusion about differences in average depletions before and after 1950.

As described in Section 5, average depletions from the Caballo Reservoir outlet (or Percha Dam prior to 1938) to El Paso remained relatively steady from the 1930s through the 1970s at about 250,000 AF, increased to around 300,000 AF during the 1990s, and fell back to around 250,000 during the last decade. Therefore, any conclusions about long term persistent trends in depletions are not supported by the available data.

***Brandes Opinion 6** – A 1997 report by a hydrologic task committee appointed by a New Mexico District Court is described and the following conclusion from the report is cited as evidence that ground water pumping causes depletions to Rio Grande flows.*

> *Well withdrawals in the LRGB have been derived partly from stored groundwater, partly from surface-water depletion and partly from capture of evapotranspiration. The fraction derived from the surface water grows through time. The historical portion of well withdrawal from surface-water depletion is estimated to be between 80 and 90 percent. Specific wells may derive water from appreciable different proportions of each source. (Page 15 paragraph 6).*

Response:

The 1997 report describes a ground water model that was developed and used for analysis of basic effects of ground water pumping.

> *Various pumping scenarios were examined using a ground water model to illustrate basic hydrologic relationships. The ground water modeling results are dependent on a number of simplifying assumptions and do not simulate the historical development within the LRGB.*

The 1997 report indicates that the model was used to simulate the effect of pumping of a hypothetical well at a rate of 500 gallons per minute ("gpm") at various locations in the basin and distances from the river and at various depths to assess the effect that well location had pumping impacts to (a) ground water storage, (b) river flow, and (c) capture of evapotranspiration (of native vegetation). The report concluded that the location and depth of the well had a significant impact on how much the simulated pumping depleted the river.

Support for the reported conclusion that between 80% and 90% of historical well withdrawals come from surface water depletions was not found in the 1997 report. The results of various model runs in Appendix A of the 1997 report show substantially more variability in the amount of pumping that is derived from the stream after 100 years of pumping (42% - 93%).

Details about the ground water model construction were not provided in the 1997 report and it is unclear whether the model was calibrated. The report includes the following caveats regarding the model results:

> *Although the work presented in this report is based on the most recent technical information available, it should not be considered as a definitive description of the hydrogeologic system or its response to stresses.*
>
> *A cautionary note is in order. Model simulations quantify the impacts of pumping in the LRGB, but are affected by the way that a model is constructed. The simulations are also affected by the assumptions made regarding hydrologic relationships. If an accurate quantification of the effects of ground-water withdrawals is desirable, the key hydrogeologic relationships that are assumed in any model should be subjected to scrutiny and verification.*

Based on stated purpose of the 1997 modeling work, the simplified nature of the model runs, and the caveats regarding the model results, the report conclusions should be interpreted as preliminary, approximate, and conceptual. The NMR-M Model is far more sophisticated and evolved than the relatively simple model described in the 1997 Report. There is no point in relying on results from a model developed over 20 years ago when more capable tools, like the NMR-M Model and the ILRG Model, are available today.

Brandes Opinion 7 *– Dr. Brandes summarizes a 2008 presentation by Gary Esslinger, manager of the EBID concerning the 2008 Operating Agreement. Esslinger explained the development of the D1/D2 Curves that were used to allocate Project water from 1979 - 2007, and which continue to be used to allocate water to Texas and Mexico under the 2008 Operating Agreement, allowed groundwater pumping in New Mexico to be grandfathered at the 1951-1978 levels that are embedded in the D1/D2 Curves. (Page 16 paragraph 5)*

Response:

Figure 4.6 in the Brandes Report illustrates the annual reservoir release and diversion data for 1951 - 1978 (red dots) that were used to develop the D2 Curve (red line). The D2 line is the best fit straight line through the 1951 - 1978 data that are generally scattered above and below the line. More recent data are shown in the plot for two periods from 2003 - 2007 (before full implementation of the 2008 OA) and for 2008 - 2017 (after the 2008 OA). The recent data in Figure 4.6 are charged diversions during Project releases from storage as compared to the 1951 - 1978 data used to develop the D2 Curve which are total annual diversions and include diversions outside of the Project release period. As a result, recent data are biased low compared to the 1951-1978 data.

Additionally, as to the 2003 - 2007 data, all years except 2005 are within the scatter range of the D2 Curve data and therefore do not exhibit unusually low deliveries. Lastly, during the 2008 - 2017 period, Texas received annual allocations based on the 2008 OA procedure, and therefore any deviation in Project performance below the D2 line was fully shouldered by New Mexico under the D3 allocation procedure. During the 2008 - 2017 period, Texas was also able to carry over significant amounts of water, resulting in Texas's annual allocation far exceeding its historical 43% share, and forcing more ground water pumping New Mexico, for which Brandes seeks to blame New Mexico.

Brandes Opinion 8 *– Figure 5.2 is a plot of cumulative releases from Caballo Reservoir (or from Elephant Butte before 1938) and cumulative Rio Grande flows at El Paso beginning in 1930 and extending through 2015. As shown, the cumulative curves for both the Caballo releases (red circles) and the El Paso Rio Grande flows (green squares) exhibit steeper segments reflecting higher flow conditions and also flatter segments indicating lower flow conditions. The effects of the high flows during the early 1940s and mid-1980s and the low flows of the early to mid-1950s are readily apparent in the two curves. Lower flow conditions also are indicated beginning around 2010, which is consistent with observed climatic and hydrologic conditions. Overall, the cumulative curve for the Rio Grande flows at El Paso generally shows a somewhat flatter trend after the 1950s, indicating less river water reached El Paso relative to what was released from Caballo. The early 1950s, of course, is when significant groundwater pumping for irrigation began in New Mexico. Flattening of the slope of the cumulative curve for the Rio Grande flows at El Paso beginning in the early 1950s is more likely than not indicative of the effects of lowered groundwater levels and increased losses from the Rio Grande and drainage ways that resulted from the development of significant groundwater pumping in the Rincon and Mesilla basins. (Page 19 paragraph 1).*

Response:

The historical flow of the Rio Grande at the El Paso gage is not relevant to this litigation because (a) it is not a point of compliance for the Compact, and (b) it is not a point of delivery for the Project. The Project was conceived and has been operated to provide equal delivery of water per acre of irrigated land. Until 1979, Reclamation was responsible for making water available for delivery to the users on an equal per acre basis. After the districts took over the internal distribution of water to the Project water users, Reclamation's obligation to deliver water was changed to the major canal headings with the idea that the district would perform the remainder of the water distribution that would continue equal delivery of water per acre. Since 1979, Reclamation has accounted for deliveries to EBID and EPCWID at canal headings and other points upstream and downstream the El Paso gage, but there continues to be no Project accounting at the El Paso gage.

The relative steep slopes of the reservoir releases (red circles) and El Paso flows (green squares) during the 1930s and 1940s reflects the generally above average water supply conditions that resulted in full Project supplies through that period and relatively high releases from storage. There were no annual water allocations set by Reclamation during the 1940s and 1950s and farmers ordered whatever water they thought they needed.

The general flattening of both curves after 1950 reflects the decline in average annual releases that occurred because the average water supply after 1950 was much lower than before 1950, despite the wet periods of the 1980s and 1990s. The following are comparison of the average reservoir releases before and after 1950:

Comparison of Average Annual Storage Releases (acre-feet)

Years	All Years	Excluding Spill Years
1930-1950	829,000	781,000
1951-2017	607,000	575,000

In addition, as shown in Figure 5.1 of the Brandes Report, the Project is generally more efficient in conveying flows released from the reservoir downstream to El Paso at higher flows. The flattening and slight divergence of the cumulative reservoir release and El Paso flow curves in Figure 5.2 after 1950 are consistent with reduced river efficiency that exists at lower flows.

Brandes Opinion 9 *– Dr. Brandes presents a plot of the cumulated annual flows of the Montoya Drain from 1938 - 1995 in Figure 5.3. As shown on the graph, the historical data exhibit a drastic change of slope beginning during the early 1950s and then continuing with a flatter slope through 1995. This flattening of the slope of the historical data compared to the straight-line extension of the pre-1950 data trend (red dashed line) indicates that the flow discharging from the drain was significantly reduced – by an average of approximately 39,000 acre-feet per year from 1951 through 1995. While some of this flow reduction may be attributed to improved irrigation efficiency, it more likely than not was due to the loss of groundwater inflows to the drain that resulted from the lowering of groundwater levels caused by irrigation pumping that began in the early 1950s. (Page 21 paragraph 2).*

Response:

It appears that the Montoya Drain data plotted by Dr. Brandes in Figure 5.3 were taken directly from the USBR reports. Detailed review of these reports showed that Reclamation was inconsistent in how it aggregated and reported the drain data. Beginning in 1934 (except for 1937) the flows of the West Drain and NeMexas Drain are included in the Montoya Drain records. Prior to 1934 and in 1937, these flows are not included in the Montoya Drain records, and the recorded flows for these two drains need to be added to the Montoya Drain records during these years to create a consistent historical record.

The reported flows of the Montoya Drain were much greater during the wet period before 1950 than during comparable wet and low pumping periods after 1950. As described above, projecting conditions during the wet period of 1938-1950 forward for comparison to conditions that existed during the drier period after 1950 may exaggerate the apparent deviation in flows. As to the pumping impacts, it should be noted that most of the Montoya Drain is located in Texas and therefore most of the pumping impacts to Montoya Drain flows are likely from Texas wells.

Further, as recognized by Dr. Brandes, there likely are other factors that contributed to the reduction in drain flows other than irrigation pumping. Dr. Brandes specifically mentions improvements in irrigation efficiency as one cause. Other potential causes are listed in the response to Brandes Opinion 10 below.

***Brandes Opinion 10** – A double-mass plot of the cumulative annual Rio Grande at El Paso flow versus the cumulative annual releases from Caballo Reservoir from 1930 - 2017 is presented in Figure 5.4 of the Brandes Report. The deviation of the historical flows curve after 1950 (blue triangles) from the extension of the curve before the 1950s (dashed red line) averages 78,667 acre-feet per year, which is equivalent to a total reduction in the flow of the Rio Grande at El Paso of about 5,000,000 acre-feet for the period from 1951 through 2017, excluding the flood years of 1986-1987 and 1995. Based on this demonstration, it is more likely than not that groundwater pumping in New Mexico within the Rincon and Mesilla basins that began in the early 1950s and continues today played a major role in reducing flows in the Rio Grande at El Paso from what they were prior to the 1950s without groundwater pumping for the same annual quantities of water released from Caballo Reservoir. In essence, the extension of the 1930-1950 curve represents the "no compact violation" condition.*

In essence, the extension of the 1930-1950 cumulative flow curve beyond 1950 to 2017 on the plot in Figure 5.4 (red dashed line) can be considered to represent the cumulative flows of the Rio Grande at El Paso that would have occurred if substantial groundwater pumping had not developed in the Rincon and Mesilla basins. (Page 22 paragraph 2).

Response:

Dr. Brandes initially observes that ground water pumping in New Mexico played a major role in reducing flows in the Rio Grande at El Paso. However, he goes much further in later statements without additional evidence to conclude that extension of the 1930 - 1950 cumulative flow line represents the "no compact violation" condition and that any post-1950 deviations from the 1930 - 1950 projection were caused by pumping in the Rincon and Mesilla basins.

As previously described, Dr. Brandes used reservoir releases for Elephant Butte Reservoir prior to 1938, and this affects the 1930 - 1950 projection line. If Dr. Brandes had instead used the Rio Grande at Percha Dam flow for 1930-1938, the average deviation between the 1930-1950 projection line and the cumulative Rio Grande at El Paso flow would be less than 78,667 AF/y.

Further, it is unreasonable to attribute all deviations from the 1930 - 1950 projection line to New Mexico pumping. There are many other factors that may have contributed to the change in the slope of the double-mass curve in Figure 5.4, including the following:

- Pumping in Texas Mesilla – Well pumping in the Texas portion of the Mesilla basin including Irrigation well pumping, municipal well pumping by EPW at the Canutillo wellfield, and other non-irrigation pumping.
- Pumping in El Paso Valley and Juarez Valley – Well pumping in the El Paso Valley and the Juarez Valley that depleted deliveries of Project water and caused additional water to have to be released from Project storage to deliver water to EPCWID farms.
- Reduction in Reservoir Releases – Generally lower reservoir releases after 1950 coupled with the reduced Project delivery efficiency that exists at lower flows as shown in Figure 5.1 of the Brandes Report.
- Reduction in Diversions and FHG Deliveries – Reductions in surface water diversions and farm headgate deliveries as a result of the reduced reservoir releases that occurred after 1950.
- Increased Project Operating Efficiency – Increases in Project operating efficiency (enactment of annual water allotments, reduced waste, etc.) that occurred after the first Project water shortages in the early 1950s.
- Increased On-Farm Irrigation Efficiency – Increases in on-farm irrigation efficiency resulting from land-leveling, lateral lining, increased use of level basin irrigation, soil moisture monitoring, education, and other factors that led to reduced irrigation return flows.
- Reduced Irrigated Area – Reduction in irrigated area in New Mexico and especially in Texas that led to reduced water demands. Increasingly, the EPCWID did not take delivery of its full annual allocation.
- Changes in Crops – Changes to crops that consume more water and return less water to the stream.
- Implementation of 2008 OA – Implementation of the 2008 OA accounting starting in 2006 that reduced the overall delivery efficiency of the Project through reduced deliveries to EBID and reduced drain flow returns to the Rio Grande.

It is also important to note that the cumulative Rio Grande at El Paso flows plotted in Figure 5.4 of the Brandes Report are year-round flows, including flows during the winter period that are not considered a part of the Project water supply. Review of the Brandes analysis indicates that an average of about 16,000 AF/y of the deviation in El Paso flows from the pre-1950 line is represented by changes in flows during the non-irrigation season. Since there are no Project releases during the non-irrigation season, changes in flows during that time are not considered Project water. Further, since the flows at El Paso during the winter are reportedly comprised primarily of poor-quality drain flows, they are less usable for irrigation than Project supplies during the irrigation season.

For the reasons listed above, it is improper to conclude that pumping in New Mexico was the sole cause of reduced flows in the Rio Grande at El Paso after 1950. While the double-mass curve analysis presented as Figure 5.4 in the Brandes Report does show there was a reduction in flow relative to the releases from Project storage, it provides no information or evidence for what caused the reduction in flow.

In addition, as described above, changes in flow at the El Paso gage are irrelevant to this case, to the Compact, and to the Project operations. What is relevant is that the Project has always operated as a unit, and prior to the 2008 OA, operated to allocate and deliver equal amounts of water to each farm acre based on the D1/D2 procedure, which allowed for conjunctive use of ground water to meet irrigation demands (Lopez, 2019) In order to understand whether pumping anywhere within the Project area has impacted the historical Project deliveries, it is necessary to develop and apply a robust simulation model of the entire Project. As described previously, the simulation model must be capable of simulating the full dynamic response of the Project operations to changes in supply. The simple double-mass curve analyses presented in the Brandes Report are not useful for determining the impact of New Mexico pumping on Texas water deliveries.

Brandes Opinion 11 *– The corresponding annual river flows in the absence of groundwater pumping after 1950 (no compact violation condition) can be estimated by calculating the incremental annual increases in the extended cumulative flow curve (red dashed line). These estimated annual flows of the Rio Grande at El Paso without the effects of groundwater pumping for the 1951-2017 period are plotted on the bar chart in Figure 5.5 along with the corresponding historical annual flows. As expected, the annual flows without the effects of groundwater pumping are higher than the actual historical annual flows which were influenced by groundwater pumping. (Page 23 paragraph 2).*

Response:

Figure 5.5 in the Brandes Report is presented as evidence for the annual effects of ground water pumping on Rio Grande at El Paso flows. The differences between the historical flows and the flows without the effects of ground water pumping in Figure 5.5 of the Brandes Report are plotted in **Figure 11-2.** The green shading in the chart indicates whether there was a full allocation of Project water in each year. The estimates of substantial impacts on El Paso flows during every non-spill year of the study period except 1988 do not make sense given how the Project operates. In full allocation years, it is reasonable to assume that the Project water users took delivery of all of the Project water they were allocated or needed. Therefore, assuming there would be more water in the river without pumping, Reclamation would reduce reservoir releases so that the same amount of water would be delivered to the Project water users in full allocation years, including EPCWID. As a result, in full allocation years without pumping, there should be little if any additional flow at El Paso compared to the historical condition, except for some additional flows during the winter resulting from the increase in drain flows that would occur without pumping.

Because the year-in and year-out effects of pumping shown in Figure 5.5 of the Brandes Report are not consistent with the expected response of the Project to changes in supply, the annual differences in the bars in Figure 5.5 are not reliable indicators of the impact of pumping in the Rincon basin and Mesilla basin on El Paso flows.

Brandes Opinion 12 *– The counterpart to the analysis of the change in the Rio Grande flows at El Paso caused by the development of groundwater pumping in the Rincon and Mesilla basins is a similar analysis of streamflow depletions. For purposes of this analysis, streamflow depletions are defined as the difference between the annual releases from Caballo Reservoir and the corresponding annual flows in the Rio Grande at El Paso. Streamflow depletions in this case are the result of diversions from the river into the main canals for irrigation in the Rincon and Mesilla basins, river channel losses due to evaporation and seepage, and evapotranspiration by vegetation along the river, offset by arroyo inflows to the Rio Grande between Caballo Reservoir and El Paso and discharges into the Rio Grande from irrigation drains and canal wasteways. Figure 5.6 presents the double-mass graph of these cumulative streamflow depletions for the 1930 through 2017 period. Here again, the distinct change in slope after groundwater pumping began in the early 1950s and the increasing deviation of the historical data after the 1950s (brown diamonds) from the projection of the pre-1950 historical data (green dashed line) are indicative of the expected effects of groundwater pumping on streamflow depletions. (Page 23 paragraph 3).*

Response:

The results shown in Figure 5.6 of the Brandes Report are skewed due to the use of Elephant Butte Reservoir releases before 1938. This affects the slope of the green line and inflates the differences between the projected 1930 - 1950 line and the cumulative depletions after 1950.

As described in Section 5, the average annual depletions between Caballo Reservoir and El Paso are about the same today as they were in the late-1930s at approximately 250,000 AF/y.

The criticisms of the double-mass curve analysis of El Paso flows described above also apply to the double-mass curve analysis of Rio Grande depletions in Figure 5.6 of the Brandes Report. The double-mass curve can show there was a change in depletions relative to reservoir releases, but does not inform as to the causes for any changes in depletions. Dr. Brandes provided no evidence to support an opinion that all increases in depletions after 1950 are due to pumping. A robust model capable of dynamic response to changes in flow is necessary to compute the portion of the changes in depletions to Rio Grande flow above El Paso caused by pumping in New Mexico and Texas.

Brandes Opinion 13 *– The various graphical illustrations presented in this section all exhibit the common theme that hydrologic conditions along the Rio Grande in the Rincon and Mesilla basins changed noticeably beginning after the 1950s. While this coincides with the onset of the severe drought of the 1950s that affected much of the southwestern United States, it also is when significant groundwater pumping began to develop and accelerate along the Rio Grande in the Rincon and Mesilla basins to provide a supplemental water supply for irrigation in New Mexico. Based on the significant changes that occurred in the observed Rio Grande flows, streamflow depletions, and drain discharges that began with the substantial increase in groundwater pumping, there is strong empirical evidence that groundwater pumping was a primary cause of these changes, which, in turn, lead to reductions in the availability of surface water supplies from the Rio Grande for Project users in Texas. (Page 24 paragraph 3).*

Response:

While I agree with Dr. Brandes that the graphical illustrations presented in Section 5 show that there were changes in drain flows, Rio Grande flows, and streamflow depletions after 1950 relative to releases from Project storage, his quantification of these changes is affected by his use of Elephant Butte Reservoir releases before 1938 in developing the 1930 - 1950 projection lines in the various figures.

In addition, for the many reasons described above, I also disagree that the empirical evidence presented by Dr. Brandes shows that the post-1950 changes are due solely to New Mexico pumping. A robust model capable of simulating the dynamic response of the Project to changes in historical conditions is necessary to assess the effects of New Mexico pumping, Texas pumping, or other operations on El Paso flows and deliveries to Project water users.

Brandes Opinion 14 – *A fundamental premise of Rio Grande Project operations is that the annual supply of water available for Project users each year is determined by the volume of water either in storage or anticipated to be in storage in Elephant Butte and Caballo Reservoirs, and changes in downstream water demands or streamflow depletions do not affect the amount of the available supply. (Page 30 paragraph 5).*

Response:

It is incorrect to state that the available Project supply is solely determined by the volume of water either in or projected to be in Project storage each year. Review of the RGJI report and the record of the deliberations of the engineer representatives of Colorado, New Mexico, and Texas indicates they were very aware of the many factors that cause variations in Project water supply. The amount of water in storage at the beginning of the season and the reservoir inflows during the irrigation season are obviously important in determining the available water supply. However, the drain flows and other return flows from irrigation downstream of the reservoirs contribute substantially to the Project supply and therefore are of significant importance to the Project operation.

The amount of water that is actually released from storage and delivered for use also depends on the demands of the Project water users. In some years, the districts request delivery of most or all of their allocation and in other years they request less. As shown in **Figure 4-5**, EBID has historically requested delivery of most or all of its allocation more often than has EPCWID.

In summary, Project releases are affected by (a) the amount of water available in storage at the beginning of the irrigation season, (b) the inflows to storage during the irrigation season, (c) the gains and losses between the Caballo outlet and the downstream delivery points, and (d) the demands of the Project water users.

The effects on Project operations resulting from variations in downstream operations is evident in comparisons of historical canal heading diversions to historical reservoir releases and historical Project supplies. **Figure 11-3** contains scatter plots of the canal heading diversions versus reservoir releases during the typical March – October irrigation season. Separate graphs are presented for the canal heading diversions of EBID, EPCWID, JID, and the total. Each plot shows a range of diversions for similar reservoir releases. This is consistent with the descriptions of Project operations in the RGJI (NRC 1938), Project histories (Reclamation, 1992), operating manuals, and other information (Reclamation, undated) that indicate reservoir releases are set to deliver the amounts ordered by the Project water uses in combination with the drain flows and other gains and losses between the reservoir and the delivery points. For example, the graph of total Project diversions in the lower right of **Figure 11-3** shows that for approximately the same reservoir release, the annual diversions varied by 200,000 AF or more. Conversely, for approximately the same annual diversion, the annual reservoir releases varied by 150,000 AF to 200,000 AF.

Similar charts are presented in **Figure 11-4** showing the same irrigation season diversions plotted against the total available Project supply computed as the end of February Project storage plus the March - July reservoir inflows. There is even more scatter in the data in the graphs in **Figure 11-3** than in the graphs in **Figure 11-4**.

Another set of charts is presented in **Figure 11-5** to illustrate the year-to-year variability in Project operations. The upper left chart plots the irrigation season diversion ratio vs. the irrigation season releases and the upper right chart plots the diversion ratio vs. the annual available Project supply (end of February storage plus March-July inflows). There is substantial variability in the diversion ratio for similar annual reservoir releases and for similar annual Project supply. The diversion ratio will be higher when there are more drain flows and other return flows available to help meet diversion demands, and the diversion ratio will be lower when the return flows are lower and more reservoir water has to be released to meet demands.

Finally, the lower left chart in **Figure 11-5** shows the irrigation season reservoir releases versus the annual available Project supply. This chart shows substantial variation in annual reservoir releases for the same annual available Project supply. This variability reflects the wide range of downstream conditions that affect how much reservoir water is needed to be released to meet Project water demands.

Brandes Opinion 15 *– It is significant to note, however, that the operation of Elephant Butte and Caballo Reservoirs and the annual allocation of Project water and the associated releases from Caballo do not appear to have noticeably changed as a result of the groundwater pumping. The graph in Figure 6.4 presents a plot of annual reservoir releases from Caballo Reservoir versus the corresponding maximum combined storage in Caballo and Elephant Butte Reservoirs prior to and during the irrigation season. The storage data on this plot are limited to years when the total storage was less than 1,500,000 acre-feet because with storage amounts greater than this, annual releases have been somewhat erratic due to high river flows and releases of flood water. Data plotted on the graph are segregated into two time periods; one for 1940-1955 before the effects of groundwater pumping had fully evolved and the other for 1956-2014 after significant groundwater development had occurred. (Page 38 paragraph 4).*

Response:

The combined maximum storage in Figure 6.4 of the Brandes Report is not an accurate measure of the available annual Project water supply. Dr. Brandes computed the maximum storage separately for Elephant Butte Reservoir and Caballo Reservoir for each year based on the historical maximum end-of-month storage in each reservoir in each month from December - July. The maximum amounts for each reservoir were added together to determine the annual values plotted on the x-axis in Figure 6.4.

One problem with the Brandes methodology is that the maximum monthly storage values for each reservoir may come from different months within the December - July period, and in this instance the sum of those maximum values will exceed the maximum combined end-of-month reservoir storage for that year.

A larger problem is that the maximum monthly reservoir contents is not an accurate representation of the available supply because it does not reflect the reservoir releases before the maximum storage month, nor does it reflect the reservoir inflows after the maximum month. A better indication of the available Project supply is the end-of-February storage contents plus the sum of the reservoir inflows during March - July. These totals have appeared in prior Reclamation summaries of the Project water supply (Reclamation, 2012). This preferred indication of Project supply was used in the graphs in **Figure 11-4** and **Figure 11-5**.

Notwithstanding the inaccurate measure of Project supply plotted on the x-axis, the data plotted in Figure 6.4 of the Brandes Report do not show what Dr. Brandes claims they show. First, he states that the 1940 - 1955 data points shown as blue dots represent conditions before the effects of pumping had fully evolved. This is contrary to analyses presented in other portions of Dr. Brandes report where he describes the effects of pumping that began substantially affecting flows in 1951. Second, for similar maximum storage contents, the data in Figure 6.4 show releases from Caballo that range approximately between 100,000 AF to 200,000 AF. The reason for variations in the annual releases for similar reservoir contents is the annual variation in conditions downstream of the reservoir. This is similar to the scatter shown in the data in **Figure 11-3** through **Figure 11-5** and explained in more detail in the accompanying narrative.

Brandes Opinion 16 *– Notwithstanding the process embedded in the Operating Agreement for attempting to mitigate for the effects of groundwater pumping in New Mexico on deliveries to Texas, the fact remains that groundwater pumping along the Rio Grande in the Rincon and Mesilla basins of New Mexico is not limited and continues at significant levels, adversely affecting flows in the river and diversions for Project water users in Texas. This is evident by the data presented on the graphs in Figures 4.7, 5.4 and*

5.6 where the post-2007 data exhibit little change from conditions prior to adoption of the Agreement. (Page 38 paragraph 3).

Response:

The 2008 OA continued to allocate water to Texas and Mexico based on the D1 and D2 Curves and therefore these two entities generally receive the same allocation of water for a given amount of water in Project storage that they received under the original D1/D2 allocation procedure. To the extent that Project does not perform at the level implicit in the D1 and D2 Curves, the entire amount of the underperformance is born by a reduced allocation to New Mexico water users.

As described above, the D1 and D2 Curves implicitly grandfathered in the effects of pumping during 1951 - 1979 by New Mexico, Texas, and Mexico on Project performance and Project deliveries. To the extent that the annual flow at El Paso has declined further relative to releases from the Project storage since the 2008 OA was enacted, this may be caused in part by EPCWID taking less delivery of its allocation since the agreement was enacted. Prior to 2008 under the D1/D2 accounting in years that EPCWID had an allocation of more than 350,000 AF, the Project water deliveries to EPCWID averaged about 319,000 AF/y. Since 2008 under the 2008 OA EPCWID has taken delivery of an average of 288,000 AF/y in years with an annual allocation exceeding 350,000 AF, or about 30,000 AF/y less than before the 2008 OA was enacted.

Further, the bargain of the 2008 OA was that the percentage of surface water allocated to EPCWID would be increased, the percentage of surface water allocated to EBID would be decreased, and individual carryover accounts would be created in Elephant Butte Reservoir; and in exchange, EBID could pump additional ground water to make up for the reduction in its surface water deliveries. This forced reliance on ground water for EBID under the 2008 OA, would have reduced non-irrigation season return flows that reached the El Paso gage, and this would have contributed to further deviations in the double-mass curve lines after 2008. This impact of the 2008 OA was ignored by Dr. Brandes.

Brandes Opinion 17 *– The graph in Figure 7.2 presents an application of [the double-mass curve methodology] to the New Mexico deliveries to farms data for the 1938-2016 period. As shown, the curve represented by the historical data on this graph exhibits the same break in slope around the early 1950s as the curve for the Rio Grande flows at El Paso shown in Figure 5.4. Again, this supports the conclusion that groundwater pumping in the Rincon and Mesilla basins for irrigation of farms in New Mexico, which began to develop during the early 1950s, more likely than not impacted the deliveries of Project water to farms in New Mexico. The total reduction in farm deliveries for the 1951-2016 period is* *about 2,100,000 acre-feet, which translates to an average annual reduction of 33,547 acre-feet. (Page 41 paragraph 4).*

Response:

As for the other double-mass curves in the Brandes Report, the projection of the 1930 - 1950 line in the Figure 7.2 is skewed by the use of Elephant Butte Reservoir releases during 1930 - 1937. As described above, there are likely many other reasons that annual Project deliveries decreased relative to Project releases after 1950, and these would have also affected deliveries to New Mexico farms. To the extent that ground water pumping did affect deliveries to New Mexico farms, this obviously means that New Mexico pumping does not somehow only affect El Paso flows. In fact, because New Mexico nominally was allocated 57 percent of the Project supply (until 2008) and tended to use more of its allocation than did Texas, any changes in Project performance, regardless of the cause, would generally tend to impact deliveries to New Mexico users more than deliveries to Texas water users.

In addition to the change in slope of the New Mexico deliveries in Figure 7.2 in the early 1950s, there is another break in slope around the time that the 2008 OA went into effect. This would be consistent with the significant reduction in Project water allocations to New Mexico that resulted from the provision of the 2008 OA that causes New Mexico to bear the effect of any and all negative deviations of Project performance from the performance that is implicit in the D1 and D2 Curves.

A robust model capable of simulating the dynamic response of the Project to changes in historical conditions is necessary to assess the effects of New Mexico pumping, Texas pumping, or other operations on deliveries to New Mexico farms.

Brandes Opinion 18 *– The estimated annual values of the New Mexico farm deliveries without the reductions caused by groundwater pumping can be determined by calculating the annual incremental increases in the 1951-2016 extension of the 1938-1950 data curve (red dashed line). These values are plotted on the bar chart in Figure 7.3 along with the corresponding historical deliveries to farms in New Mexico for the 1951-2016 period. (Page 43 paragraph 1).*

Response:

Figure 7.3 in the Brandes Report compares the historical annual deliveries to New Mexico farms to the estimated annual deliveries without the effects of pumping derived from the double-mass curves presented in Figure 7.2. The estimates of substantial impacts on deliveries to New Mexico farms in all years of the study period do not make sense given how the Project operates. In full allocation years, it is reasonable to assume that the Project water users took delivery of all of the Project water they were allocated or needed. Therefore, assuming there would be more water in the river without pumping, Reclamation would reduce reservoir releases so that similar amounts of water would be delivered to the Project water users in full allocation years, including EBID. Because the year-in and year-out effects of pumping shown in Figure 7.3 of the Brandes Report are not consistent with the expected response of the Project to changes in supply, the annual differences in the bars in Figure 7.3 are not reliable indicators of the impact of pumping in the Rincon basin and Mesilla basin on deliveries to EBID farms.

***Brandes Opinion 19** – Estimates of the total annual deliveries to Texas in the El Paso Valley have been derived by subtracting from the irrigation-season Rio Grande flow at El Paso the amount of water diverted into the Acequia Madre for Mexico and adding the annual quantities of the City of El Paso's Canutillo well field pumping. These annual values are plotted on the bar chart in Figure 7.4 along with the corresponding annual deliveries to Texas farms in the Mesilla basin as developed by Montgomery. (Page 43 paragraph 2).*

Response:

The estimates of annual Texas deliveries in Figure 7.4 of the Brandes report are not reasonable estimates of deliveries to water users in Texas. The estimates of annual Texas deliveries generally represent the flow at El Paso adjusted to include Canutillo wellfield pumping and exclude Acequia Madre diversions. As such, these estimates overstate Texas deliveries because they are not reduced for the substantial conveyance losses between the El Paso gage and the Texas farm headgates and the EPW diversion points.

***Brandes Opinion 20** – The double-mass analysis approach has been applied to the historical total Project water deliveries to Texas to assess apparent changes in historical delivery patterns relative to releases from Caballo Reservoir. As shown in Figure 7.5, the curve represented by the historical data on the graph exhibits the same downward change in slope during the early 1950s as depicted on the double-mass graph for deliveries to farms in New Mexico in Figure 7.2. Again, more likely than not this is indicative of the effects of groundwater pumping that began about this same time in the Rincon and Mesilla basins for irrigation of farms in New Mexico. The deviation of the curve represented by the Texas total historical deliveries data (green squares) after 1950 from the extension of the 1938-1950 data curve out to 2016 (red dashed line) demonstrates that there was less water delivered to Texas relative to the releases from Caballo Reservoir. The total reduction in the total deliveries for the 1951-2016 period is about 2,400,000 acre-feet, which translates to an average annual reduction in deliveries of 39,689 acre-feet per year. Whether these reductions in deliveries to Texas are directly attributable to the effects of groundwater pumping in the Rincon and Mesilla basins of*

New Mexico may not be clearly established with this demonstration; however, the trend of reduced deliveries after groundwater pumping began in the late 1950s certainly is consistent with the reductions in the Rio Grande flows at El Paso. Based on these trends, one would conclude more likely than not that groundwater pumping in the Rincon and Mesilla basins played a major role in adversely affecting deliveries of Project water to Texas. (Page 45 paragraph 2).

Response:

The alleged reduction in Texas deliveries of 39,689 AF/y described in the report text does not match the 37,689 AF/y reduction shown on Figure 7.5.

The previously described issue with use of Elephant Butte Reservoir releases during 1930 - 1937 affects the projection of the 1930 - 1950 data in Figure 7.5 (dashed red line). As previously stated, a double-mass curve can illustrate a change in the relationship between two variables (in this case reservoir releases and Texas diversions); however, it does not provide information on the cause(s) of the change. Dr. Brandes admits that the curve in Figure 7.5 does not clearly establish that the reductions in Texas diversions are caused by New Mexico pumping. As described above, there are many factors other than New Mexico pumping that may have affected downstream water supplies relative to Caballo releases, and these factors would have also affected Texas diversions.

A robust model capable of simulating the dynamic response of the Project to changes in historical conditions is necessary to assess the effects of New Mexico pumping, Texas pumping, or other operations on diversions by Texas and deliveries to Texas farms.

Brandes Opinion 21 *– The deliveries of Project water to Texas that would have occurred in the absence of these apparent effects of groundwater pumping can be derived from the incremental annual increases in the projected extension of the 1938-1950 data curve from 1950 out to 2016 (red dashed line) in Figure 7.5. The resulting annual Texas deliveries without the effects of groundwater pumping are plotted on the bar chart in Figure 7.6 along with the corresponding historical Texas deliveries. As shown, the total deliveries to Texas without the effects of groundwater pumping generally are greater than the historical deliveries, thus demonstrating the adverse impacts of groundwater pumping. As discussed above, the average reduction in Texas deliveries from the projected deliveries without the effects of groundwater pumping in the Rincon and Mesilla basins is about 40,000 acre-feet per year. Since both the historical delivery values and the projected delivery values without groundwater pumping reflect the underlying calculation approach for estimating the historical deliveries of Project water in the El Paso Valley, any inherent uncertainties in this approach are embedded in both sets of total deliveries, which* *suggests that the calculated annual differences between the two sets of total delivery values are likely unaffected by these uncertainties. (Page 45 paragraph 3).*

Response:

Similar to the above criticisms of Figure 5.5 in the Brandes Report, the annual differences between the historical Texas deliveries (actually diversions as described above) and the estimated deliveries without pumping do not make sense in the context of the Project supply conditions. For example, there are significant differences between the green bars and orange bars in each year from 1979 - 1985 and yet these were full supply years under the Project, and Texas would have received the same full allocation with or without the effects of pumping. Further, during 1979 - 1985 EPCWID's Project water deliveries averaged approximately 58,000 AF/y less than its average annual allocation (see **Table 4-3**). During these full supply years that EPCWID left substantial portions of its annual allocations unordered and unused, it is unreasonable to claim that Texas deliveries were being impacted by New Mexico pumping. The annual effects of pumping on Texas deliveries allegedly shown in in Figure 7.6 of the Brandes Report are not consistent with the expected response of the Project to changes in supply, and therefore the annual differences in the bars in Figure 7.6 are not reasonable or reliable indicators of the impact of New Mexico pumping on Texas deliveries or diversions.

I disagree that cancelling of errors in the method used to compute the Texas deliveries causes the results to be unaffected by the errors. Cancelling of errors does not relieve the method of its deficiency in not considering the conveyance losses in delivering water to Texas farmers. There is also the problem of the 1930 - 1950 projection line being skewed by the use of Elephant Butte Reservoir releases. Finally, the 1930 - 1950 projection line inherently assumes there is no variability in the straight-line accumulation of annual values in the dashed red line in the double-mass plot in Figure 7.5. The lack of variation in the dashed red line compared to the inherent annual variability in the green squares likely introduces significant error when deriving annual values from the differences between the projected 1930-1950 line and the accumulation of actual values in the green squares.

12.0 RESPONSE TO MONTGOMERY AND ASSOCIATES REPORT

Staffan W. Schorr and Colin P. Kikuchi, Ph. D. of Montgomery & Associates ("M&A") prepared a May 31, 2019 expert report on behalf of the State of Texas entitled, *Water Budget Estimates in Support of Groundwater Model Development: Rincon and Mesilla Basins, New Mexico, Texas, and Northern Mexico, 1938 Through 2016* ("M&A Report"). Information in the M&A Report was used for three primary purposes. First, M&A compiled much of the hydrologic and water use data for the study area into a database for use by the other Texas experts. Second, M&A prepared water budgets for the Rincon and Mesilla basins for the period from 1938 - 2016 period for the purpose of estimating certain inputs for the Texas Model, including irrigation pumping, and return flows from irrigation and non-irrigation uses. Finally, M&A prepared a water budget analysis of irrigation operations in the El Paso Valley in Texas that was used in analysis of alleged damages to Texas from water quality impacts caused by New Mexico pumping during the period from 1985 - 2016.

SWE was asked by legal counsel for New Mexico to review the water budget analyses and data compilations presented in the M&A Report to identify information or opinions that we disagreed with, and to prepare expert opinions to respond these issues. We attempted to identify and respond to all substantive issues in which there appeared to be differences of opinion, however a lack of response to a particular issue should not be interpreted as tacit agreement with the opinions in the M&A Report.

M&A Opinion 1 *– I prepared separate water budgets for Rincon Basin and Mesilla Basin because the basins are separated by a bedrock constriction, which limits the hydrologic connection between the basins. The overall water budget for each basin comprises three types of budgets: Land-Surface Water Budget, Surface Water Budget, and Groundwater Budget. I used this approach to facilitate budget development by compartmentalizing common components. (Page 3 paragraph 2 and 3).*

Response:

The Montgomery water budget analyses provide comprehensive and detailed accounting of the inflows and outflows of (a) the Land Surface system, (b) the Surface Water system, and (c) the Groundwater system using actual data, estimated data, and water balances, and other calculation and modeling techniques. Certain of the computed water budget terms were used as inputs to the Texas Model and these were the focus of our review of the M&A analyses.

In all water budget analyses the sum of the inflows minus the sum of the outflows equals the change in storage. For the Land Surface Budget, this would be the change in soil moisture storage. For the Ground Water Budget this would be the change in ground water storage in the subsurface aquifers. In the Surface Water Budget, there are no changes in storage at the monthly time scale the budgets were prepared, and there are no reservoirs simulated (Elephant Butte Reservoir and Caballo Reservoirs are upstream of the geographical areas included in the water budget analyses).

Figure 12-1 through **Figure 12-3** summarize that computed average annual values for each of the water budget terms in the M&A Land-Surface Budget, Surface Water Budget, and Groundwater Budget, respectively. Positive values (bars to the right) represent inflows to the system and negative values (bars to the left) indicate outflows from the system. Changes in storage are shown as positive or negative as appropriate.

The bars in **Figure 12-1** through **Figure 12-3** are color-coded in relation to whether and how each of the water budget terms are used in the Texas Model.

- Blue bars – Model inputs that do not change in the reduced pumping model runs.
- Red bars – Model inputs that change in the reduced pumping model runs.
- Yellow bars – Quantities that are simulated in the model.
- Black bars – Quantities that are neither input to or simulated in the model.

For the water budget values that are inputs to the model, the abbreviations at the end of the bars indicate the whether the values are input through the MODFLOW WEL Package as cell-by-cell inputs or through the MODFLOW SFR Package as stream segment inputs.

The size of the bars gives an indication of the relative significance of the water budget terms to the three water budgets and to the modeling. The colors of the bars reflect the importance of the terms to the modeling of alternative scenarios. Model inputs that are changed between model runs (red bars) or are simulated in the model (yellow bars) are most significant. Model inputs that do not change between runs are less significant because they have little effect on the simulated differences between model runs. Obviously, the quantities that are not input or simulated in the model (black bars) are of least importance in the modeling. Note that while the on-farm consumptive use is not simulated in the model, the specified amount of consumptive use in the Land Surface Budget affects the computed pumping and irrigation returns flows (deep percolation and surface runoff) that are inputs to the Texas Model.

M&A Opinion 2 *– A farm water budget analysis was conducted to estimate monthly farm deep percolation and agricultural applied groundwater pumping in each basin (Rincon* *basin and Mesilla basin). In addition, estimates for change in agricultural soil moisture storage and agricultural surface water return flows were also determined by the farm water budget analysis. (Page 16 paragraph 1).*

Response:

The M&A Farm Budget Model was used to compute inputs to the Texas Model for applied ground water pumping for irrigation, and on-farm deep percolation and surface runoff from irrigation in the Rincon and Mesilla basins. The Farm Budget analysis was performed for the period from 1938 - 2016 using a monthly timestep. The monthly results were aggregated to annual values for input to the Texas Model which has annual stress periods.

The M&A Farm Budget Model is similar to the SWE CFB Model (and to the almost identical RiverWare farm budget algorithm) in that both models use a mass balance water budget approach to simulate the on-farm water deliveries, consumptive use, soil moisture storage, and irrigation return flows. In addition, supplemental pumping is assumed to meet unmet irrigation demands after commencement of widespread irrigation pumping in the Rincon basin and Mesilla basin. While there are similarities in the farm budget simulations, there are also some significant differences in model inputs and processes that result in material differences in the farm budget model outputs for irrigation pumping and on-farm irrigation losses due to deep percolation and surface runoff.

M&A Opinion 3 *– A soil water balance model was developed to estimate agricultural groundwater pumping and deep percolation over the time period of interest, 1938 through 2016. The model tracks soil moisture within the maximum extent of irrigated agricultural lands of the Rincon and Mesilla basins on a monthly time step. Four separate models were developed for this analysis: lands inside District boundaries in Rincon Basin, lands outside District boundaries in Rincon Basin, lands inside District boundaries in Mesilla Basin, and lands outside District boundaries in Mesilla Basin. The models follow identical governing equations and differ only in their respective data inputs. (Page 19 paragraph 1).*

Response:

The soil water balance model developed by M&A is a complex, non-linear iterative model. Inputs to the model include precipitation, applied surface water, and ground water pumping; and outputs consist of crop evapotranspiration (“ET”), deep percolation (“DP”), and soil moisture storage. The crop evapotranspiration and deep percolation are computed as functions of the soil moisture storage, and the soil moisture storage depends on the computed ET and DP. Because of these interdependencies, an iterative simulation process is performed in the model to simultaneously solve for the ET, DP, and soil moisture in each monthly stress period.

The soil water balance model simulates "virtual fields" for the Rincon basin and the Mesilla basin (including the Texas portion of the Mesilla basin) that are intended to represent aggregations of all the fields in each basin. Each virtual field is simulated as if it was a gravity-irrigated field as illustrated in Figure 2.3 of the M&A Report. Applied irrigation water (surface water and pumped ground water) is assumed to be introduced at the top of the field (left side in Figure 2.3) and assumed to flow across the virtual field to the bottom of the field (right side in Figure 2.3). Because irrigation water is present at the top of the field longer than at the bottom of the field, the soil water balance model simulates more infiltration of surface water at the top of the field than at the bottom of the field. Thus, the top of the virtual field can be adequately irrigated to bring the soil moisture to a level sufficient to avoid crop stress and meet the full ET demand of the crop, while the lower portion of the field can be insufficiently irrigated resulting in crop stress and a reduction in crop ET.

There are two time-series ET inputs to the soil water balance model that come from Land IQ. The first is the crop-weighted average theoretical ET computed as the reference ET multiplied by crop coefficients obtained from various references. The crop coefficients used by Land IQ were not locally calibrated. The second is an adjusted ET that is roughly 30% less than the theoretical ET until about 1970, with the adjustment transitioning to no adjustment by about 1990.

The parameterization of the soil moisture distribution under each virtual field is adjusted in the M&A soil water balance model during each month of the study period so that the simulated soil moisture across the virtual field is at the levels necessary for the computed aggregate ET to match the adjusted ET from Land IQ. Before 1970, when the target ET for most crops is 30% lower than the theoretical ET, the soil water balance model is calibrated to simulate substantial soil moisture stress in order for the simulated ET to match the target ET. The simulated soil moisture stress is gradually reduced during 1970 - 1990 as the adjusted ET from Land IQ transitions to the full theoretical ET. After that time, there is little or no simulated soil moisture stress and therefore the ET computed in the soil water balance model reaches the full theoretical ET across the entire virtual field.

There are five soil moisture states that represent important soil moisture thresholds in the root zone of an irrigated crop. These soil moisture thresholds are listed below in order from low to high soil moisture levels:

- Residual Moisture – Lowest soil moisture level.
- Wilting Point – Soil moisture level below which the crop is incapable of extracting water through the roots.
- Critical Moisture – Soil moisture level below which the crop will begin to experience stress and a reduction in ET.
- Field Capacity – Approximately maximum soil moisture content that can be retained in the soil against gravity. This typically occurs within a few days after a thorough irrigation or heavy precipitation event after gravity drainage of moisture stored temporarily above the field capacity level.
- Porosity – Maximum soil moisture content in which the soil is saturated and virtually all of the pore spaces between the soil particles are filled.

As described above, the soil water balance model simulates a continuous range of soil moisture across each virtual field creating sufficient stress (or no stress) so that the simulated aggregate ET matched the adjusted ET values from Land IQ. The model generally simulates less soil moisture stress through time as the adjusted ET values become closer to the theoretical ET values.

Figure 12-4 and **Figure 12-5** contain graphs that show the simulated monthly soil moisture in the Rincon and Mesilla virtual fields during the 1938 - 2016 study period. Each graph contains five dotted horizontal lines that represent the five soil moisture states referenced above. The solid black line represents the simulated maximum soil moisture level (θmax) at the top of the virtual field where infiltration would be greatest. The solid grey line represents the simulated minimum soil moisture level (θmin) at the bottom of the virtual field where infiltration would be least. The solid red line is the simulated average soil moisture across the virtual field (θavg).

The graphs for the simulated virtual fields representing the Rincon basin and Mesilla basin are generally similar. The following observations regarding the soil water balance model simulation of the Mesilla virtual field illustrated in **Figure 12-5** are also generally applicable to the simulation of the Rincon virtual field.

1. Maximum Soil Moisture – The simulated maximum soil moisture at the top of the field (black line) fluctuates from month to month, but remains well above the field capacity of the soil, and often reaches the total porosity of the soil. This result is nonsensical as the soil moisture in the root zone of a crop cannot physically remain above field capacity for more than a few days after an irrigation. The soil water balance model simulates the soil moisture at the top of the virtual field well above field capacity for the entire 1938 - 2016 simulation period.

2. Minimum Soil Moisture – The simulated minimum soil moisture at the bottom of the field (grey line) fluctuates from month to month, but remains below the wilting point through the mid-1980s. This is also nonsensical as it indicates that prior to the mid-1980s, significant portions of the fields in the Mesilla basin never had sufficient soil moisture to produce any ET. In other words, the crops were dead in those portions of the fields.
3. Average Soil Moisture – The average soil moisture fluctuates between field capacity and the critical level until around 1970. After that time, the average soil moisture begins fluctuating above field capacity for months at time through about 1985 and then generally remains continuously above field capacity through the remainder of the study period. As described above, this result in nonsensical.

The soil moisture conditions simulated in the M&A soil water balance model are illustrated in another form in the graphs presented in **Figure 12-6**. These figures show the simulated soil moisture conditions across the virtual field from top to bottom for an entire year at 10-year intervals from 1945 - 2015. There are four charts on each page and each chart shows the conditions for a three-month period – Jan-Mar, Apr-Jun, Jul-Sep, and Oct-Dec. The solid lines in each chart display the simulated soil moisture, which is highest at the top of the field and lowest at the bottom of the field. Note that the vertical axis for the soil moisture is reversed so as to intuitively mirror the infiltration of water below the ground surface. For reference, each chart includes horizontal dashed black and grey lines that depict the five key soil moisture states described above.

Also shown in each chart is the simulated crop stress coefficient (Ks) for each month across each virtual field, represented as dotted lines that are read on the right axis. The soil moisture water balance model simulates soil moisture stress when the simulated soil moisture falls below the critical level. The stress coefficient increases linearly from 0% at the critical soil moisture to 100% at wilting point. When the stress coefficient is at 0.0, the ET simulated in the soil water balance model is at the full theoretical value, and when the stress coefficient is at 1.0 the simulated ET is zero.

The following are observations of the conditions during the principal growing season (April - September) in decadal interval charts presented in **Figure 12-6**.

- 1945 - 1965: 40% of the field is above field capacity, 60%-70% of the field is above critical soil moisture with no stress and full theoretical ET. 10%-20% of the field is in a stressed condition with reduced ET. 20% of the field is at or below wilting point, indicating the crop is dead.
- 1975: 40%-50% of the field is above field capacity, 65%-75% of the field is above critical soil moisture with no stress and full theoretical ET. 10%-20% of the field is

in a stressed condition with reduced ET. 20% of the field is at or below wilting point, indicating the crop is dead.

- 1985: 60% of the field is above field capacity, 85% of the field is above critical soil moisture with no stress and full theoretical ET. 10%-15% of the field is in a stressed condition with reduced ET. 5% or less of the field is at or below wilting point, indicating the crop is dead.
- 1995 - 2015: 70% of the field is above field capacity, 95% or more of the field is above critical soil moisture with no stress and full theoretical ET. 5% or less of the field is in a stressed condition with reduced ET. None of the field is at or below wilting point.

The results from the M&A soil water balance model are nonsensical because they depict simulated conditions that are physically impossible and contrary to the conditions that would be expected to exist in a productive and well-managed irrigation district like EBID in the Rincon and Mesilla basins. As described above, it is physically impossible for the moisture content in the crop root zone of a well-drained soil to be above field capacity for more than a few days after an irrigation. It is also wholly unreasonable for 20% of the virtual field representing all fields in the Mesilla basin to be under soil moisture stress and another 20% of the virtual field to be dead during all simulated years through about 1970. This would reflect a level of irrigation incompetence that is not consistent with (a) farmers whose livelihood depends on their work, and (b) the adequate water supply that existed between the available Project supply and the supplemental ground water available to most farmers.

***M&A Opinion 4** – Annual surface water deliveries to farms (farm deliveries) and agricultural groundwater pumping in Rincon and Mesilla basins are shown on Figures 2.9 and 2.10, respectively. Agricultural groundwater pumping in Rincon and Mesilla basins varied through time depending principally on surface water availability. Groundwater pumping generally increased during years when surface water deliveries were low, and vice versa. The largest groundwater withdrawals occurred during the early to mid-1950s, and from 2003 through 2016, when surface water deliveries to farms were small for many consecutive years. The smallest amount of groundwater pumping occurred during the period of full Project allotment from 1979 through 2002. (Page 45 paragraph 2 and 5).*

Response:

Figure 12-7 through **Figure 12-9** summarize and compare various annual values from the M&A Farm Budget Model and the SWE CFB Model. One of the key outputs from the models is the simulated pumping, as the effects of ground water pumping are a primary focus of the case. The differences in the simulated annual pumping in large part reflect the aggregation of all differences in input data and computational methods into a single result. This is because pumping to compute the unmet demand after applied surface water is one of the last steps in both the M&A Farm Budget Model and the SWE CFB Model.

The simulated annual pumping volumes from the M&A Farm Budget Model and the SWE CFB Model for the Rincon and Mesilla basins combined are shown in **Figure 12-7**. The simulated annual pumping in the SWE CFB Model exceeds the pumping in the M&A Farm Budget Model in most years until the early 1980s when the results flip and the M&A Farm Budget Model pumping exceeds the SWE CFB Model pumping in most years through the remainder of the study period.

Most of the differences in the outputs from the M&A Farm Budget Model and the SWE CFB Model, including the differences in pumping, are due to differences in the following:

- Irrigated area,
- Crop evapotranspiration,
- Farm headgate deliveries,
- On-farm seepage losses, and
- Soil moisture simulation procedure.

The M&A Farm Budget Model includes two soil water balance models for each simulated region (e.g., two models for the Mesilla basin Project lands). One model simulates irrigation and evapotranspiration for the cropped area that is being actively irrigated, and another model simulates bare soil evaporation in the non-cropped or fallowed area.

The simulated cropped area varies from month to month depending on the monthly ET for each crop. If there is no ET demand (i.e., during the early spring before the crop has been planted or during the fall and winter after the crop has been harvested) M&A assumed the crop was not irrigated (with some exceptions for simulated pre-irrigation). The land associated with a crop is in the crop model if it is being irrigated and in the non-crop model if it is not being irrigated. As a result, the simulated area in the crop model is highest in the middle of the irrigation season and lowest or zero in the winter. As the simulated irrigated area changes through the year, the simulated soil moisture is transferred between the two soil water balance models based on changes in the overlying areas. When the cropped area increases from one month to the next, a portion of the non-cropped soil moisture is moved to the irrigated model, and when the cropped area decreases, a portion of the cropped area soil moisture is moved to the non-irrigated model.

The upper right chart in **Figure 12-8** compares the sum of the maximum monthly cropped areas in each year in the Rincon and Mesilla basins in the M&A Farm Budget Model to the comparable annual irrigated areas in the SWE CFB Model. The total crop area for the Rincon and Mesilla basins is generally higher in the M&A Farm Budget Model than in the SWE CFB Model until about 1977, when the comparison flips and the area in SWE CFB Model is higher than the M&A Farm Budget Model through the end of the study period.

The upper left chart in **Figure 12-8** compares the simulated annual ET of applied water in M&A Farm Budget Model against the annual values from the SWE CFB Model. There are two lines for the M&A Farm Budget Model values shown in **Figure 12-8**. The solid line reflects the ET of applied water during the growing season for each crop and the dotted line reflects the addition of computed ET on bare ground outside of the growing season within the annual irrigated acreage for each year. This adjustment was made to make the M&A figures more comparable to the SWE values obtained from DE that also included bare ground ET outside of the growing season.

The difference between the M&A and SWE lines in **Figure 12-8** reflect differences in irrigated area, cropping pattern, unit crop ET values, and other factors. The annual ET of applied water in the M&A Farm Budget Model is generally greater than the annual values in the SWE CFB Model through 1984. From 1985 through the end of the study period, the ET of applied water is greater in the M&A Farm Budget Model during most years and this is the primary reason that the pumping in the M&A Farm Budget Model is also greater during this period.

The lower left chart in **Figure 12-8** compares the area-weighted annual unit crop ET for the Rincon and Mesilla basins for the M&A Farm Budget Model and the SWE CFB Model. The unit ET for the M&A Farm Budget Model was computed as the simulated annual ET volume (shown in the upper left chart in **Figure 12-8**) divided by the simulated maximum monthly irrigated area in that year (upper right chart in **Figure 12-8**). As for the upper left chart, there are two lines for the M&A values. The solid line is the computed weighted average ET for the crop ET and the dotted line adds the additional ET on bare ground within the annual irrigated area. The differences in the annual unit ET values reflect the combination of differences in the unit ET values for the individual crops and differences in the annual crop mix. The unit ET values in the M&A Farm Budget Model are less than in the SWE CFB Model until the mid-1980s, and more than in the SWE CFB Model thereafter.

The lower right chart in **Figure 12-8** summarizes the annual FHG delivery inputs to the M&A Farm Budget Model and the annual totals for the SWE CFB Model. The FHG deliveries are very similar between the two models through 1979, after which there are some differences. The post-1979 differences in FHG deliveries are due to differences in how the EPCWID delivery totals were disaggregated between the El Paso Valley and the Texas Mesilla areas. M&A disaggregated the EPCWID deliveries based on irrigated area, and SWE disaggregated the deliveries based on diversions. On average, the M&A farm headgate deliveries are 4% greater than the SWE farm headgate deliveries during the 1985 - 2016 period.

Another difference between the M&A Farm Budget Model and the SWE CFB Model involves an assumption regarding on-farm conveyance losses. M&A assumed a 10% on-farm conveyance loss, and so the surface water applied to the fields was specified as 90% of the FHG deliveries. The SWE CFB Model does not explicitly simulate on-farm seepage losses, but rather any such losses are incorporated in the specified MFE that is part of the irrigation simulation procedure in the SWE CFB Model. Note that the M&A FHG deliveries shown in the lower right chart in **Figure 12-8** are before the 10% on-farm conveyance loss.

The SWE CFB Model and the RiverWare Model both employ a widely used water balance process that simulates the process of delivering irrigation water to the field, limiting the amount of water made available for crop water consumption based on a specified maximum farm irrigation efficiency, and simulating storage of irrigation water in the soil moisture reservoir underlying the field for later use when the surface water supply is inadequate. The simulation algorithm in the SWE CFB Model is described in more detail in Section 6.

Figure 12-9 compares the simulated deep percolation and surface runoff from irrigation in the Rincon and Mesilla Valleys The deep percolation is less in the M&A Farm Budget Model than in the SWE CFB Model before the mid-1980s, and then becomes roughly comparable thereafter. Conversely, the surface runoff in the M&A Farm Budget Model is much greater than in the SWE CFB Model.

M&A Opinion 5 *– A non-farm water budget analysis was conducted to estimate consumptive use, runoff, and deep percolation for urban and non-urban (upland watershed) areas in the Rincon and Mesilla basins, based on measured or estimated water supply and wastewater discharges. Non-farm lands in the study area include urban areas and undeveloped areas consisting primarily of native vegetation. The non-farm water budget is subdivided into urban lands and upland areas that are not classified as farm (agricultural) or urban (i.e., watershed area minus farm and urban areas) (Figure 2.1). The urban water budget is evaluated by water source: applied water and precipitation water. The applied water budget analysis is based on measured or estimated groundwater withdrawals (pumping), measured or estimated wastewater discharges, and estimates for consumptive use and deep percolation. The precipitation water budget analysis uses monthly precipitation and estimates for consumptive use (i.e., effective urban precipitation) and runoff to estimate urban deep percolation of precipitation. Use of* *surface water deliveries for non-farm purposes is minor compared to groundwater use and considered negligible for this analysis. (Page 16 paragraph 1 and Page 52 paragraph 1).*

Response:

The M&A Non-Farm Water Budget analyses were also performed for the period from 1938 - 2016 using a monthly timestep with certain results aggregated to annual values for input to the Texas Model.

The M&A Urban Applied Water Budget was used to prepare inputs to the Texas Model for applied ground water pumping for urban and domestic uses, wastewater treatment plant discharges, and urban deep percolation from applied water. While SWE did not prepare a full urban applied water budget, data were compiled or estimated for urban and domestic pumping, WWTP discharges, and urban deep percolation for the entire LRG Area, including the Rincon and Mesilla basins. Several charts were prepared to compare the values used in New Mexico's ILRG Model to the comparable values developed by M&A for the Texas Model as shown in **Figure 12-10**.

The upper left chart in **Figure 12-10** compares the urban and domestic pumping in the Rincon basin and Mesilla basin that were input to the ILRG Model against the values used in the Texas Model. The urban and domestic pumping volumes in the Rincon and Mesilla basins are similar between the Texas Model and the ILRG Model, with slight variations throughout the study period.

The upper right chart in **Figure 12-10** compares the WWTP discharges input to the ILRG Model in the Rincon basin and Mesilla basin against the values used in the Texas Model. The annual WWTP discharges simulated in the ILRG Model average approximately 1,300 AF more than the values used in the Texas Model. The reason for the difference is that (a) the ILRG Model includes estimates of El Paso Electric WWTP discharges prior to the records that begin in 2004 while the Texas Model does not and (b) the ILRG Model uses actual records of Las Cruces WWTP discharges while the Texas Model uses estimates.

The lower left chart in **Figure 12-10** compares the estimated urban deep percolation inputs for the ILRG Model in the Rincon and Mesilla Valleys against the values input to the Texas Model. On average, the urban deep percolation in the Rincon and Mesilla basins is approximately 5,300 AF/y greater in the Texas Model than the ILRG Model, and the Texas Model shows more variability than the ILRG Model throughout the study period. Reasons for differences between the urban deep percolation estimates are generally two-fold. First, the Texas Model estimates reflect an assumption that all pumping from the Canutillo wellfield is used locally in the Texas portion of the Mesilla basin compared to the values for the ILRG Model that are based on estimates of urban deep percolation from all the EPW supplies distributed evenly across all of the EPW service area. Second, the values for the Texas Model were computed as a residual in an urban water budget calculation compared to the values for the ILRG Model that were computed based on percentages of non-irrigation water use.

The M&A Urban Precipitation Water Budget was used to estimate the urban precipitation runoff and urban deep percolation of precipitation that were input to the Texas Model. The lower right chart in **Figure 12-10** shows the annual urban precipitation runoff and deep percolation values that were input to the Texas Model. While the ILRG Model does not simulate urban precipitation runoff and deep percolation, this not a substantive deficiency for two reasons. First, the combined urban precipitation runoff and deep percolation represents only 0.1% of the total input to the Texas Model. Second, these inputs are not varied in the alternative model runs involving changes in pumping. As a result, the presence or absence of simulated urban precipitation runoff and deep percolation will have very little or no effect on the computed differences between the alternative model runs.

M&A Opinion 6 *– Tributary inflows represent the volume of water that flows into the Rio Grande from ephemeral streams as a result of stormwater runoff in the upland areas of the study area. The watersheds that contribute flow to the Rio Grande were taken from a 1996 study by the U.S. Army Corps of Engineers. The majority of tributary arroyos in Mesilla Basin do not contribute runoff discharges to the Rio Grande. Contributing watersheds in each basin are shown on Figure 3.4. Watershed runoff models require detailed streamflow data and information on physical characteristics for drainages and sub-watersheds. The lack of streamflow gages on the majority of drainages to the Rio Grande within the study area prevents the use of surface water modeling for determining tributary runoff for this water budget. Because of this limitation, we estimated runoff as a percentage of the precipitation falling on the contributing watersheds. Tributary inflow was assumed to be three percent of precipitation, based on results of a rainfall-runoff study conducted by Stone and Brown (1975) in a small semiarid watershed in the Jornada Basin in New Mexico. Annual tributary inflows in Rincon and Mesilla basins are shown on Figure 3.5. The estimated average annual tributary flows are about 5,500 AF in Rincon Basin and about 100 AF in Mesilla Basin. (Page 72 paragraph 1, 2, 4 and Page 74 paragraph 2).*

Response:

Precipitation runoff from undeveloped areas as a percentage precipitation can vary widely depending on slope, soils, vegetation cover, precipitation intensity and other factors. The estimate of 3% runoff from the PRISM precipitation data, while not unreasonable, should be considered approximate and having substantial uncertainty.

The estimated average annual tributary inflows from upland areas totaling 5,600 AF/y for the Rincon and Mesilla basins represents only 0.2% of the simulated average annual inflows to the Texas Model. Also, similar to the urban precipitation runoff and deep percolation, the tributary inflows from upland areas do not vary in the alternative runs of the Texas Model and therefore have little or no difference on the computed differences between the model runs.

M&A Opinion 7 *– Natural aquifer recharge in the Rincon and Mesilla Basins principally occurs as mountain-front recharge along the basin margins near the lateral extent of the Santa Fe Formation. Recharge occurs where runoff from precipitation in the upper portions of the watershed infiltrates into the basin alluvium deposits. Mountain-front recharge in the United States portions of the study area was evaluated using the Hearne-Dewey (1988) regression equation for mean annual recharge of a tributary basin. The Hearne-Dewey regression equation was developed, based on data for 16 basins in northern New Mexico, to estimate average annual basin water yield based on winter precipitation, basin slope, and basin area. The Hearne-Dewey (1988) regression analysis yielded mountain-front recharge rates of about 9,360 AF/year and 5,430 AF/year for the Rincon and Mesilla basins respectively. (Page 97 paragraph 3 and Page 99 paragraph 3).*

Response:

The M&A estimates of mountain front recharge are input as specified inflows around the lateral boundaries of the Texas Model. A comparison of the annual M&A mountain front recharge estimates against the annual mountain front recharge in the Rincon and Mesilla basins in the ILRG Model is provided in **Figure 12-11**.

The annual combined mountain-front recharge for the Rincon and Mesilla basins in the ILRG Model averages 15,700 AF during 1951 - 2016 compared to 14,800 AF in the Texas Model. Given that the average difference of 900 AF/y is only 0.03 % of the total inflows to the Texas Model and the mountain front recharge is not varied in alternative model runs, the differences in mountain front recharge between the Texas Model and the ILRG Model is not significant.

M&A Opinion 8 *– I was asked by counsel to develop farm water budget for two agricultural districts located in El Paso Valley, Texas to support economic analyses by Dr. David Sunding and Dr. Lydia Dorrance. The two districts are El Paso County Water Improvement District #1 (EPCWID#1) and Hudspeth County Conservation and Reclamation District 1 (HCRRD1). EPCWID#1 has lands in both Mesilla Basin and El Paso Valley; this* *farm budget considers only the portion of EPCWID#1 located in El Paso Valley. For the analysis, a farm water budget was developed for agricultural lands in EPCWID#1 and HCRRD1 with the principal goals of estimating (1) agricultural groundwater pumping for irrigation and (2) deep percolation beneath agricultural fields. Due to the lack of historic direct measurements of agricultural applied groundwater (pumping) and agricultural deep percolation, soil water balance models were used to estimate these components, along with surface runoff and soil moisture changes on agricultural lands. The soil water balance models were developed and implemented using GoldSim simulation software. Model results were used to prepare the farm water budgets for EPCWID#1 and HCRRD1. (Appendix G, Page 1, Paragraph 1).*

Response:

The monthly farm budget analyses prepared by M&A for the EPCWID (El Paso Valley) and the HCRRD (a.k.a. HDDRD1) for the period from 1985 - 2016 utilized the same soil water balance model as was used for the farm budget analyses of the Rincon and Mesilla basins. These farm budget analyses were compared to the SWE CFB Model analyses for the same areas to assess differences between the input data and results. The farm budget inputs and outputs during the 1985 - 2016 study period are compared in **Figure 12-12** through **Figure 12-14** for the El Paso Valley and **Figure 12-15** and **Figure 12-16** for the HCCRD.

<u>**El Paso Valley**</u>

Figure 12-12 compares the computed annual supplemental pumping in the M&A Farm Budget Model to the comparable values from the SWE CFB Model during the 1985 - 2016 period. The annual pumping in the M&A Farm Budget Model averages about 78,900 AF compared to an average of 14,300 AF in the SWE CFB Model, a difference of about 64,700 AF. The differences in supplemental pumping are due largely to differences in the ET of applied water between the models.

The simulated pumping in the M&A Farm Budget during the full supply years from 1985 - 2002 is unrealistically high considering the following:

- Full Project water allocations made by Reclamation (see **Table 4-3**),
- Unused EP1 allocations (see **Table 4-3**),
- High FHG deliveries per acre (see **Figure 5-12**), and
- High operational waste through this period (see **Figure 5-23**).

The upper right chart in **Figure 12-13** compares the maximum annual cropped area in the El Paso Valley in the M&A Farm Budget Model to the annual irrigated area in the SWE CFB

Model. The M&A Farm Budget Model simulates much greater irrigated area than the SWE CFB Model until the last ten years when the values are similar. On average, the M&A Farm Budget Model acres for the El Paso Valley are about 14% greater than SWE CFB Model acres.

The irrigated area figures used in the M&A Farm Budget Model were provided by Land IQ. Based on review of the Land IQ data files, it seems possible that the irrigated area data that M&A used for the El Paso Valley portion of EPCWID may also include the EPCWID irrigated area in the Texas portion of the Mesilla Valley. This would explain most of the difference in irrigated area between the models in the El Paso Valley.

The upper left chart in **Figure 12-13** compares the annual ET of applied water in the El Paso Valley. The annual ET of applied water in M&A Farm Budget Model is much larger than the SWE CFB Model values throughout the 1985 - 2016 period, averaging about 47% more. In some years, the ET of applied water in the M&A Farm Budget Model is almost double the SWE CFB Model values. The differences are due largely to differences in irrigated area, unit crop ET, and cropping pattern.

The lower left chart in **Figure 12-13** compares the area-weighted annual unit crop ET in the El Paso Valley for the M&A Farm Budget Model and the SWE CFB Model. The differences in the unit crop ET reflect the combined differences in cropping pattern and the unit irrigation requirements of the individual crops. The unit ET for the M&A Farm Budget Model was computed as the annual ET of applied water volume (shown in the upper left chart in **Figure 12-13**) divided by the maximum monthly irrigated area in that year (upper right chart in **Figure 12-13**). The unit ET values in the M&A Farm Budget Model average almost 30% greater than the SWE CFB Model values during 1985 - 2016.

The lower right chart in **Figure 12-13** compares the annual FHG delivery volumes that are simulated in the M&A Farm Budget Model of the El Paso Valley to the SWE CFB Model values. On average, the FHG deliveries in the M&A Farm Budget Model are about 11% less than the values in the SWE CFB Model. It appears that the reported 2010 FHG deliveries for the El Paso Valley may be in error. If these are corrected, the average difference will be larger than 11%.

A closer look at the differences in the annual FHG deliveries is shown in **Figure 12-14**. The small differences in FHG deliveries that are present from 1985 - 2008 are due to differences in how the records of total Eastside Canal and Westside Canal FHG deliveries were disaggregated between EBID and EPCWID. SWE disaggregated the FHG deliveries based on relative diversions and M&A disaggregated the deliveries based on relative irrigated area.

After 2008, the differences in FHG deliveries are more substantial, and except for 2010, in which the data used by M&A appear to be in error[7], the M&A FHG deliveries are much less than the SWE FHG deliveries. During this time (except for 2010), there are no FHG delivery data for the El Paso Valley or for EPCWID. SWE estimated the FHG deliveries after 2008 for the El Paso Valley based on the reported monthly El Paso Valley diversions reduced by monthly average conveyance loss percentages derived from historical records. M&A estimated the missing data by first estimating the Texas Mesilla FHG deliveries from data and estimates of EBID FHG deliveries, then extrapolating the estimated Texas Mesilla FHG deliveries to total EPCWID FHG deliveries, and finally pro-rating those values to estimates of the El Paso Valley FHG deliveries. The convoluted M&A procedure did not consider that EBID and EPCIWD FHG deliveries were no longer comparable on a per acre basis after the 2008 OA went into effect. As shown in the lower chart in **Figure 12-14**, the M&A procedure results in unrealistically low estimates of El Paso Valley FHG deliveries as a percentage of El Paso Valley canal heading diversions.

<u>**HCCRD**</u>

Figure 12-15 compares the computed annual supplemental pumping in the M&A Farm Budget Model to the comparable values from the SWE CFB Model during the 1985 - 2016 period. The annual pumping in the M&A Farm Budget Model averages about 19,400 AF compared to an average of 2,100 AF in the SWE CFB Model, a difference of about 17,300 AF. The differences in supplemental pumping are due largely to differences in the ET of applied water and differences in FHG deliveries between the models.

The simulated pumping in the M&A Farm Budget Model during the full supply years from 1985 - 2002 is unrealistically high considering the following:

- High FHG deliveries per acre (see **Figure 5-13**),
- High Ft. Quitman flows (see **Figure 5-3**), and
- High operational waste through this period (see **Figure 5-23**).

The upper right chart in **Figure 12-16** compares the maximum annual cropped area in the HCCRD in the M&A Farm Budget Model to the annual irrigated area in the SWE CFB Model. The irrigated figures are relatively comparable with the M&A Farm Budget Model acres averaging about 3% less than the SWE CFB Model acres.

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[7] As described in Section 6.4.5, Reclamation records of EPCWID FHG deliveries exceed canal heading diversions in many months and are assumed to be in error.

The upper left chart in **Figure 12-16** compares the annual ET of applied water in the HCCRD. The annual ET of applied water in M&A Farm Budget Model is larger than the SWE CFB Model values throughout the 1985 - 2016 period, averaging about 30% more. The differences are due largely to differences in unit crop ET and cropping pattern.

The lower left chart in **Figure 12-16** compares the area-weighted annual unit crop ET in the HCCRD for the M&A Farm Budget Model and the SWE CFB Model. The differences in the unit crop ET reflect the combined differences in cropping pattern and the unit irrigation requirements of the individual crops. The unit ET for the M&A Farm Budget Model was computed as the annual ET of applied water volume (shown in the upper left chart in **Figure 12-16**) divided by the maximum monthly irrigated area in that year (upper right chart in **Figure 12-16**). The unit ET values in the M&A Farm Budget Model average over 30% more than the SWE CFB Model values.

The lower right chart in **Figure 12-16** compares the annual farm headgate delivery volumes that are simulated in the M&A Farm Budget Model of the HCCRD to the SWE CFB Model values. On average, the farm headgate deliveries in the M&A Farm Budget Model are about 26% less than the values in the SWE CFB Model.

13.0 RESPONSE TO HUTCHISON REPORT

William R. Hutchison, Ph.D., P.E., P.G. prepared a May 31, 2019 expert report on behalf of the State of Texas ("Hutchison Report"). The subjects of the Hutchison Report are generally twofold. First, the report describes the development of a MODFLOW ground water model of the Rincon and Mesilla basins in New Mexico and small portions of Texas and Mexico ("Texas Model") over a study period from 1938 - 2016. Second, the report describes use of the Texas Model to simulate reduced pumping and other scenarios during all or portions of the historical study period. The Hutchison Report includes a main summary report, 17 technical memoranda detailing the development and calibration of the Texas Model, and 4 technical memoranda describing use of the model to simulate reduced pumping and other scenarios.

SWE was asked by legal counsel for New Mexico to review the input data sets for the Texas Model and the model simulations of the reduced pumping scenarios to identify information or opinions with which we disagreed, and to prepare expert opinions to respond these issues. We attempted to identify and respond to all substantive issues in which there appeared to be differences of opinion, however a lack of response to a particular issue should not be interpreted as tacit agreement with Dr. Hutchison's opinion(s).

Hutchison Opinion 1 – *The 1938 condition can be viewed as a combination of three elements: 1) minimal groundwater pumping, 2) a specific number of irrigated acres and a specific distribution of irrigated crops, and 3) a specific amount of irrigation water that was applied (expressed in terms of acre-feet of water per irrigated acre). Simulations with the Texas Model demonstrate that increases in groundwater pumping have had a larger impact to Rio Grande at El Paso flows than increases in agricultural consumptive use. (Page 12 paragraph 1).*

Response:

New Mexico's legal counsel have advised that a 1938 condition is not appropriate for characterizing the water entitlements of the states. Moreover, it would be inappropriate to define a 1938 condition based on historical operations in a single year as Dr. Hutchison does in his analyses.

Hutchison Opinion 2 – *Simulations with the 2007 OSE Model and the Texas Model demonstrate that groundwater pumping resulted in decreased flows in the Rio Grande. Brandes (2019) developed an estimate of hypothetical Rio Grande at El Paso flows that would have occurred under a "without the effects of groundwater pumping" condition.*

Brandes (2019) concluded that the average increase in flow as compared with historic flows from 1951 to 2017 is about 79,000 AF/yr. (Page 12 paragraph 2).

Response:

As described in the response to Brandes Opinion 10 in Section 11, the analyses of historical data by Dr. Brandes unreasonably attributed all changes in Rio Grande at El Paso flow that occurred after 1950 to the effects of New Mexico pumping and did not consider other factors that may have contributed to reductions in flow at El Paso. Likewise, the modeling by Dr. Hutchison does not consider these other factors.

Hutchison Opinion 3 *– Simulations with the Texas Model demonstrate that an overall 60 percent reduction in all pumping would result in a hypothetical increase in Rio Grande at El Paso flow of about 73,000 AF/yr from 1951 to 2016. About 81 percent of the increase (59,000 AF/yr) is attributable to New Mexico pumping, and about 19 percent of the increase is attributable to Texas pumping (13,000 AF/yr). (Page 12 paragraph 2).*

Response:

The reduced pumping simulations performed by Dr. Hutchison are unreasonable and unreliable because the Texas Model does not simulate the dynamic operational responses of the Project and the LRG Area irrigation systems that would occur if pumping was reduced or turned off.

The following is a summary of the changes in inputs that are specified to occur in each of Dr. Hutchison's reduced pumping simulations:

- Irrigation pumping is reduced by a specified percentage (10% to 100%),
- Non-irrigation pumping and the corresponding urban infiltration are reduced by the same percentage, and
- On-farm deep percolation is reduced proportionately based in the reduction in total irrigation supply (SW+GW).

The following are inputs that are not changed in the reduced pumping simulations:

- Releases from Project storage,
- Canal diversions of Project water, and
- Wastewater treatment plant discharges.

The following are the simulated responses in Texas Model resulting from the foregoing changes in model inputs:

- Increased ground water levels and ground water storage,
- Increased riparian ET,
- Increased drain flows,
- Reduced canal seepage and river seepage,
- Increased Rio Grande flow from increased drain flows and reduced river seepage.

Because the reservoir releases and canal diversions are fixed at the historical amounts in the alternative runs, all increases in Rio Grande flow accumulate as increased flow at the downstream end of the model at El Paso. This simple process of the additional river flow running out the bottom of the model is not what happens during the irrigation season in the real world when the supply changes. In the real world, reservoir releases are continually adjusted in response to changing conditions downstream so as to deliver the ordered amounts of water.

The system response to the additional flow that would be in the river with a reduction in pumping would vary depending on whether it occurred in a year with a full allocation of Project water or a year with less than a full allocation. In a year with a full allocation, deliveries of Project water are limited by either the allocated amount or the water demand. In either case, it is reasonable to assume that Project water deliveries in a full allocation year would be about the same in a reduced pumping scenario as they were in the historical operation. Therefore, during a full allocation year in a reduced pumping scenario, the additional flow in the river would allow Reclamation to reduce reservoir releases and still deliver the same amounts to the Project water users. The reduction in reservoir releases would accumulate additional water in storage that would be carried over and allocated to EBID and EPCWID in subsequent years. The additional reservoir storage would also result in increased evaporation due to the greater surface area in the reservoir and would also result in increased spills when the Project storage filled to capacity.

During non-full supply years, the additional water in the river and additional accumulated reservoir storage during prior full allocation years would lead to increased allocations and increased deliveries to Project water users.

Because the Texas Model does not include simulation of reservoir and Project operations, it has no capability to simulate the real-world responses of the Project including changes in allocations, reservoir releases, diversions, and farm headgate deliveries. As a result, the increased river flow that occurs in the reduced pumping scenarios simply runs downstream to El Paso. This causes the Texas Model to overstate the effects of pumping in the Rincon and Mesilla basins on the flow of the Rio Grande at El Paso. The lack of simulation mechanisms in the Texas Model for reasonable dynamic responses to the changes in supply that would occur under conditions that are different from historical conditions renders the results from the Texas Model simulation of alternative scenarios meaningless and not helpful in assessing the effects of reduced pumping or changed conditions on Project operations and deliveries to LRG water users.

Figure 13-1 and **Figure 13-2** were prepared to compare the simulated changes in El Paso flow from the Texas Model and the ILRG Model for the scenario in which all pumping in the Rincon and Mesilla basins is turned off. In each figure the simulated changes in flows in the ILRG Model are summarized to show the changes during March - October (blue bars) and the changes during November - February and during months that the Project storage is spilling (grey bars). The results from the Texas Model are shown as a colored line representing the annual change in El Paso flow (purple line for simulation of no pumping during 1951-2016 and orange line for simulation of no pumping during 1985-2016).

Figure 13-1 compares the simulated change in El Paso flow in the ILRG Model for the a scenario in which all pumping in the Rincon and Mesilla basins is curtailed to the Texas Model simulation of the comparable scenario The average annual change in El Paso flow in the Texas Model during 1985 - 2016 is 124,700 AF compared to 93,900 AF in the ILRG Model (of which 25,100 AF occurs during reservoir release periods and 68,800 AF occurs during the non-release season or during spills). The simulated change in flow in the Texas Model is substantially greater because most of the increased river flow in the no-pumping scenario flows downstream to El Paso. In the ILRG Model with a simulated dynamic response to the changes in river flow, the reservoir releases are reduced in full allocation years and some of the increased flow in non-full supply years is allocated to EBID and as a result, much less of the additional flow makes it to El Paso. The simulated annual changes in El Paso flow in the ILRG Model reflect the expected response of the Project operation with little increased irrigation season flow during full allocation years (e.g., during the much of the 1980s and 1990s). Conversely, in the Texas Model the simulated changes in annual El Paso flow are relatively steady as they represent increases in river flow without the re-operation of the Project.

Figure 13-2 is similar to **Figure 13-1** with the results from the ILRG Model shown for the scenario with no New Mexico pumping (i.e., the pumping in the Texas Mesilla area was left on). The simulated average annual change in El Paso flow in the ILRG Model during 1985 - 2016 of 74,400 AF is about 19,500 AF less than when all pumping in the Rincon and

Mesilla basins is turned off, and only 17,600 AF of the average annual change in flow occurs during periods when reservoir releases are occurring (excluding spills).

Hutchison Opinion 4 *– One of the components of the "1938 condition" is the irrigated acreage and associated consumptive use expressed as acre-foot per acre in 1938. As documented in Technical Memorandum 3, agricultural consumptive use in New Mexico has increased since 1938 as shown in Figure 1. This technical memorandum documents the results of five scenarios where agricultural consumptive use is limited to that of 1938. The simulations were run from 1938 to 2016, but the modifications were applied only after 1950 to provide a means of comparison with other scenarios.*

The agricultural pumping, agricultural deep infiltration, and surface water diversion components of the hypothetical consumptive use scenarios were developed by summing the consumptive use of 1938 (149,005 AF/yr) and the associated canal losses and farm-level infiltration associated with irrigation. For each year, this sum was viewed as a demand and was compared with the annual historic surface water diversions for agricultural use. If the historic surface water deliveries were higher than the new demand, the excess remained in the surface water system (i.e. surface water flow diversions were reduced as compared with historic levels). If the historic surface water deliveries were less than the new demand, groundwater pumping for irrigation was set equal to the deficit. The five scenarios involve alternative urban and domestic groundwater pumping:

- *Scenario 1: limit of 10,000 AF/yr*
- *Scenario 2: limit of 20,000 AF/yr*
- *Scenario 3: limit of 30,000 AF/yr*
- *Scenario 4: limit of 40,000 AF/yr*
- *Scenario 5: limit of 50,000 AF/yr*

(Technical Memo 20 - Page 1 paragraphs 1 and 2; and page 4 paragraph 2).

Response:

Dr. Hutchison's Technical Memo 20 describes simulations under a presumption that New Mexico is entitled to consume for irrigation the same amount of water that it was consuming in 1938, which he estimates was 149,005 AF. When the historical annual surface water diversions during the simulation period were insufficient produce 149,005 AF of irrigation consumptive use, it was assumed that New Mexico water users could pump water to eliminate the deficit. Conversely, if the surface historical water supply was more than needed to produce 149,005 AF of consumptive use, then the diversions were reduced by the excess amount.

New Mexico's legal counsel have advised that a 1938 condition is not appropriate for characterizing the water entitlements of the states. Moreover, it would be inappropriate to define a 1938 condition based on historical operations in a single year.

The Alternative Consumptive Use scenarios imply that New Mexico should be limited to the irrigation consumptive use that allegedly existed in 1938 (149,005 AF), even if that means that New Mexico would have to reduce its use of Project water. However, Texas has provided no technical support for the notion that New Mexico's Project deliveries should be limited to the 1938 level.

Further, the simulations of reductions in New Mexico diversions of surface water in the Texas Model are nonsensical because there is not a corresponding reduction in simulated reservoir releases. Therefore, when the New Mexico diversions are reduced, the volume of the reduced diversion is left in the Rio Grande to run downstream to El Paso. In reality, if New Mexico's irrigation consumptive use was somehow limited under a 1938 condition, the reservoir releases would be reduced as necessary to limit the consumptive use of surface water and there would be no increase in El Paso flow during such years.

In addition, as described in the response to the reduced pumping scenarios, any change in pumping from what occurred historically would result in a dynamic response of the Project operation that would change the available surface water supply resulting in changed Project water allocations, diversions, and deliveries to Project water users. The Texas Model is not capable to simulating this dynamic response.

Because of the limitations of the Texas Model, the results of the simulations described in in Technical Memorandum 20 are of little value in assessing any alternative consumptive use scenarios based on a 1938 condition or otherwise.

It is unclear if the Alternative Consumptive Use scenarios are presented to illustrate Dr. Hutchison's analysis of how to achieve potential Compact compliance for New Mexico. It is also unclear whether Dr. Hutchison is proposing an analogous consumptive use cap for all Texas Project lands based on his 1938 condition.

Hutchison Opinion 5 – *The preferential use of surface water and the use of groundwater to meet demand deficits is the definition of conjunctive use. The simulations documented in this technical memorandum evaluated alternative hypothetical conjunctive use scenarios where historic groundwater pumping only occurred in years with less than specified amounts of surface water availability (i.e. pumping only in dry years to meet* *demand deficits). For purposes of these simulations, five scenarios were developed as follows:*

- *Scenario 1 assumed that groundwater pumping is zero when annual releases from Caballo are above 790,000 AF/yr (i.e. no pumping in 13 years, historic pumping in 66 years)*
- *Scenario 2 assumed that groundwater pumping is zero when annual releases from Caballo are above 700,000 AF/yr (i.e. no pumping in 30 years, historic pumping in 49 years)*
- *Scenario 3 assumed that groundwater pumping is zero when annual releases from Caballo are above 600,000 AF/yr (i.e. no pumping in 52 years, historic pumping in 27 years)*
- *Scenario 4 assumed that groundwater pumping is zero when annual releases from Caballo are above 500,000 AF/yr (i.e. no pumping in 60 years, historic pumping in 19 years)*
- *Scenario 5 assumed that groundwater pumping is zero when annual releases from Caballo are above 400,000 AF/yr (i.e. no pumping in 66 years, historic pumping in 13 years)*

(Technical Memo 21 - Page 2 paragraphs 1 and 5).

Response:

The Conjunctive Use scenarios described in Technical Memorandum 21 are similar to the 100% reduced pumping scenario described in Technical Memorandum 18 except that the pumping is only turned off in selected years rather than every year. Therefore, the same criticisms of the reduced pumping scenarios described above also apply to the Conjunctive Use scenario simulations. The lack of a mechanism in the Texas Model to simulate a dynamic response in the Texas Model to changing water supply renders the results of the Conjunctive Use scenarios as unreasonable.

It is also unclear if the Conjunctive Use scenarios are presented to illustrate Dr. Hutchison's analysis of how to achieve potential Compact compliance. It is also unclear whether Dr. Hutchison is proposing the same type of conjunctive use limits for Texas.

Exhibit C

Expert Report of Gilbert R. Barth, Ph.D.

Re:
In the Matter of: No. 141 Original,
In the Supreme Court of the United States,
State of Texas v. State of New Mexico and the State of Colorado

Prepared for:
State of New Mexico

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

October 28, 2019

3100 Arapahoe Ave, Suite 203, Boulder, Colorado 80303-1050 • (303) 939-8880

Expert Report of
Gilbert R. Barth, Ph.D.

Re:
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Glossary

Term	Definition
af	acre-feet. Typically indicating volumes of water. One acre-foot of water represents water to a depth of one foot spread over an entire acre (43,560 square feet), or 43560 cubic feet of water, or 325,851 gallons of water
af/yr	acre-feet per year. A rate of flow using acre-feet for volume and years as the interval.
CMI	Commercial, municipal and industrial pumping (*comparable to "Urban pumping", but without domestic*)
DCMI	Domestic, commercial, municipal and industrial pumping (*comparable to "Urban pumping"*)
FHG	Farm Headgate
GHB	General Head Boundary package. A MODFLOW groundwater model input package which in the NMR-M model is used to represent transboundary in and outflows.
Gradient	The measure of rate of hydraulic potential change at a point in space. Typical examples would be the slope of groundwater elevation change at a location. In this report, summarizes the change in potential (in feet of groundwater elevation for unconfined portions of the aquifer) over a distance (also in feet). The resulting ratio (feet/feet) is dimensionless.
GWO	Groundwater Object. One of 24 Rincon or Mesilla Valley subregions delineated for passing results back to RiverWare. These subregions are objects within RiverWare: NMR-M outputs are processed to provide RiverWare with inputs at the GWO level.

head	In this report, typically referring to groundwater elevation. However, for confined conditions this term represents the potentiometric surface.
ILRGM	Integrated Lower Rio Grande Model. The coupled model system comprised of the NMR-M Groundwater Model, the Hueco Groundwater Model, and the Rio Grande surface water operations RiverWare model.
MAF	Million Acre-Feet, this acronym is typically used for large volumes of water.
MNW2	Multi-Node Well 2 package. A MODFLOW groundwater model input package representing specified flux from the aquifer, with the ability to dynamically allocate fluxes across multiple model layers based on the solution of hydraulic gradients within the aquifer and well.
MODFLOW	The USGS's modular groundwater flow modeling software, for numerical simulation of groundwater flow and associated boundary conditions
MODFLOW OWHM	The One Water Hydrologic Model version of MODFLOW. Significant features of MODFLOW OWHM include additional capabilities to represent complex boundary conditions.
MUL	Multiplier file. This MODFLOW input file can supplement other input-package files, providing data values and/or formulas for processing data provided in the MUL or other input-package files.
NMR-M model	New Mexico's Rincon-Mesilla model of groundwater flow
potentiometric surface	The level to which water would rise if a well were drilled into the associated confined aquifer
RCH	Recharge package. A MODFLOW groundwater model input package representing specified flux inflows into the aquifer.

RIP-ET	Riparian Evapotranspiration package. A MODFLOW groundwater model input package representing head dependent consumption of groundwater by vegetation that typically relies substantially on uptake of water from the groundwater table.
RMSE	Root Mean Squared Error. A statistical summary of the deviation of simulated results from observed values. Lower numbers indicate a better match between simulated and observed.
SFR	Streamflow Routing package. A MODFLOW groundwater model input package capable of representing head-dependent flux between the aquifer and surface water features
Transmissivity	Measure of an aquifer's capacity for flow. Transmissivity reflects both the aquifer's material properties and the aquifer thickness. Units in this report are in terms of ft^2/day (square-feet per day)
surface water features	Surface water features in the NMR-M include the Rio Grande, canals and drains.
UPW	Upstream Weighting Package. A MODFLOW groundwater model input package, primarily for representing aquifer properties in the form of hydraulic parameters.

9.3 Texas Model Hydrogeologic Framework and Limited Shallow Resolution

Schorr and Kikuchi (2019) developed model layers based on the primary formations and their thicknesses. The Texas Model groundwater system is represented as a four-layer aquifer system. The active portions of the model layers are bounded by the bedrock units that are assumed to be impermeable. Model layers are delineated as follows:

- Model layer 1 comprises the valley-fill/river alluvium deposits and upper Santa Fe (85 foot average thickness)
- Model layer 2 comprises the upper Santa Fe unit (500 foot average thickness)
- Model layer 3 comprises the middle Santa Fe unit (640 foot average thickness)
- Model layer 4 comprises the lower Santa Fe unit (average thickness of 560 feet)

This approach has similarity to the NMR-M model, cuing on the transition of alluvium to different Santa Fe formations. Calibration adjustment of hydraulic conductivity could allow for similarities in lateral-flow potential in the NMR-M and Texas models. The primary difference is with regard to shallow layering. The NMR-M model incorporates 4 layers within the first roughly 600 feet, compared to 2 layers in the Texas Model. This additional refinement may play a significant role in reproducing observed flows, vertical gradients and drawdowns, especially in areas exhibiting interbedding of fine-grained materials.

9.4 Texas Model Issues

9.4.1 Ignoring the Seasonal Fluctuations with Annual Stress Periods

The Texas Model uses annual timesteps, precluding the representation of seasonality, especially with respect to surface-water depletions and seasonal drought recovery opportunities. The decision to reduce temporal resolutions appears to reflect an orchestrated effort to reduce accurate representation of the physical system, ignoring the resulting inability of the Texas Model to reasonably represent anything other than Rio Grande flows at the El Paso gage. Extensive data sets including estimation of the Land Surface, Surface Water, Farm Water budgets were developed on a monthly basis *Schorr and Kikuchi* (2019). Observations of flows and water levels were collected and processed to provide sub-annual variability. To create annual inputs, *Hutchison*

(2019) had to convert inputs provided from his collaborators as well as any information extracted from the seasonal NMOSE model (*SSPA*, 2007).

Without seasonality the Texas Model cannot represent groundwater elevation fluctuations which typically vary several feet during the course of the year (see the monthly time series in Appendix B, Figure B-2, for a full set of monthly groundwater-elevation seasonality examples). More importantly, without seasonal fluctuations, drain flows are not activated: if groundwater elevations are simulated as annual averages the groundwater elevation will not have a seasonal rise and will not result in groundwater flowing into the drains. This process is exacerbated by using winter observations of groundwater elevations, which are typically even lower than annual average (see Section 9.5.1 "Using Midwinter Targets for a Model with Annual Stresses") as calibration targets. The net result of omitting seasonal fluctuations is best summarized by the Texas Model simulated drainflows, as discussed in the Section 9.6.2 "Underestimation of Drain Flows". The limited amount of groundwater seepage into drains simulated by the Texas Model demonstrates the lack of simulated groundwater elevation fluctuations. With annual stress periods these fluctuations cannot be represented.

9.4.2 Misrepresenting Transbasin Boundary Conditions

A constant head boundary more typically provides a reasonable approximation of pumping induced gradients for boundary conditions representing features such as large lakes or reservoirs, where groundwater pumping induced water-level changes are assumed to be negligible. For the Texas Model, a constant head boundary may be an appropriate choice for the Caballo Reservoir representation, however it seems more reasonable to incorporate boundary conditions at the other transbasin locations that have some representation of conductance limitations specific to those locations. Without these limitations, the boundary conditions are likely to be far too sensitive to water level changes, e.g., see Section 9.6.5 "Texas Model Transbasin Response to Conejos Médanos".

9.4.3 Tributary Inflows Inconsistent with Estimated Water Budgets

Hutchison implements tributary inflows that are approximately 15% lower than the budget values provided by *Schorr and Kikuchi* (2019). This difference probably reflects calibration adjustments, is not documented, and it is not apparent whether other water budget adjustments were made to remain consistent with the *Schorr and Kikuchi* (2019) budget.

9.4.4 Inadvertent Assignment of Agricultural Surface Return Flows as Urban Return Flows

In the Texas Model, agricultural surface runoff (also referenced by *Hutchison* as "field level surface runoff") was incorporated by subtracting agricultural surface runoff from the terminal diversions, providing net farm diversions. *Hutchison* (2019) describes this adjustment on page 17 of Technical Memorandum 13. However, the Texas Model pre-processor AnnualFlows.f95 has an error in the code and inadvertently assigns the Mesilla urban runoff, averaging about 2,200 af/yr, to a variable representing Mesilla tributary flows, and the Mesilla agricultural surface runoff, averaging about 20,000 af/yr, to a variable representing Mesilla urban runoff. These flows are distributed to SFR segments associated with tributary inflow and urban runoff, respectively, and written to the Texas Model SFR package. The result of this error is that the volume of Mesilla agricultural surface runoff (1.6 MAF) is effectively added to the surface water system twice; thus, an extra 1.6 MAF is added directly to the Rio Grande.

9.4.5 Misrouting Canal Flows into Drains

Within the Texas Model, settings in the SFR network are configured in a manner allowing large amounts of flow from the canal system to move directly into the drains. While some amounts of flow from canals directly into drains may occur in the physical system, the canal system exists to deliver water to farm headgates and the amounts passing directly from canals to drains will typically be small compared to the amount of water in the system. The Texas Model, however, is configured so that large amounts of water pass through the entire canal system, without any diversion, and are then routed into drains. Much of this water should have seeped from canals into the shallow groundwater contributing to both seasonal groundwater elevation fluctuations and seepage into drains. These mechanisms are not represented in the Texas Model. This construction is a misrepresentation of the physical system.

Discussions with the State of New Mexico Lower Rio Grande Water Master (*Serrano*, 2019) confirm that while it is possible to have occasions for this sort of routing to occur, it is not common and not at the levels of flow simulated in the Texas Model. The following list provides specific examples of Texas Model routing of canal flows into drains that are inconsistent with the physical system.

- At the Arrey diversion, 5.9 MAF are diverted into the Rincon Canal System, of which the Texas Model routes 1.1 MAF to the drain at the bottom of the canal system. Historical records indicate 0.4 MAF of flow passing Rincon Drain gage from 1940 – 2016. The Texas Model simulates:
  - 18% of Arrey diversion, or roughly 14,000 af/yr, is routed to drains (not deliveries, not wasteway flow)
  - 81% of simulated flow past Rincon drain gage is routed from canals (19% is from aquifer seepage to drains)
  - The Texas Model simulated Rincon Drain gage flow is 360% of the measured amount
- At the Leasburg Diversion, 9.5 MAF are diverted into the Leasburg Canal System. The Texas Model simulates 2.8 MAF flowing from the Leasburg System to East Canal through Louisiana Lateral, Mesilla Lateral, and Las Cruces Lateral combined.
  - 30% of the total Leasburg Diversion is routed to the East Canal System
  - The Texas model simulates routing an average of 37,000 af/yr from the Leasburg system directly into the East Canal.
- At the West Mesilla Diversion 12.4 MAF are diverted into the Westside Canal System, of which the Texas Model routes 1.7 MAF from Lower Chamberino Lateral directly into Nemexas Drain. Historical records indicate 0.6 MAF of flow passing the Nemexas Drain gage from 1940 – 2016. The Texas Model simulates:
  - 14% of Westside diversions, or roughly 22,000 af/yr, is routed through Lower Chamberino Lateral to the drain (not deliveries, not wasteway flow)
  - 94% of simulated flow past Nemexas drain gage is routed from canals (6% is from aquifer seepage into the drains)
  - The Texas Model simulated Nemexas Drain flow is 330% of the measured amount

- The Eastside Diversion of 4.8 MAF plus the Texas Model simulated 2.8 MAF of flow from the Leasburg system puts a total of 7.6 MAF into the Eastside Canal, of which the Texas Model routes 1.5 MAF through the Anthony and Texas laterals plus 0.4 MAF from Apache Lateral into the Eastside Drain. Historical records indicate 0.9 MAF of flow passing the East Drain gage from 1940 – 2016. Based on this information, the Texas Model simulates:
    - 25% of the Eastside Canal plus Apache Lateral inputs, or roughly 25,000 af/yr, is routed through laterals into East Drain (not deliveries, not wasteway flow),
    - 90% of flow past East Drain gage is routed from canals (10% is from aquifer seepage into the drains), and
    - East Drain flow as 90% of the measured amount, and 90% of that flow is water routed from canals.

9.5 Texas Model Calibration Deficiencies

9.5.1 Using Midwinter Targets for a Model with Annual Stresses

The Texas Model groundwater elevation targets are intentionally taken from the records when groundwater levels are the most stable. The process, in essence, entailed selecting observations that were recorded during January. While mid-winter Rincon and Mesilla water level observations are typically the most stable and reliable indicators of water levels within the aquifer, they also happen to reflect the lowest water level observations of the year. A seasonal model, such as the NMOSE (*SSPA*, 2007) or a monthly model (e.g., NMR-M) can use these observations as targets during the appropriate season with the appropriate stresses. For the Texas Model, with annual stress periods, the contribution of the mid-winter water level observations in constraining model calibration is limited by the inconsistency between the model's annual stress periods and the seasonal stresses producing the observed groundwater levels.

9.5.2 Calibrating Selectively: Matching Only One Target

Hutchison (2019) inappropriately used calibration targets sequentially: there is no Texas Model calibration effort simultaneously using all available targets. Incremental calibration provides opportunities to ignore extreme parameter correlation and, as a result, creates

Exhibit D

No. 141, Original

In the

SUPREME COURT OF THE UNITED STATES

STATE OF TEXAS,

Plaintiff,
v.

STATE OF NEW MEXICO and
STATE OF COLORADO,

Defendants

OFFICE OF THE SPECIAL MASTER

UNITED STATES OF AMERICA'S DISCLOSURE OF EXPERT REBUTTAL WITNESS DR. IAN M. FERGUSON

NOEL J. FRANCISCO
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Counsel for the United States

irrigation in any year, the distribution of the available supply in such a year, shall so far as practicable, be made in the proportion of 67/155 thereof to the lands within the El Paso County Water improvement District No. 1, and 88/155ths to the lands within the Elephant Butte Irrigation District." Under the 1938 contract, the division of Project water supply between EBID and EPCWID based on acreage is explicitly limited to years in which there is a "shortage of water for irrigation" – it does not apply to all years.

Dr. Barroll's statement that "from 1938 through 1978, Reclamation operated the Project so that EBID farmers were entitled to 57% of the US share of Project supply" is also incorrect. From 1938 through 1950, Reclamation operated the Project without allotments – *i.e.*, farmers were able to call for water as needed, with no allotment or limit imposed. From 1951-1978, Reclamation allotted water equally to all Project acres. However, Reclamation did not guarantee equal delivery to all lands; rather, actual deliveries to farms depended on the amount of water called for by farmers. Farm delivery data provided in the expert report of Sullivan and Welsh demonstrate that the proportion of annual farm deliveries from 1938-1978 delivered to EBID ranged from 49-60 percent.

> *Barroll Opinion 4: Starting in 1979, Reclamation explicitly allocated Project Supply to the Districts in the ratio of 57% to EBID and 43% to EPCWID. The total amounts allocated were defined using the D1/D2 Curves. The amounts of water diverted by the Districts and delivered to their farmers were consistent with this 57:43 ratio.*

Opinion: The amounts of water diverted by the Districts and delivered to their farmers depended on the amounts of water called for by the districts and farmers, respectively. River diversion data provided in the expert report of Sullivan and Welsh demonstrate that the percentage of annual diversions to EBID from 1979 to 2007 ranged from 52 to 59 percent of the total annual diversion to the Districts and annual farm deliveries to EBID during this period ranged from 32 to 62 percent of the total annual farm delivery by the Districts. Table A.8 of Appendix A of Dr.

Exhibit E

No. 141, Original

In the

SUPREME COURT OF THE UNITED STATES

STATE OF TEXAS,

Plaintiff,
v.

STATE OF NEW MEXICO and
STATE OF COLORADO,

Defendants

OFFICE OF THE SPECIAL MASTER

UNITED STATES OF AMERICA'S SUPPLEMENTAL DISCLOSURE OF EXPERT WITNESS IAN M. FERGUSON

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B. Summary of the Facts

Project operations are carried out according to terms and procedures specified in the Operating Agreement, Operations Manual, and existing contracts and agreements between Reclamation, Elephant Butte Irrigation District ("EBID"), and El Paso County Water Conservation District No. 1 ("EPCWID").

The Operating Agreement specifies how the United States allocates water to Mexico and to EPCWID using the D1 and D2 Curves, respectively. Reclamation determines the annual allocation to the United States for delivery to Mexico using the D1 Curve, which is a linear regression equation between historical annual Project releases and historical annual Project deliveries. Reclamation determines the annual allocation to EPCWID using the D2 Curve, which is a linear regression equation between historical annual Project releases and historical annual Project diversions. Both the D1 and D2 Curves were developed in the early 1980s based on historical data from the period 1951-1978.

The Operating Agreement specifies how the United States allocates water to EBID using the D2 Curve and the diversion ratio. The diversion ratio, as defined in the Operating Agreement, is the ratio of total annual allocation charges to EBID, EPCWID, and Mexico to the total release from Caballo Dam. If the total Project release for the current year is less than 600,000 acre-feet, the annual allocation to EBID is the lesser of its D2 allocation and its diversion ratio allocation; if the total Project release for the current year is greater than 600,000 acre-feet, the annual allocation to EBID is equal to its diversion ratio allocation. In years when the total Project release is less than 600,000 acre-feet and EBID's diversion ratio allocation greater than its D2 allocation, each district's allocation is adjusted based on the difference between EBID's diversion ratio allocation and its D2 allocation.

IN THE SUPREME COURT OF THE UNITED STATES
BEFORE THE OFFICE OF THE SPECIAL MASTER
HON. MICHAEL J. MELLOY

Exhibit F

STATE OF TEXAS	)	
	)	
Plaintiff,	)	
	)	Original Action Case
VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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ORAL DEPOSITION OF
WILLIAM R. HUTCHISON
OCTOBER 1, 2019
VOLUME 2

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ORAL DEPOSITION of WILLIAM R. HUTCHISON, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on October 1, 2019, from 9:04 a.m. to 2:58 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the MOODY GARDENS SPA & CONVENTION CENTER, 7 Hope Boulevard, Galveston, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

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concluded the same thing I did was the reason we just said, you know, we don't need to put this in here coupled with the fact that the questions that had been asked of me didn't have anything to do with reservoir operations. We were interested in the -- essentially the physical connection between groundwater pumping and stream flow, and we were not getting into operational issues, at least with the four questions that are covered in my report.

Q. So when you say you weren't getting into operational issues, what about under your -- what I'll call your what-if scenarios or your change in historic conditions scenarios, does that involve any operational issues?

A. Not related to the reservoir.

Q. Okay. So if in your no-pumping run, you made the assumption that the reservoir releases would remain the exact same as they did historically; is that correct?

A. That's correct.

Q. Okay. So is it your understanding that if in your no-pumping run, groundwater levels came up and drain flows increased, that reservoir releases would not be impacted by those new conditions?

A. Under the assumptions, the hypothetical, I assume that releases would remain exactly the same. What I was trying to do was hold that variable constant and look at the response to other changes and other variables.

Q. And so I understand yesterday, you did say that you were trying to not make it complicated, you were trying to hold one variable constant. Is it your opinion that if in the what-if scenario, no pumping, that reservoir releases would have remained the same?

A. I don't know. Simulating a physical response is a different problem, a different issue, than simulating the effects of alternative operations, and the work that I completed was limited to looking at just the physical changes associated with changes in pumping.

Q. In your work, did you make any simulations related to alternative operations?

A. Are you talking about reservoir operations?

Q. Yes. Thank you.

A. No. There were no changes in reservoir operations. All the scenarios relied on the same historic Caballo releases.

Q. What's your understanding of how Bureau of Reclamation determines how much water to release from the reservoir on an annual basis?

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A. I would say I have a superficial understanding of the details. The -- the general ideas that releases are determined by a combination of how much water is in storage in Elephant Butte and the timing of the -- what's the right term -- orders. But I don't know any of the details of how that works precisely. It's more of a conceptual understanding.

Q. Do you know whether or not reclamation considers, in addition to storage and the timing of orders, any gains or losses in the system between the release point and the delivery point?

A. I know that was a concern when a few years ago -- a few years ago, Mexico had requested water that was out of sync with the irrigation districts, and there was a concern expressed that by trying to satisfy that order, there would be a lot of losses along the way that the irrigation districts would essentially have to absorb because of the treaty obligations. As a routine thing, I don't know. I just remember that as sort of an outstanding example of how the -- the stream losses were recognized as a -- as an issue.

Q. So outside of that isolated example you provided, you don't know how Bureau of Reclamation considers gains or losses for their release determination?

A. Not in any detail.

Q. Did you attempt to investigate how reservoir operations occur within -- from, excuse me, Caballo reservoir for this case?

A. Again, back in 2007, I looked at it on an annual basis with respect to what I was doing with the climate variability analysis for the Hueco, and then as part of this case, I looked at it more in the context of Rincon and Mesilla, and most of the -- and the analysis was limited to annual numbers, so a lot of the details of within a year operations, I did not consider.

Q. Did you consider it within your annual numbers?

A. I looked at it with the annual numbers and concluded that basically the most important factor in determining the releases was the Elephant Butte Reservoir storage and that everything else was difficult to tease out of that annual data.

Q. Through this case, did you have any discussions with Bureau of Reclamation representatives related to reservoir releases?

A. No.

Q. Do you know whether or not the irrigation districts themselves, and when I say "irrigation districts," I mean EBID and EP1, have to make any estimates about how much water to order to get to -- excuse me -- how much water they have to order to get to their diversion point in order to get a certain amount of water to the farms?

A. As a concept, I understand that, but I don't know any of the details of how they do it.

Q. Do you know whether or not they have to consider any type of conveyance losses between the point of delivery at the canal heading and the point of delivery at the farms?

A. Again, as a conceptual matter, I understand that they do that, but I don't know any of the details.

Q. Do you know where the EP1 project delivery points are?

A. Not entirely.

Q. Do you know where any of them are?

A. Well, I know they divert to the American canal, Franklin, Riverside. I mean, I don't know the details. I know when we were doing -- when I was doing the -- the Hueco model and the simulations back in 2007 for the climate variability analysis, I had to take the -- the MODFLOW model and make sure I had accounted for changes in stream flow diversions that were based on the historic data. How those were, you know, related to project water or actual farm deliveries or El Paso deliveries, I -- I wasn't paying attention in the institutional sense. I was doing it in the physical sense, and that -- the details of that, you know, that was 12 years ago. I don't remember. I'd have to go back and review exactly how I did that.

Q. Would you expect losses from American canal prior to its lining?

A. Expect? The data -- you can see it in the data.

Q. And what data are you referring to?

A. Well, the most -- the most -- the data I am most familiar with are the groundwater levels in that area, and you can track when the canal was lined because that's when water levels started to drop.

Q. Do you know what year it was lined?

A. Not offhand.

Q. So earlier, you mentioned when I asked about the delivery points to the project, American canal, Franklin, and Riverside. Do you know where the project delivery measurement points are located?

A. No.

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Q. Do you believe that that's relevant to your investigations in this case?
A. No.
Q. Do you know where the project deliveries for EP1 were in the 1930s?
A. No.
Q. Have you had any exposure to the Tornillo canal in EP1?
A. I've heard of it.
Q. Do you have any understanding of how the project delivery points in EP1 changed over time?
A. No.
Q. Do you know whether or not the project accounting reflects any changes over time to the delivery system in EP1?
A. No.
Q. Are you familiar with any project accounting credits that are provided to EP1?
A. I don't know if the third-party agreement is considered a project accounting credit. If it is then that's the one I know about; if it's not then I don't know any others, how they do the specific accounting.
Q. Okay. Have you ever heard of the American canal credit provided to EP1?
A. I think I've heard of that. I don't know

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Q. Is it your understanding that the El Paso gauge is a Compact delivery point?
A. It is my understanding that it is not a Compact delivery point.
Q. And so in your analysis, why did you limit your investigation on impacts to the El Paso gauge?
A. Because its physical location is geologically, hydro-geologically ideal to understand the impacts upstream. It's at a good point where you're at the narrows of the stream where the bedrock has risen up, and there's very little groundwater exchange at that point between the Mesilla and the Hueco. It's very small. It's very thin alluvium there.
Q. If it's determined in this case that delivery points for Texas are the project delivery points through time and those would include the Riverside canal diversion and even further downstream, the Tornillo canal diversion, would that change your opinion?
A. I'm afraid I don't understand what you're asking, because what I did was look at the physical system. I did not look at institutional things like project delivery points and get myself all involved in that. So I don't have -- I -- I don't know how to

respond to that because the work I did was based on the physical system, not the institutional system.

Q. So what information did you rely upon or consider from Dr. Brandes other than his estimates of El Paso stream gauge information, his 78,000 acre foot number?

A. You lost me. His 78,000 acre foot number. I don't know what you mean by that.

Q. What information -- what communications did you have with Dr. Brandes since 2012?

A. Bob was asked to look at with -- with -- with the data, what -- what he could come up with in terms of the basic relationship between Caballo releases and flow at El Paso, and so through the -- through his data and his double mass curve -- well, let's back up.

He developed a -- he gathered a bunch of data. A lot of it was for Montgomery. Some of it was from his own research and so through that analysis, he came up with a double mass curve that evaluated the flow at -- the Caballo releases and the flow at El Paso and concluded that there was some -- some amount of water that was -- was affected by presumably groundwater pumping in the Rincon and Mesilla area. So I received his spreadsheet where he had done those calculations and developed that graph as a means to

A. Well, if you ever wanted to take -- take the model and -- and expand it out for -- you know, by years or by turning it into a seasonal or monthly model, most of the input data is already organized on a monthly basis.
Q. So are you planning to expand it to a monthly model?
A. I'm not.
Q. Are you planning to expand it to a seasonal model?
A. I'm not.
Q. Do you know if anybody is?
A. Not that I know of.
Q. And so like you mentioned before, a lot of the inputs are on a monthly basis, and you decided to keep the model, though, on an annual basis. My understanding of the reasons are that it was simple, it was more efficient, and that you didn't need monthly to address the questions you were provided?
A. That's correct.
Q. Is there any other reason?
A. I think that covers it.
Q. What's your understanding of what model the U.S. is using -- planning to use in this case?
A. Well, based on the May 31st report and their

A. That's a problem.
Q. Back to the question on seasonality of the model, are Rio Grande drains and canal seepages dependent on gradients that are seasonal?
A. Sure. Yeah.
Q. In your report, the questions you were asked, were those asked of you by counsel?
A. Yes.
Q. Were there any other questions asked of you, other than the four that are provided in your report?
A. No.
Q. The first question that you were asked, you state, "What is the nature and extent of hydrologically connected groundwater and its relationship to the Rio Grande and the Rio Grande project and the relevant issues raised in the Texas complaint?" In your answer, you reference to Figure 1, the gaining and losing stream, and also the disconnected -- excuse me, the gaining stream and -- yeah, and the losing stream and the disconnected stream, Figures 1 through 3. Where along the Rio Grande in the Rincon and Mesilla do the conditions for gaining stream occur?
A. It varies. These are conceptual diagrams, so the -- in general, the conditions of gaining stream,

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Exhibit G

STATE OF TEXAS	)	
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Plaintiff,	)	
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VS.	)	No. 220141
	)	(Original 141)
STATE OF NEW MEXICO,	)	
and STATE OF COLORADO,	)	
	)	
Defendants.	)	

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ORAL DEPOSITION OF
WILLIAM R. HUTCHISON
SEPTEMBER 30, 2019
VOLUME 1

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ORAL DEPOSITION of WILLIAM R. HUTCHISON, produced as a witness at the instance of the Defendant State of New Mexico, and duly sworn, was taken in the above-styled and numbered cause on September 30, 2019, from 9:13 a.m. to 5:11 p.m., before Heather L. Garza, CSR, RPR, in and for the State of Texas, recorded by machine shorthand, at the MOODY GARDENS SPA & CONVENTION CENTER, 7 Hope Boulevard, Galveston, Texas, pursuant to the Federal Rules of Civil Procedure and the provisions stated on the record or attached hereto; that the deposition shall be read and signed.

hypothetical scenarios; is that correct?

A. Well, the hypotheticals I developed and used didn't have anything to do with reservoir operations. It held them static. In other words, operations means what was the inflow, what was the storage change, what was the evaporation, and what was the outflow, and I took the outflow as -- as historic and didn't change it. So, in other words, I didn't -- I didn't make -- none of my hypotheticals required me to consider any operations changes within the reservoir. They were designed specifically not to -- in order to focus the attention on the physical changes associated with groundwater pumping and not complicate the analysis with reservoir operations changes.

Q. So do you think that using Dr. Brandes' reservoir spreadsheet in conjunction with your groundwater model, the results would have been exactly the same?

A. Clearly, they would not. There wouldn't be any changes in the conclusions and wouldn't have added anything in terms of being able to evaluate physical changes in terms of gaining stream, losing stream conditions or anything like that. Clearly if you change the reservoir operations, you change the outflow, that would cause a change, and that was the

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whole idea was to minimize -- to only look at one -- essentially one variable at a time. And in this case, the variable was pumping and not complicate it with adding another factor like reservoir operations.

MS. THOMPSON: So it's a little after 5:00, so we're going to go ahead and stop for the day, and we'll pick up here tomorrow.

(The deposition concluded at 5:11 p.m.)