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Attached is my submission "Proposal to Abolish or Limit Water Data Confidentiality to 1-5 Years: Improving Water Resource Management and Increasing Net Water Benefits in the State of California" to the SWRCB for the Public Workshop Regarding Immediate Drought Response Options.

I am presently chair of the Department of Economics at the State University of New York at Fredonia. I have a Ph. D. in Agricultural and Resource Economics and a B.A. in Physics and Applied Mathematics from the University of California at Berkeley. I have researched and published on California water issues for 20 years starting with a 1995 publication "Alternatives for Managing Drought: A Comparative Cost Analysis" examining potential EBMUD demand and supply side responses after the last major drought in California. I have also published hydrologic-economic models on seawater intrusion into groundwater aquifers originally applied to the Salinas Valley. In 2012, I was the lead guest editor for a special issue of Hydrogeology Journal, the official journal of the International Association of Hydrogeologists, on the Economics of Groundwater Management, as well as co-authoring an overview paper on "Factors Determining the Economic Value of Groundwater".

I have also consulted on many water issues for the Law Offices of Patrick J. Maloney over the last 17 years including historical benefits of district operations, seawater intrusion, and district and project cost allocation and environmental impacts in the Salinas Valley, nitrate loading of groundwater in the Central Coast Region and water rights, beneficial use, conservation methods, Part 417 determination, Quantification Settlement Agreement and Salton Sea restoration in the Imperial Valley. My consulting economic analysis has always been aimed at optimal management of water resources through maximizing the net economic benefits of the state's scarce water resources. A common barrier to the analysis of optimal management in all locations has been local water agencies' claims of data confidentiality that prevent the release of data necessary for comprehensive review and independent development of hydrologic-economic models. The proposal submitted herewith presents a conceptual economic framework for a comprehensive review of the economics of water data confidentiality with the goal, in furtherance of both public and private interests, of improving water resource management and increasing net water benefits in the State of California.

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Proposal to Abolish or Limit Water Data Confidentiality to 1-5 Years: Improving Water Resource Management and Increasing Net Water Benefits in the State of California

With water supplies constrained by prolonged drought and future climate change and with continuing population growth raising water demands, California faces a future of increasing water scarcity and attendant impacts on water quality. As water becomes more economically scarce, improvements in resource management will require greater integration of surface and groundwater supply quantity and quality, more extensive and accurate measurement of relevant water parameters, and storage of this critical information in comprehensive databases available to state planners, affiliated and independent researchers, and the public.

A recent report for the State Water Resource Control Board "Addressing Nitrate in California's Drinking Water" recognizes many of these issues and proposes a statewide groundwater data task force to solve them. The report concludes that "It is now critical that the state has a coherent and more forward-looking policy and technical capability for the collection and management of groundwater data"[1] based on the following assessment:

> Inconsistency and inaccessibility of data from multiple sources prevent effective and continuous assessment. A statewide effort is needed to integrate diverse water-related data collection activities by various state and local agencies. Throughout this study, we often faced insurmountable difficulties in gaining access to data already collected on groundwater and groundwater contamination by numerous local, state, and federal agencies. Inconsistencies in record keeping, labeling, and naming of well records make it difficult to combine information on the same well that exist in different databases or that were collected by different agencies. A statewide effort is needed to integrate diverse water-related data collection activities of various state and local agencies with a wide range of jurisdictions. Comprehensive integration, facilitation of data entry, and creation of clear protocols for providing confidentiality as needed are key characteristics of such an integrated database structure. (p. 74)

Extreme scarcity demands that the unexamined assumption of "confidentiality as needed" (regularly cited to grant an indefinite time period for water data confidentiality for some water users but not others) be thoroughly analyzed in light of the pressure on current water institutions and how they are likely to evolve. The benefits to society from accessible data, granting the ability to review water resource modeling and policy decisions, has routinely been dismissed or ignored at the local resource agency level. The State, with the development of the Electronic Water Rights Information Management System (eWRIMS), has created a foundation for water data reporting and public access, but the scope of information is inconsistent. Monthly surface water diversions and use are publicly available on eWRIMS for individual diverters reporting under Section 5101 of the Water Code, but the same information is not publicly available for other individual users that receive their water from a water purveyor. While water purveyors also report diversions under Section 5101, they are only required to report monthly aggregated farm-

[1] Harter, Thomas and Jay R. Lund et al. of Center for Watershed Sciences, "Addressing Nitrate in California's Drinking Water, With a Focus on Tulare Lake Basin and Salinas Valley Groundwater: Report for the State Water Resources Control Board Report to the Legislature, California Nitrate Project, Implementation of Senate Bill X2 1", January 2012.

gate delivery data under Section 531.10, rather than delivery data for each farm gate. Groundwater extractors in Los Angeles, Riverside, San Bernardino and Ventura Counties must report their groundwater extraction either with local water agencies or with the State. State-filed groundwater recordation appears on eWRIMS. Furthermore, many individual well extractors who cannot physically or legally distinguish between "percolating groundwater" and "underflow" also report quantities pumped that are accessible on eWRIMS.[2] The time has come for a comprehensive state-level review of water data confidentiality policies for all water end-users and water sources that considers the interests of all citizens.

Are there any business gains to protecting 20-year-old data? Does society benefit at all by protecting 20-year-old data? What is the public benefit of making water data available? Are there business losses associated with releasing this claimed "proprietary information"? Is water data confidentiality socially beneficial or should it be abolished? If not abolished, should it be conferred for a limited time frame?

Before continued acceptance of indefinite water data confidentiality, the potential societal tradeoffs from limiting confidentiality must be examined based on the physical and societal relationships embodied in individual water rights and how readily accessible data may produce societal gains through better public analysis, monitoring and transparency of the water institutions charged with managing extractive and non-extractive uses, thus leading to better performance, accountability, credibility and confidence in the integrity of laws governing water use. This proposal examines these issues with reference to existing emissions reporting requirements and the economic theory of patents. Specific water data that serve the public interest is identified for disclosure either contemporaneously or after a fixed time delay. Recommended water data disclosure is limited to that which is necessary for the public purpose and structured to allow other data to remain proprietary to mitigate private costs. Finally, adjustments in the method of gaining accessibility for some data are considered in light of water system security concerns.

Existing Environmental Reporting and Public Access to Data

Requirements to disclose data on some aspects of business operations that impacts public health and commerce and grant public access are not new. EPA has long required reporting of emissions and public access to data that affects public health, commerce, and the environment. "Most U.S. environmental laws require that self-reported data be made available to the public."[3] The SO_x and NO_x allowance trading programs collect hourly data.

> The accurate measurement and reporting of emissions is essential, along with the rigorous and consistent enforcement of penalties for fraud and noncompliance. Also critical is transparency,

[2] See discussion on interlinkages between surface water and groundwater in "Physical and Legal Relationship between Water Diversion/Extraction and Public Interest" section below, and footnote 9 references from that section for the nonexistence of an absolute technical or legal line that divides surface water flows from groundwater flows.

[3] International Network for Environmental Compliance and Enforcement, "Principles of Environmental Compliance and Enforcement Handbook", April 2009.

> such as public access to source-level emissions and allowance data. The coupling of stringent monitoring and reporting requirements and the power of the Internet makes it possible for EPA to provide access to complete, unrestricted data on trading, emissions, and compliance. This promotes public confidence in the environmental integrity of the program and business confidence in the financial integrity of the allowance market. It also provides an additional level of scrutiny to verify enforcement and encourage compliance. Finally, accountability requires ongoing evaluation of the cap and trade program to ensure that it is making progress toward achievement of its environmental goal.[4]

EPA's 1995 policy "Incentives for Self-Policing: Discovery, Disclosure, Correction and Prevention of Violations" further creates incentives for regulated firms to self report violations of hazardous waste limits.

Patents

In the simplest form of the economic theory of patents, the government confers a exclusive property right on an inventor for a limited period of time to encourage investment in innovation in cases where the innovation could be easily appropriated/duplicated and the innovator could not recoup the investment costs that lead to the innovation. Patents require that the applicant publicly disclose the innovation for future public use and limits the time frame of the monopoly property right with the purpose of offsetting societal loss from monopoly with societal gains from innovation, thereby increasing *societal* benefits over the course of time. While the patent right assigns greater gains to the inventor, its purpose is to increase innovation for society and societal well-being more generally.

Patents can have other effects besides inducing innovation. For example, patents can also be used as litigative barriers-to-entry and for rent seeking. Patents can impede follow-on innovation until expiration, but increase future innovation after the patent expires through information disclosure. Furthermore, if the investment leading to an innovation is small or the discovery would likely soon be independently duplicated without the inducement of a monopoly property right, then patent research demonstrates that long-lived patents are detrimental to societal well being. In those cases, granting a monopoly right to an inventor for a long period of time produces excessive private gains at a cost to society. Some recent research on the gains from patents suggests the optimal time limit may be quite small in many circumstances.[5]

Proprietary Information, Water Data Confidentiality and the Public Interest

Protection of trade secrets is an alternative method of promoting investment in innovation. Government does not force disclosure of proprietary information to force diffusion of the innovation and reduction of economics rents for the benefit society. However, acceptance of the assumption of indefinite water data confidentiality ignores the potential societal tradeoffs beyond that between the value of innovation and economic rents.

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[4] EPA, "Cap and Trade Essentials", http://www.epa.gov/captrade/documents/ctessentials.pdf.

[5] See for example, Boldrin, Michele and David K. Levine, "The Case Against Patents", Journal of Economic Perspectives, 2013, and a critique by Gilbert, Richard "A World without Intellectual Property? A Review of Michele Boldrin and David Levine's Against Intellectual Monopoly", Journal of Econmic Literature, 2011.

Since agriculture is the largest sectoral water user in California, we discuss the societal tradeoffs in a farming context; however, the conceptual framework can be applied to other sectors. To examine those tradeoffs, we first analyze the physical and legal relationship between water diversion/extraction and the public interest, and then discuss the public values of dispensing with or limiting water data confidentiality in favor of public access. From this discussion we identify two potential subsets of individual farming unit water data whose release would foster the identified public benefits and thus improve water resource management. Finally, we discuss the potential impact on farming profits of releasing this data and how security of water system concerns might alter the proposal.

Physical and Legal Relationship between Water Diversion/Extraction and Public Interest

Both the physical properties of water flows and legal conventions governing its use only exist in relationship between the extractive user and other extractive users, which constitute the public at large, as well as in relationship to societal benefits from non-extractive uses and the public trust.

Groundwater extraction impacts both groundwater levels and stocks available for other extractors. Percolation beyond the root zone of water containing unused fertilizer and pesticide residues eventually impacts water quality of other extractors. The right to extract groundwater is a correlative right between landowners overlying an aquifer, a right always in relation to other landowners. In situ groundwater values include buffering periodic shortages of surface water supplies, subsidence avoidance, water-quality protection and prevention of seawater intrusion.[6] Natural groundwater discharge can also support natural environments and recreation.

Surface water diversions and return flows physically and legally impact junior right holders and the environment. While usufructuary water rights establish the right to use, they also establish a relationship to public ownership of water. Beneficial use is the foundation of western appropriative water rights: "beneficial use shall be the basis, the measure, and the limit of the right" echo many western state constitutions and water statutes.[7] As operatively defined in United States v. Alpine Land & Reservoir[8] beneficial use is a relational concept:

> There are two qualifications to what might be termed the general rule that water is beneficially used (in an accepted type of use such as irrigation) when it is usefully employed by the appropriator. First, the use cannot include any element of 'waste' which, among other things, precludes unreasonable transmission loss and use of cost-ineffective methods. Second, and often overlapping, the use cannot be 'unreasonable' considering alternative uses of the water.

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[6] Qureshi, M., Andrew Reeson, Peter Reinelt, Nicholas Brosovic, Stuart Whitten, "Factors determining the economic value of groundwater", Economics of Groundwater Management issue of *Hydrogeology Journal*, International Association of Hydrogeologists, 2012.

[7] Weil, Samuel C., *Water Rights in the Western States*, 1911.

[8] United States v. Alpine Land & Reservoir Co., 697 F.2d. 851, 854 (9th Cir. 1983) (discussing the beneficial use requirement of Section 8 of the Reclamation Act of 1902), cert. denied, 464 U.S. 863 (1983).

Waste and alternative uses are relative to other extractive users and with respect to non-extractive environmental, recreational and navigational in-situ uses.

Furthermore, understanding groundwater surface-water interactions is critical for evaluating interlinkages between alternative extractive and non-extractive uses, as groundwater extraction can reduce surface flow and surface water extraction can reduce groundwater flows.[9]

The Public Interest for Publicly Accessible Water Data

Publicly accessible water data creates the following public benefits that apply to the management and administration of water rights, conservation agreements, water trades, pollutant loading and water quality.

1) Allows independent public review of water resource models to better manage existing resources (data available only to restricted club creates opportunities for mismanagement).
2) Accountability for water right holders, local water agencies and consultants.
3) Reporting data and making it publicly accessible encourages compliance with existing laws and regulations.
4) Public verification of compliance with water rights, pollutant loading, and water conservation achievements tied to water exchanges/trades.
5) Public vigilance of public trust elements of water rights including environmental uses.
6) Public confidence in the integrity of laws governing water use.
7) Transparency (discourages political rent seeking, discourages protecting administrative turf/principal-agent problem, and discourages inequitable favorable treatment by local water agencies)
8) Reduction in delay time of regulatory solutions (and the water supply and public health consequences of those delays) caused by those who use water data confidentiality as a barrier to development and implementation of socially beneficial regulation.
9) Reinforces mutual credibility between agricultural sector and M & I sector water users, strengthening mutual acceptance of voluntary or mandatory drought reductions.
10) More civic and democratic participation.

Examples from recent years illustrate some of these issues.

The Salinas Valley Integrated Ground and Surface Water Model (SVIGSM) has been used to model historical benefits of reservoir operations, analyze proposals to halt seawater intrusion, and apportion cost for water projects and district operations. The

[9] Moreover, there is no absolute technical or legal line that divides surface water flows from groundwater flows. For example, see section on "Myth: Groundwater is Separate from Surface Water" in Hanak, Ellen, Jay Lund et al., "Myths of California Water – Implications and Reality", *West Northwest*, 2010; and Sax, Joseph L., "Review of the Laws Establishing the SWRCB's Permitting Authority over Appropriations of Groundwater Classified as Subterranean Streams and The SWRCB's Implementation of those Laws", 2002.

Monterey County Water Resource Agency collects monthly groundwater pumping data from well operators and maintains the data in the Groundwater Extraction Management System (GEMS) database. Detailed pumping data from the GEMS database was used to calibrate pumping simulated by the consumptive use methodology for truck crops and vineyards and also verify and adjust irrigation efficiencies, and could be used to model higher resolution of spatial variations in pumping. "The accuracy of the SVIGSM depends on the accuracy of calibration and host data and parameters used in the model. These include… Estimates of ground water pumping and distribution…" as well as eight other factors.[10] No analysis of the accuracy of the factor data was performed, and thus no propagation of error calculation to final results. However, by inspection of the model residuals, a "valley-wide level of accuracy of ±5 feet" is claimed for the SVIGSM. The National Resource Council recommends a full error analysis of ground water models as standard practice.[11] Independent confirmation of this extensively used model and its accuracy are impossible without the data used in its construction and calibration. As extended drought limits surface deliveries to the Castroville Seawater Intrusion Project for blending with lower quality reclaimed water, accurate prediction with the SVIGSM of the extent that replacement pumping in the deep aquifer will induce seawater intrusion into the last unintruded coastal aquifer is critical.

Measurement and data availability from Imperial Irrigation District including conservation and flows to the Salton Sea provides another relevant example. Investments of the magnitude considered for Salton Sea restoration require 1) a transparent process in which the public and decision makers can reliably analyze alternatives, 2) cost-effective reduction of inflow uncertainties since design success critically depends on future water flows, 3) a robust design that has flexibility to be adjustable over the remaining range of possible future inflows.

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. 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 commendable 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.

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.[12] Stating that "Data gaps were identified and assumptions were made to

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[10] MCWRA, Draft Technical Memorandum Update of the SVIGSM, p. 27, October 1999.
[11] National Research Council, *Ground Water Models, Scientific and Regulatory Applications*, National Academy Press, Washington, D.C., 1990.
[12] IID, Summary Report IIDSS, December 2001.

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.

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*. Planning investments of the magnitude contemplated for Salton Sea restoration based on this level of uncertainty when much could be resolved through systematic measurement is nearly unconscionable.

As water becomes more scarce during shortage situations necessitating an allocation program and substantial investments in conservation 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 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.
>
> 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.

In October 2013, the IID board revised its shortage apportionment plan from 100% straight-line only to 50% historical use and 50% straight-line.

Proposed Measurement and Water Data Disclosure to Serve the Public Interest

The water data proposed for release to achieve the public benefits enumerated is limited to that which would allow for observation of water policy, rights and management outcomes on water sources and environmental flows. Water quantity and quality interactions of any water user with both other users and non-extractive uses, and thus the public beyond the unit, satisfies this criterion. Therefore, the proposed data requirement is the location, timing, quantity and quality of any diversion/extraction and location, timing, quantity and quality of return flows, whether surface runoff (tailwater) or deep percolation (also accounting for drain interception of percolation). Any other information about the practices on the farm would be unnecessary for the purposes of observing water quantity and quality resource management outcomes. Water diversion/extraction occurs at the farm gate or well making either the natural location for reporting. However, since multiple gates or wells could serve a field or farming unit, the water database would have to be structured to link appropriate diversion/extraction with return flow.

Since measurement of quantity and quality of return flows may incur substantial cost especially with respect to percolation, the farmer would have the option to report substitute information that could be used to estimate return flow location, timing, quantity and quality. Crop type, crop yield (to estimate ET), applied fertilizer and pesticides by type and quantity, irrigation technology, irrigation and fertilizer management processes, soil type, soil slope, and tailwater quantity measurement combined with available effective rainfall data would be a reasonable substitute for the minimal data requirements relating to return flows identified above. A further option could require reporting, but not disclosure, of this additional information if quantity and quality measurement data on return flows is reported.

These reporting and database requirements are robust for achieving the identified public benefits under the most likely potential future evolutions of water institutions to relieve reallocation pressures: 1) more extensive use of water markets for exchange of conserved water to improve allocative efficiency through shrinking the gap between the marginal value of water in different uses or 2) more extensive administrative or judicial evaluations of waste and alternative beneficial uses and subsequent “transfers” to achieve the same purpose.

Finally, the reason for the inclusion of return flow reporting requirements is two-fold. First, only actual return flow quantities can be diverted for subsequent use or left in-situ for environmental benefits. It is well-known by economists that increasing irrigation efficiency may not save any water, as consumptive use of water may increase even as water application decreases; more accurate timing and location of water in the root zone increases consumptive use and crop yield and reduces return flow.[13] Therefore, conservation programs measured in terms of changes in applied water without accounting for changes in return flow can only overestimate the actual amount of conserved water. Return flow measurements are needed for the determination of actual "wet water" conservation in terms of changes in consumptive use. Second, return flow quantity and quality are needed to assess water quality management outcomes. Both the quantity of pollutant loading and the dilution effect from increasing water quantity are needed to model later pollutant concentrations from multiple return flows.

Value of Protection of Water Data Confidentiality

How will the disclosure of previously confidential water data affect business? Since agriculture is the largest sectoral water user in California, we discuss the issues in a farming context. However, the framework of the analysis can be applied to other sectors.

The value of proprietary information to the holder and the ability to control the information depends on 1) any profit differential between those with the information and those without, 2) how widely the information is known by competitors, employees and suppliers, 3) the cost or ease to acquire or develop the proprietary information, and 4) the value of the proprietary information to competitors.

The two possible proposed data disclosure methods allow for less disclosure if an owner is willing to pay for quantity and quality measurements of return flows. Thus, if the owner attributes a large profit differential to proprietary information, return flow measurements will be more affordable and more information can remain confidential. For lower perceived value proprietary information, more information would be disclosed as a substitute for return flow measurements, but some information would remain proprietary: labor and equipment costs for field preparation, planting, and harvest.

These options allow for choice in disclosure relative to the value of the propriety information, and only that data necessary to achieve the identified public benefits through observation of water quantity and quality resource management outcomes are ever publicly disclosed.

On the other hand, disclosure and public scrutiny may encourage better utilization of applied water and improved economic performance for some farms. From Technical Report 2, Nitrogen Sources and Loading to Groundwater of recent SWRCB Nitrate Study (see footnote 1):

> The role human decisions play in irrigation system performance and water management should not be overlooked. In SV and TLB, growers and their irrigators decide when, where, and how much water to apply. The operator manages soil water and, by extension, deep percolation. While

[13] Caswell, Margriet, and David Zilberman , "The effects of well depth and land quality on the choice of irrigation technology", *American Journal of Agricultural Economics*, 1986; Ward, Frank and Manuel Pulido-Velazquez, "Water conservation in irrigation can increase water use", Proceedings of the National Academy of Sciences, 2008; and Huffaker, Ray, "Conservation potential of agricultural water conservation subsidies," *Water Resources Research* , 2008.

> pressurized irrigation systems, sprinklers and microirrigation, can precisely control water flow and thus have a greater technical potential for field uniformity and delivery efficiency, using a high-efficiency technology (e.g., drip) will only increase irrigation performance if managed properly. It is the management of those systems that results in optimal or non-optimal performance. Likewise, performance of surface irrigation systems are significantly influenced by operators and can achieve reasonable efficiency levels, though their absolute technical potential is far less than pressurized systems. As a point of reference, Hanson (1995) reported that efficiencies among irrigation types were similar in practice across nearly 1000 irrigation systems monitored in California. Drip and microsprinkler systems did not show appreciably higher performance (*ibid*.). Observed irrigation efficiencies ranged between 70 and 85% for both microirrigation and furrow irrigation. It is worth noting that actual efficiencies may be below or above this range, and that changes in management practice may have improved to capture the technical advantage of pressurized systems in the 16 years since this study was published. At least one study suggests that variance in efficiency may not have increased despite the recent use of more sophisticated equipment. When irrigation performance was measured on nine drip irrigated celery fields in the Salinas Valley, performance was low. Water application rates ranged between 85% and 414% of ET, indicating under- and over-irrigation were common despite advanced capabilities (Breschini & Hartz 2002). Celery may not be representative of other cropping systems less sensitive to water stress; however, the results illustrate the potential for current irrigation system mismanagement even with advanced technology. Though the ability to apply the desired amount of water with each application is limited by the configuration of the irrigation system and hence uniformity and efficiency are somewhat predetermined, there are many practices growers can use to optimize water delivery systems (Dzurella et al. 2012).

Therefore, while recommended data disclosure is limited for the identified public purpose and structured to allow other data to remain proprietary to mitigate private costs, public scrutiny may also encourage better water management and economic gains for other currently water inefficient farmers who do not possess that proprietary information, independent of any valuable proprietary information disclosure.

Water System Security

Concerns about potential for sabotage of water infrastructure systems has long existed but has greatly heightened since the 9/11 terrorist attacks.

> Broadly speaking, water infrastructure systems include surface and ground water sources of untreated water for municipal, industrial, agricultural, and household needs; dams, reservoirs, aqueducts, and pipes that contain and transport raw water; treatment facilities that remove contaminants from raw water; finished water reservoirs; systems that distribute water to users; and wastewater collection and treatment facilities.[14]

For drinking water systems, most experts identified the distribution system as the single most important vulnerability and more experts identified it as among the top vulnerabilities than any other vulnerability.

> The explanations they offered most often related to the accessibility of distribution systems at numerous points. One expert, for example, cited the difficulty in preventing the introduction of a contaminant into the distribution system from inside a building "regardless of how much time, money, or effort we spend protecting public facilities." Experts also noted that since the water in the distribution system has already been treated and is in the final stages of being transferred to the

[14] Copeland, Claudia, "Terrorism and Security Issues Facing the Water Infrastructure Sector", Congressional Research Service, December 5, 2010.

> consumer, the distribution of a chemical, biological, or radiological agent in such a manner would be virtually undetectable until it has affected consumers.[15]

As compared to the distribution system, very few experts identify the source water supply as the single most important vulnerability but they do identify it as a top vulnerability but at a lower rate than the distribution system because:

> (1) that source water typically involves a large volume of water, which in many cases could dilute the potency of contaminants; (2) the length of time (days or even weeks) that it typically takes for source water to reach consumers; and (3) that source water will go through a treatment process in which many contaminants are removed.[16]

A state-level review on water data confidentiality must consider these real water security risks in the context of the public interest in conjunction with other risks to water quantity and quality. The discussion here is limited to potential modifications in data disclosure to reduce these risks, while still achieving the public interest gains of disclosure in water data.

Of the minimal data requirements for the public interest, disclosure of location of diversion/extraction is most often cited as the greatest security risk. Surface water diversion locations are public and known. Groundwater well location information is publicly disclosed in all western states except California. Therefore, precise well location disclosure should be reviewed in the context of these competing public interests.

Precise location is not needed for most of the public interest benefits enumerated above, except for "independent public review of water resource models to better manage existing resources." From the perspective of modeling groundwater, most often accomplished by finite element calculations, well location only needs to be known up to the resolution of the model (finite element size). Thus, extraction and diversion locations could be publicly accessible with less precision, perhaps in broad areas or zones, such as "...to the nearest 40-acre subdivision…" from Section 5103 of the Water Code. Then, an application review board could be established to consider limited use and no public disclosure of more precise location data for legitimate modeling in pursuit of reviewing existing models or in development of independent models for the public interest. This extra layer of the disclosure process would mitigate the terrorist risk from direct public access to a specific subset of reporting requirements without substantially reducing the gains in water management benefits from direct access.

Conclusion

Little or no attempt has been made to balance the public and private interest with respect to water data confidentiality for all water users. With water becoming more economically scarce, the need for greater coordinated management at the state level, coupled with the unresponsiveness of local water agencies to data requests to review existing models and develop independent models, indicates the time has come for a

[15] GAO, "Drinking Water: Experts' Views on How Future Federal Funding Can Best Be Spent to Improve Security", Report to the Committee on Environment and Public Works, U.S. Senate, p. 25, 2003.
[16] GAO report p. 8.

comprehensive state-level review of water data confidentiality policies for all water end-users and water sources that considers the interests of all citizens.

Permanent confidentiality is not in the public interest. Disclosure of water data can improve water resource modeling and management, increase accountability, compliance, transparency, and credibility and reduce delays to solving pressing water quality and quantity problems. The scope of water data disclosure can be limited to that which most serves the public interest, thus mitigating potential profit losses from disclosure of proprietary information. Similarly, online, publicly accessible locational data for groundwater wells could be available only at a coarse spatial resolution in consideration of water security threats, but more precise locational data would be available after demonstrating a legitimate public purpose.

After consideration of the public and private interests, such a state-level review could establish a limited water data confidentiality period of 1-5 years or perhaps abolish confidentiality altogether.

Then a publicly accessible and searchable water information database, based on systematic measurement and recordkeeping of individual unit water use and return flows, would be established in furtherance of the public and private interests in better water resource modeling and management in the State of California.