SUPPLEMENTAL EXPERT REPORT

JOSEPH P. KUBITSCHEK, M.S., P.E.

1. Introduction and Summary of Opinions

I have been identified as an expert by the U.S. Department of Justice to provide testimony in *NRDC v. Rodgers*. I have been asked to supplement my opinions based on review of the NRDC expert reports provided by Dr. Moyle, Dr. Kondolf, Dr. Deas, and Dr. Deverel as they relate to the unknowns, uncertainties, and the scientific process associated with physical conditions and engineering considerations for establishing a reasonable, prudent, and feasible management plan to rehabilitate the San Joaquin River from Friant Dam to the Merced River confluence.

I have the following supplemental opinions:

- San Joaquin River rehabilitation to support both spring and fall run Chinook salmon presents a challenging objective in the context of temperature management. Much of the analysis presented by NRDC focuses almost entirely on spring flows for migration and provides limited consideration of thermal conditions within Millerton Lake affecting release temperatures from Friant Dam. The ability to manage temperature for all life stages has yet to be demonstrated. Managing temperature in late summer and fall will be constrained primarily by meteorological conditions and limited Millerton Lake cold water storage capacity. For San Joaquin River rehabilitation there are two primary temperature management issues: The first involves managing temperature along the entire reach of the San Joaquin River from Friant Dam to the Merced River during critical migration periods and the second involves managing temperature in the near field of Friant Dam for holding, spawning, incubation, and rearing. These issues arise at different times of the year, but how Friant Dam is operated in the spring (*i.e.*, how river releases are made for both flood control and rehabilitation purposes) will have implications for the ability to manage temperature in the late-summer and fall.

- Releases from Friant Dam along with minor passage improvements may be enough to restore salmon, but it has yet to be demonstrated. Without improved demonstration of temperature management opportunities and constraints for all critical seasonal periods it is premature to assume that *restoration* can occur with little effort beyond simply releasing water from Friant Dam and resolving passage impediments. Rehabilitation would indeed benefit from additional studies and development of improved modeling to better understand the San Joaquin River temperature characteristics and determine how best to manage temperature over a wide range of hydrologic and meteorological conditions to maximize whatever potential there is for success. There is a need to develop improved scientific methods that inform decision making and reduce uncertainties. In my opinion the reasonable and prudent approach is to do so before taking any management actions.

- Routing of rehabilitation flows through Mendota Pool presents potentially significant difficulties. Operational issues affecting the ability to maintain flow in the river downstream

of Mendota Dam should be considered along with the import of Delta water and associated mixing dynamics that may negatively impact or at least limit the ability to manage temperature below Mendota Pool during critical seasonal periods. These issues among other considerations (*e.g.*, fish passage, screening, and predation) should be fully addressed prior to establishing the feasibility of flow routing through Mendota Pool.

- It has been suggested by NRDC that sufficient cold water is available within Millerton Lake and upstream reservoirs to manage temperatures in the San Joaquin River below Friant Dam. This, it is claimed, is evidenced by the existence of a successful fish hatchery below Friant Dam. However, the argument only pertains to current operating conditions consisting of small river releases and small hatchery flows (approximately 30 cfs) that do not exhaust the cold water supply within Millerton Lake. NRDC has yet to demonstrate that the cold water volumes in Millerton Lake will not be exhausted by the proposed NRDC *restoration* flow schedule. Depleting the cold water volume in Millerton Lake is a potentially significant constraint on the feasibility of managing San Joaquin River temperature in late-summer and fall.

- The notion that fish passage barriers along the San Joaquin River can be easily overcome is over-simplified. In Reclamation's experience fish passage is not usually a trivial issue. Providing passage (any passage) should not be construed as providing effective or even adequate fish passage. Experience on the Sacramento River and other river systems reveal the often complex challenges in providing effective fish passage to include passage of adequate numbers of target species with minimal or no delay. Hydraulic and operating considerations as well as fish behavior all affect the potential for successful fish passage. In the context of the San Joaquin River and the associated challenges for managing temperature during critical migration periods, the minimal delay requirements are stringent. Furthermore, developing effective fish passage solutions requires consideration of attraction flows and guidance for both upstream and downstream migration, the constraints for which have the potential to make this rehabilitation component challenging and costly. Screening of existing unscreened diversions presents additional difficulties and those difficulties along with maintenance requirements should be considered during the development of a reasonable, prudent, and feasible management plan for rehabilitation of the San Joaquin River.

- The potential impact of releases from Friant on downstream tributaries that support salmon has yet to be demonstrated. This issue should be considered in terms of magnitude, timing, frequency, and duration prior to implementing any management actions, including and perhaps most importantly simply releasing more water from Friant Dam.

- There are two important technical issues associated with surface-groundwater interactions affecting flow determination: 1.) Adequate analysis of accretion and depletion to support minimum flow requirements to maintain a wetted channel from Friant Dam to the Merced River confluence and 2.) The affect of groundwater sources in providing thermal refugia during critical times of the year. Although the existence of thermal refugia is hypothesized, there is as yet no demonstration that groundwater sources of cold water will be reliably available during seasonally-warm periods for a range of hydrologic conditions. The existence of thermal refugia may become an important temperature management opportunity, but until

demonstrated it is speculative, particularly in light of groundwater demands and limited understanding of surface-groundwater interactions.

- Under the proposed NRDC *restoration* approach, little or no specific metrics for determination of *restoration* success have been identified. How progress will be measured and the length of time it will take before which the need for corrective actions are apparent is a significant and complex management issue that should be considered in the development of a reasonable, prudent, and feasible management plan for rehabilitation. Furthermore, it has been suggested by Dr. Moyle and Dr. Kondolf that it may be possible to achieve *restoration with less water* (via non-flow actions or if tested or if further studies were conducted or if fish movement was monitored) than proposed under the NRDC *restoration* flow schedule, yet there is little description of how this could be tested or studied or monitored and more importantly the length of time before which it will be possible to determine. Furthermore, to my knowledge, NRDC's proposed *restoration* hydrographs have not been tested, making the baseline for comparison in that context, arbitrary.

- The adaptive management approach as described by the NRDC experts to enhance successful *restoration* presents practical difficulties and does not entirely address the need for a predictive component that enables directed or corrective actions. In the NRDC approach, it appears to consist of experimentation following the initial *restoration* actions of overcoming passage impediments and releasing water from Friant Dam. The practical difficulty with this approach is one could then potentially be dealing with threatened and endangered species (assuming proposed *restoration* flows are minimally sufficient and fish passage impediments are adequately overcome) that could increase risk and limit flexibility to experiment further. Without a systematic approach to the prediction component of management, there will be limited ability to identify what are the necessary corrective actions. In my opinion, a more prudent approach would be to demonstrate feasibility, address current unknowns, and reduce significant uncertainties to reasonable levels by further developing predictive capability prior to taking management actions. It is acknowledged that some experimentation could be considered in expediting the development of a management plan. However, such experiments should be conducted prior to implementing management actions and should be designed to efficiently produce meaningful results.

2. Data and Other Information Considered by the Witness in Forming Opinions

In forming the opinions set forth and in preparing this supplemental expert report, in addition to the documents considered in my initial expert report, I reviewed the NRDC expert reports by Dr. Moyle, Dr. Kondolf, Dr. Deas, and Dr. Deverel. I also relied on my experience with scientific issues on the San Joaquin River and other river systems as well as discussions with scientists in the fields of aquatic ecology, fisheries biology, hydraulic engineering, river hydraulics, sediment transport, hydrology, and geomorphology.

3. Discussion

The structure of this section includes discussion on the NRDC expert opinions by Dr. Moyle, Dr. Kondolf, Dr. Deas, and Dr. Deverel as they relate to selected physical conditions and engineering considerations for rehabilitation of the San Joaquin River and forms the basis for my supplemental opinions and conclusions.

Temperature Management

It has yet to be fully demonstrated that San Joaquin River temperatures can be effectively managed to support all life stages of spring and fall run Chinook salmon. Much of NRDC's expert analysis focuses on spring temperatures and does not fully consider the limitations of cold water availability within Millerton Lake or the limitations in Friant Dam operational flexibility as they affect release temperature capability from Friant Dam. Furthermore, it has been suggested that the existence of a hatchery below Friant Dam is evidence that sufficient cold water within Millerton Lake is available. However, this is only the case for current operating conditions representing smaller releases from Friant Dam than those proposed by NRDC which do not exhaust the cold water supply. Increasing releases is expected to deplete cold water volumes within Millerton Lake. Although the analysis is limited by calibration for a single year, CE-QUAL-W2 reservoir temperature simulation results to date indicate that release temperatures from Friant Dam increase in late-summer and fall under the proposed NRDC dry and normal-dry *restoration* hydrographs during 2004. These findings suggest that temperature management during those seasonal periods will be constrained under certain hydrologic and operating conditions by release temperatures from Friant Dam. Improved temperature models calibration and additional simulations linking Millerton Lake Reservoir and San Joaquin River temperature models is required to further demonstrate the temperature management opportunities and constraints for San Joaquin River rehabilitation as they relate to a broad range of hydrologic, meteorological, and operating conditions.

The existence and persistence of thermal refugia via groundwater sources has yet to be fully demonstrated. Without improved demonstration of the reliability of this source of thermal refugia it is, in my opinion, speculative to assume it to be a viable temperature management opportunity. Groundwater sources of thermal refugia may indeed represent an opportunity for temperature management, but until the hypothesis is scientifically tested for a range of hydrologic, meteorological, and operational conditions it should not be relied upon to support the argument that thermal conditions during seasonally warm periods will be adequate even if surface water temperatures cannot be managed within required temperature tolerances.

Flow Routing

Routing of flows for rehabilitation purposes is constrained by channel capacities and system operations. The existing channel capacity for Reach 2B (downstream of Chowchilla Bifurcation Structure) is design-limited to 2,500 cfs for flood protection, although the actual capacity was limited to less than 2,000 cfs during 2005 spring flood management releases. Thus, to accommodate the proposed NRDC *restoration* hydrographs the channel capacity in this reach would need to be at least doubled to safely pass 4,000 cfs. Increasing the capacity of Reach 2B represents actions beyond simply releasing more water from Friant Dam and resolving passage impediments.

The extensive gravel pits existing along the San Joaquin River limits the potential for rehabilitation success. Flow routing through gravel pits will likely create predator habitat and temperature management difficulties as well as migration delays. Hydraulically isolating the gravel pits from the main channel may potentially be costly. Further consideration of how best to mitigate the effects of gravel pits is needed and likely represents more than simply releasing water from Friant Dam with minor improvements to passage impediments.

Flow routing through Mendota Pool also presents difficulties from operational and temperature management perspectives that affect the viability of releases from Friant Dam. For example, Mendota Dam is neither owned nor operated by Reclamation, yet physical and operational modifications to Mendota Dam will likely be required to pass proposed *restoration* flows and resolve fish passage and screening issues. Furthermore, the implications for temperature management have yet to be fully explored. The import of water from the Delta-Mendota Canal has the potential to at least limit the ability to manage temperatures downstream of Mendota Dam.

Fish Passage and Screening

Fish passage will also be required at Mendota Dam and fish screening will most likely be required at the diversion points from Mendota Pool. Without adequate passage (both upstream and downstream migration) and screening, rehabilitation will be constrained and it is unknown what the implications are for supporting salmon in good condition. Given Reclamation's experience on the Sacramento River other river systems, inadequate fish passage and unscreened diversions will likely have a significant impact on whatever potential exists for successful rehabilitation. In any case, providing screening at Mendota Pool represents more extensive and costly requirements than simply releasing more water from Friant Dam and resolving passage impediments.

Routing flows through Mendota Pool present guidance and predation difficulties. Although not excessively large, reduced velocities within Mendota Pool will likely create predator habitat and complex flow patterns owing to inflows from the Delta-Mendota Canal and Fresno Slough along with diversions from Mendota Pool will likely produce migration delay. These effects combined with temperature management issues represent a constraint on the potential for successful rehabilitation. The opportunities and constraints should be further explored before establishing flow routing through Mendota Pool as a reasonable, prudent, and feasible alternative.

Surface-Groundwater Interactions

The surface-groundwater interactions along critical reaches of the San Joaquin River need to be further addressed. Determination of accretion and depletion has implications for minimum flow requirements to maintain a wetted channel as well as the potential for managing surface water temperatures and providing thermal refugia during critical seasonally warm periods, all of which factor into flow determinations over a range of hydrologic and meteorological conditions. If depletion rates are under-estimated, then the proposed NRDC *restoration* hydrograph base flow components may not be sufficient to maintain a wetted channel from Friant Dam to the Merced River confluence or maintain habitat quality and availability. Furthermore, depletion will limit

the ability to manage surface water temperatures, an effect that has yet to be fully considered in NRDC's temperature modeling results, as acknowledged by Dr. Deas.

Need for Improved Scientific Methods in the Development of a Management Plan

The existing unknowns and uncertainties associated with the potential for successful rehabilitation of the San Joaquin River have yet to be fully considered such that initiating management actions prior to addressing those unknowns and reducing those uncertainties is not, in my opinion, reasonable or prudent. Given uncertainties with regard to temperature and the unknowns associated with surface-groundwater interactions as well as constraints associated with fish passage, protection, and guidance, the efficacy of simply releasing more water from Friant Dam with minor improvements to fish passage has not been fully demonstrated. There is the need for improved scientific methods in the form of monitoring and modeling to develop a management plan for rehabilitation of the San Joaquin River prior to taking management actions. Reclamation and the scientific community have the capability for addressing many of the present unknowns discussed herein and reducing uncertainties to reasonable levels. In doing so, emphasis should be placed on quantitative estimation of uncertainties. Reporting results without estimating uncertainties can be misleading and limits the ability to gauge the accuracy of those results or the quality of trends they represent. Development of improved modeling methods with some field experimentation (although it is acknowledged that field experimentation will not be without difficulties and cost, owing mainly to the large spatial extent of the San Joaquin River) affords the opportunity to further explore rehabilitation alternatives in improving whatever potential there is for success while minimizing the risks of poor allocation of a limited resource or failure that could otherwise be incurred by first implementing management actions.

4. Conclusions

At this time we do not have enough information to develop a reasonable and prudent management plan for rehabilitation of the San Joaquin River that can be demonstrated as feasible from a technical perspective. The NRDC expert opinions imply that *restoration* to some level is feasible with little effort beyond simply releasing water from Friant Dam and making minor passage improvements. However, given the unknowns and uncertainties discussed herein, whatever potential there is for meaningful rehabilitation appears speculative at this point in time. Further consideration of system operational complexity, competing demands on a limited water resource, infrastructure modifications, re-establishment of channel connectivity, surface-groundwater interactions, habitat availability and suitability, and challenging temperature management issues points to the need for further development and application of improved scientific methods that form the basis of demonstration (via exploration of rehabilitation possibilities over a wide range of hydrologic and meteorological conditions) to support whatever potential there exists for successful rehabilitation prior to implementing management actions.

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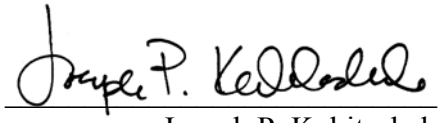

Joseph P. Kubitschek