# SALTON SEA RESTORATION: WHERE IS THE DATA?

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The landowners and farmers near the Salton Sea in Imperial County have a large stake in the success of any Salton Sea restoration plan. In many cases, they have farmed in the area for generations. Whatever occurs with the Salton Sea, the agricultural community near the Sea will be directly affected. For this reason, they asked that I assist in their consideration of restoration alternatives and undertake a critical analysis of the reliability of the data upon which successful restoration planning depends. My preliminary findings are reported below.

Stated succinctly, the critical data is not publicly available for review and thus disputes arise between the consultants of various stakeholders. Pointedly, this renders the analysis of future flows of water to the Sea as tenuous at best, as evidenced by the uncertainty analysis in DWR's January 2006 Draft Hydrology Report. Recent studies discussing private analysis of the data sources upon which restoration efforts are likely to be based indicate that the data is inconsistent and incomplete. The manner in which assumptions replace reliable data in the estimation of flows to the Sea is hidden from public scrutiny. Upon such an opaque data foundation, neither the public nor the decision makers can reliably analyze the Salton Sea restoration options under consideration.

## IID Flow Measurement and Database Recording: Accuracy and Reliability

For the public to make informed decisions about the restoration of the Salton Sea, a transparent analysis of the alternatives is needed. The success of any restoration design critically depends on the prediction of future water flows. Any analysis of future flows must begin with a well-founded understanding and modeling of current flows. The water balance method, which tracks all inflows and outflows through any region, is the logical basis to physically model water flows. Accurate measurement and recording of flows form the foundation of the water balance method; water balance model results cannot be reliable without reliable water flow input data.

Careful reading of recent reports by IID, DWR, U.S. Bureau of Reclamation, and consultants hired by each agency highlight the gaps in understanding of current flows and the need for improvement in measurement and database management. This draft report examines three interrelated issues: 1) the accuracy of regularly measured flows, 2) the uncertainty in estimation of unmeasured flows, and 3) the reliability of flow information recording into IID's database.

The opaque development and documentation of the data inputs used to calibrate the Imperial Irrigation Decision Support System (IIDSS), the model used to estimate changes in all flows through the Imperial Valley, do not satisfy the criteria for public transparency (Summary Report IIDSS, December 2001). Stating that "Data gaps were identified and assumptions were made to fill them (p. 2-7)" without further explanation is insufficient. Stating that "This

partitioning of on-farm water into consumptive use and tailwater and tilewater return flow components is a complex process within the on-farm system (p. 2-3)" without further explanation is insufficient. Stating "Because only limited flow measurements in the drainage system were available, professional judgment was used to determine the fractions of water deliveries that returned to the drainage system (p. 2-8)" without further explanation is insufficient.

As water becomes more scarce during shortage situations necessitating an allocation program and as substantial investments are considered for both conservation programs and Salton Sea restoration programs, accurate measurement of flows through the water delivery and drainage system become crucial for effective design, implementation, and management of these programs. Moreover, the fairness, economic efficiency, accuracy of water accounting, and transparency of a water allocation program are all enhanced when all significant deliveries are reliably measured and recorded.

**The Need for Accurate Measurement of Water Flows in the Imperial Irrigation District**

IID historical documents are replete with comments about the inaccuracies of gate measurements, the method still in use[1]. M. J. Dowd, a consulting engineer with the district for 43 years, in his testimony in Arizona v. California in 1957 states "…if we had the actual quantity we measure to farmers, it might be somewhat more than 10 percent [inaccurate]. The formula adopted to estimate flows "…was known at the time, has been known ever since, and is known now, that it is not accurate." The margin of error is "at least [10 percent]…and for many years the records of the district that were published carry the statement that it is known…"

The State Water Resources Control Board in its "Water Rights Decision 1600" from 1984 further describes the problem of inaccurate and missing measurements for effective water management within IID:

> The four main sources of water loss within IID which were identified at the hearing are: tailwater, canal spills, canal seepage, and leachwater. The total quantity of loss attributable to all four sources can be determined fairly accurately by subtracting the flow in the New River and Alamo River as they enter IID from the flow in those rivers as they enter the Salton Sea….Although there is general agreement on the quantity of total water losses within IID, there is considerable variation in the estimates of losses attributable to each of the four main sources described. The difficulty in determining the quantity of loss from each source is due to lack of measurements of canal spill and tailwater and problems in accurately estimating losses due to canal seepage and leachwater. (SWRCB 1984, p. 29-30)

The State Water Resources Control Board concludes:

[1] For a description of the constant-head orifice turnout measurement system and a discussion of accuracy, including the importance of maintaining constant head throughout the delivery period, see *Water Measurement Manual: A guide to effective water measurement practices for better water measurement*, U. S. Department of the Interior, Bureau of Reclamation, 1997.

> The lack of reliable information on the sources of water loss within IID, however, impedes the development of a comprehensive water conservation plan. In the view of the maximum beneficial use requirement of Article X, Section 2 of the California Constitution, the Board concludes that the right to make use of a large quantity of water carries with it the responsibility to account for its use accurately. Therefore, the IID should develop reliable procedures for determining the disposition of all water imported by the District with an emphasis on (1) an accurate accounting of farm deliveries, (2) measurements of canal spills, (3) measurement of tailwater, and (4) either measurement or computation of leachwater and canal seepage. (SWRCB 1984, p. 37)

IID's recalcitrance to adopt these recommendations is evidenced by the fact that, more than two decades later, these same measurement issues are hampering current planning efforts for the restoration of the Salton Sea, under the auspices of DWR, because again there is a lack of reliable data on water flows through the IID service area and onto the sea.

The December 2001 IIDSS Summary Report prepared by CH2MHill used in support of the January 2002 Water Conservation (QSA) Draft EIR states:

> Available on-farm data consisted of time series of crop acreage, crop type, and irrigation method; soil type; and name of delivery turnout. To simulate on-farm processes, more data than were readily available were required. Reviewing literature and performing a series of analyses were used to develop crop evapotranspiration, tailwater, tilewater, and irrigation performance data (p. 2-7).
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> Because only limited flow measurements in the drainage system were available, professional judgment was used to determine the fractions of water deliveries that returned to the drainage system (p. 2-8).

Five years later, the same consulting firm CH2MHill produces the Draft Hydrology Report (January 2006) for DWR in which their prior best estimate for tailwater as a percentage of inflows originating in IID from their 2001 and later 2002 studies (referenced in the current DWR study) is now the lower bound in the new study. According to the January 2006, Draft Hydrology Report: "Tailwater from the total IID water service area has been estimated between 15 percent and 27 percent of total on-farm water delivery (IID 2002, Reclamation 2003) and represents between 39 percent and 68 percent of Imperial Valley's contribution to Salton Sea inflow (p. 43)." The report concludes that any value in this near doubling range is equally likely. Planning investments of the magnitude contemplated for Salton Sea restoration based on this level of uncertainty when it could be resolved through systematic measurement is nearly unconscionable.

Numerous attempts to quantify the flows through the water delivery and drainage system using water balance methods have been published over the years and reviewed during the recent Part 417 process and in connection with Salton Sea restoration. The disparate estimates of component flows arise due to a lack of *direct measurement.* Different researchers chose to estimate a different set of flow components and then estimate the final component as a "closure term" (i.e. the remaining quantity necessary to balance Salton Sea inflows with evaporation—the only significant outflow from the sea—and changes in sea

storage derived from sea water levels). In essence this method folds any estimation errors for all the other flow components into the closure term.

The first recommendation by the U.S. Bureau of Reclamation included with its 2003 Part 417 Determination reaches a similar conclusion:

> **Recommendation 1. Water Measurement**. Reliable water measurement records are essential to the decisions that result in water conservation. Reclamation recommends that IID develop, maintain and use a district-wide network of water measurement devices for the consistent monitoring, recording and reporting of system and on-farm water use data. Measurements within the IID should include: 1) canal and lateral spills, 2) actual deliveries to farmers' head gates, 3) tailwater runoff, 4) drain flows, including discharges from drains, and 5) leach water and other components of water diverted from the Colorado River for use in IID.

Finally, independent consultants recently hired by IID also recommend more accurate measurement of water deliveries to farmers (August 2006 Draft Final Report of the Equitable Distribution Study):

> The District should improve its capacity for measuring deliveries at the gate and the field. If apportionment is introduced, it is likely that water users will require a higher degree of accuracy than the present measurement system provides. This may eventually entail an automated, remote measurement of delivery (p. 8).

**Database Reliability**

Recent analysis performed as part of IID's Equitable Distribution Study raises serious questions about the accuracy and reliability of recording data in IID's database that, without further clarification, calls into question the reliability and accuracy of employing a model calibrated with this data for Salton Sea restoration design analysis.

The January 2002 Water Conservation (QSA) Draft EIR states:

> The establishment of the Baseline hydrology for IID was founded on 12 years of available irrigation delivery data, provided in monthly increments. This information, collected from 1987 through 1998, was available in sufficient detail to include delivery data at the farm gate level (p. 3.1-94).

Appendix E of the same document providing a summary report of the IIDSS states:

> Historical flow data were retrieved from IID's database through a series of queries. These data represented the measured amounts of water that were delivered to each of the 5,287 turnouts during the 12-year span from 1987 to 1998. This 12-year period from 1987 through 1998 was selected for model development, calibration, validation, and verification since this was the only period of full monthly water deliveries and cropping information available in electronic form. **Data gaps were identified and assumptions were made to fill them** [emphasis added] (p. 2-7).

No further explanation as to the extent and how the data gaps were filled is provided.

The documentation stresses that there was a peer review of the model, however, since the peer review is not included and is not publicly available, it is unclear whether the reviewers were able to examine the primary data and examine the inconsistencies and gaps in the data.

The recent August 2006 Draft Final Report of the Equitable Distribution Study sheds some light on the reliability and consistency of recorded data. Independent consultants hired by IID to analyze allocation methods during shortage situations conclude:

> Regarding an apportionment based on individual field history, after a careful analysis of the District's data, we came to the conclusion that the District does not have a sufficiently consistent and complete record of these individual field deliveries and, therefore, it would not be practical for the District to apportion water based on the average historical delivery to each individual field.
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> The reason for this conclusion is as follows. There are almost 7,000 fields which have received at least one delivery of water between 1987 and 2005, and therefore have some sort of claim to receive water. About 5,000 of these fields received one delivery of water in every year over the period. The other 2,000 fields do not have a consistent long-run history of deliveries. Of the 5,000 fields with a long-run history of deliveries, we estimate that about 20-30% may have histories that are incomplete or questionable.3 In total, there are as many as 3,000 or more fields with histories that are problematic for apportionment based on individual field history (p. 3-4).

They further explain the "apparent" source of these inconsistencies:

> Having explored the data on field deliveries, we have come to the conclusion that a short-term apportionment based on the average historical use of each field is not a practical proposition because of gaps and incompleteness in the data. These arise in two ways: (1) There is not a complete history for every field in the District that received water. (2) There are sometimes errors in how the data were recorded which make the individual histories too unreliable for a statistical determination of history. As noted above, the basic unit for the delivery of water in IID is the gate. The lands served by a gate are divided into fields, and this division varies. Sometimes a single gate serves a single field; sometimes a single gate serves more than one field; and sometimes, this changes over time as the fields served by a gate are re-organized. Moreover, not all gates have had deliveries broken down among the individual fields. Thus, there is not presently a complete set of delivery histories for every individual field in the District. Additionally, the individual histories that do exist are sometimes incorrect. Errors appear to have arisen because deliveries to one gate have sometimes been recorded under another gate. This happens when the same account receives water from several adjacent gates. In these cases, for the mutual convenience of the zanjero and the water user (who pays the same amount of money regardless of the gates to which his water delivery is assigned), deliveries are not always recorded for each gate separately but, instead, on some occasions deliveries for several adjacent gates are recorded under a single gate. This would generate an implausibly high delivery per field at one gate combined with an implausibly low delivery per field at the other gates.
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> There is anecdotal evidence that this occurs and, in addition, there are anomalies in the computerized delivery data which seem consistent with this. For example, 192

> fields in the IID delivery database are recorded as having an average annual delivery history of less than 1 AF per acre over the period 1987 – 2005, which seems implausibly low. In addition, 150 fields in the IID delivery database are recorded as having an average annual delivery history greater than 12 AF per acre – ranging as high as 4,775 AF per acre in one case.

While it may be possible that all the inconsistencies in IID's recording of water delivery data "average out" to the correct answer above the gate level, there is no definitive way of knowing. In a footnote, the studies authors state:

> The delivery data are used primarily for accounting and billing purposes. There appear to be errors whereby deliveries to one field in an account are recorded as deliveries to another field in the same account: while accurate at the account level, the data are not necessarily accurate at the field level.

Anecdotal evidence and appearances are the only evidence they offer for what must otherwise be labeled a conjecture. Beyond anecdotal evidence and apparent plausibility, the only method to verify the accuracy at the account level with all the inconsistencies at lower levels would be to match up each field in an account with its crop, irrigation technology, and soil type to judge whether reported water use in the account was reasonable for all the fields covered by the account. This approach is destined to fail for two reasons as expressed by the authors of the study. First,

> In fact [with the data for field histories that is complete], we find that over 70% of the variation in field-level [water] use in the District cannot be explained by the soil, the crop grown, the method of irrigation, or the weather; rather, it appears due to individual variation in farming practices (p. 22).

And second,

> If it so chose, the District could invest resources in an effort to clarify and resolve the anomalies in the field delivery history data for these fields. However, we do not believe this would be a wise or successful investment. It would be immensely expensive, probably requiring many thousands of hours of staff time. And, in some fraction of cases, it would prove fruitless because, with the passage of time and the turnover in users working the field, it would simply be impossible to resolve all of the anomalies in the historical delivery data.

What the Equitable Distribution Study authors make abundantly clear is that water deliveries are not recorded as the system was designed at either the field or the gate level. Furthermore, the authors directly contradict the above reproduced claim of accuracy at the gate level in the January 2002 Water Conservation (QSA) Draft EIR.

The result of all of these factors is a data set of, unfortunately, questionable quality. The calibration of the IIDSS model critically depends on accuracy in measurement and recording of water deliveries.