CIG Agreement No. 68-9104-0-128, FACT SHEET

Prepared in Cooperation with the Natural Resources Conservation Service and Kings River Conservation District

ON-FARM FLOOD FLOW CAPTURE – ADDRESSING FLOOD RISKS AND GROUNDWATER OVERDRAFT IN THE KINGS BASIN

WITH POTENTIAL APPLICATIONS THROUGHOUT THE CENTRAL VALLEY

P.A.M. Bachand[1], W.R. Horwath[3,] S. B. Roy[5], J. Choperena[4], and D. Cameron[2]

[1]Bachand & Associates, Davis, CA 95618; [2]Terranova Ranch; [3]University of California Davis, [4]Sustainable Conservation; [5]Tetra Tech, Lafayette, CA

Two large hydrologic issues face the Kings Basin, severe and chronic overdraft of about 0.16M ac-ft annually (WRIME 2007), and flood risks along the Kings River and the downstream San Joaquin River. Since 1983, downstream communities along the Kings and San Joaquin Rivers have suffered $740M in damages from flooding (Reclamation 2005).

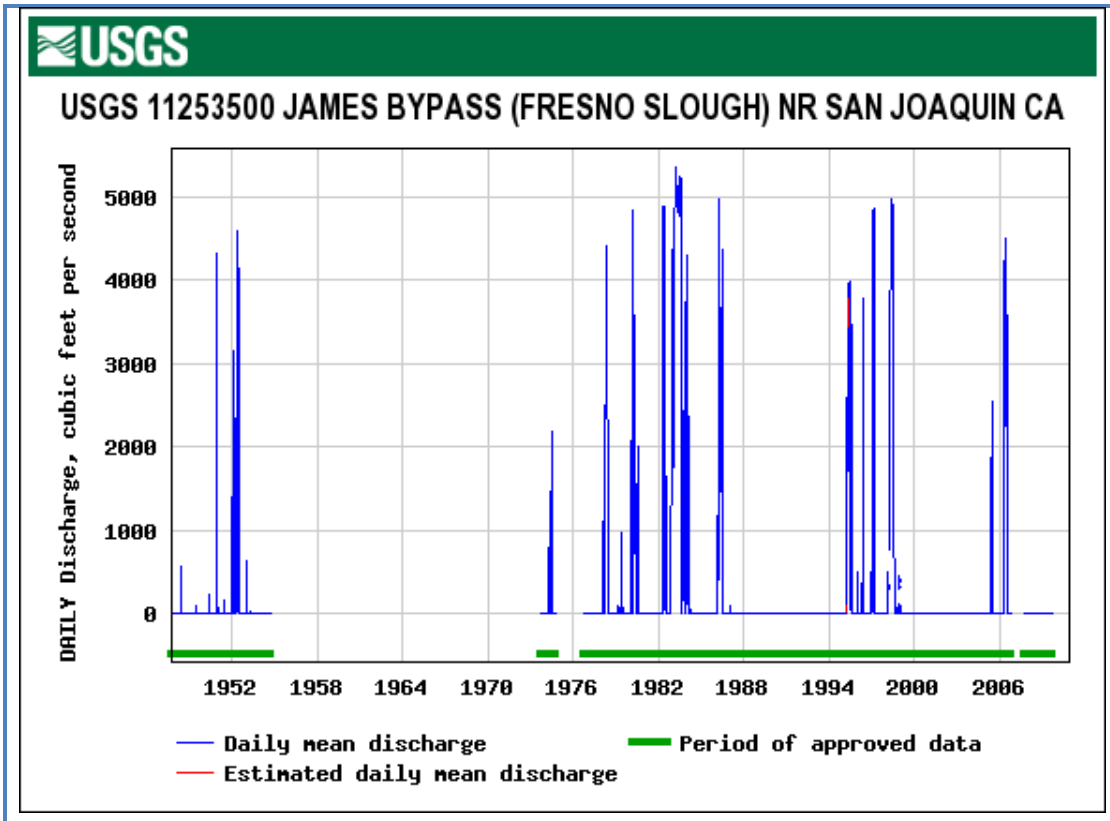

Figure 1. Flood flows past the James Weir have a reoccurrence interval of 2 – 3 years and vary greatly in magnitude, at times exceeding 4750 CFS system design.

These challenges are relevant throughout the Central Valley in California (CA). Models predict more variation in average precipitation for CA watersheds (Reclamation 2011), likely resulting in earlier snowmelt, more precipitation as rain, and increased frequency of extreme events, including drought. These changes will lead to earlier and more extreme runoff events (DWR 2003; Thorne 2012), challenging CA's current reservoir system to capture sufficient water to meet municipal, agricultural and environmental water needs. Overdraft is a common problem through much of California, with an estimated 1 – 2M ac-ft overdrafted annually to meet 30 – 40% of California's urban and agricultural water demand (DWR 2003). More than 70% of California's overdraft occurs in the Central Valley's Sacramento, San Joaquin and Tulare Basins (DWR 2003) where over 7 million acres of agriculture are irrigated (Reclamation 2012).

Increasing groundwater recharge capacity is likely to be a cost effective and effective tool to meet this challenge (Tetra Tech 2011; Langridge et al 2012). Yet more engineered solutions for capturing flood flows on dedicated public or private lands are expensive and lack the flexibility or capacity to effectively capture flood flows from rivers like the Kings River, which has

highly variability with regard to the frequency and magnitude of its flows (Figure 1).

We have studied an alternative approach for capturing flood flows. A 2010 NRCS Conservation Innovation Grant (CIG) with matching funds from Terranova Ranch (Helm, CA) tested the technical feasibility and logistics of diverting flood flows from the Kings River onto large acreages of agricultural lands (Figure 2). These lands were envisioned to be dual purpose, utilized for both farming and for flood flow capture, and developed practices were to be integrated into farming operations.

The project field tests were conducted from January through July 2010.

FINDINGS

LOGISTICS AND IMPLEMENTATION. Typically 8 – 10 CFS was diverted from the Kings River into a private canal during late January and from April through mid-July. Flows in the Kings River were generally in the 2,000 – 4,500 CFS range during those periods. Fields were prepared for shallow flooding through putting up small berms to enable shallow flooding of fields to a depth of 6 – 12 inches, similar to approaches used for setting up rice and alfalfa fields for shallow flooding. Rented pumps moved water from the canal onto the different fields with distribution of water managed by irrigation staff. One thousand acres were made available for receiving flood flows during this pilot investigation. In all, over 3,000 ac-ft were diverted from the Kings River onto the Terranova Ranch during this feasibility study.

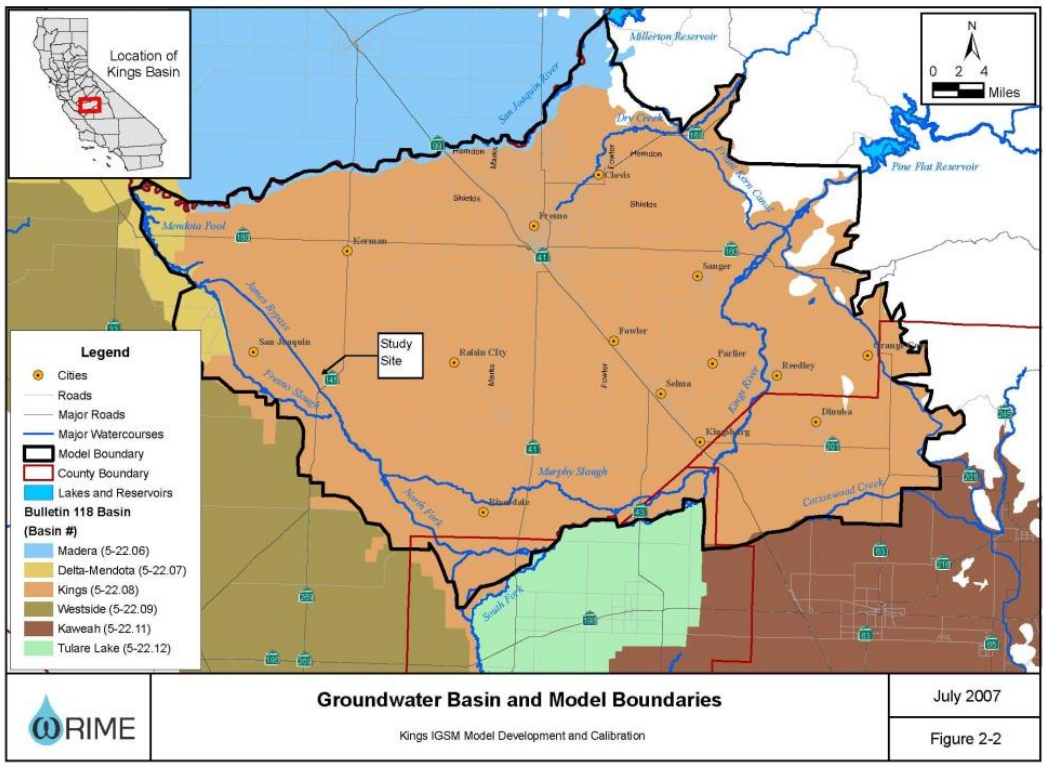

Figure 2. Groundwater Basin Map (modified from study site identification from WRIME 2007)

INFILTRATION AND FLOOD FLOW CAPTURE. Infiltration rates averaged 4.2 in/day across all utilized fields. Infiltration rates decreased overtime but long-term rates after sustained flooding continued to be between 2 – 2.5 in/day (Figure 3). At those infiltration rates approximately 10 acres are required for infiltrating 1 CFS. For a field of approximately 70 acres, this relationship corresponds to pumping water onto the field with a 3,500 gpm pump.

CROPS. Flood flows were diverted onto alfalfa, fallow fields, row crops, orchards and vineyards. Vineyards were highly successful for receiving flood flows. Land preparation and vineyard establishment benefitted infiltration through enabling infiltration rates much higher than expected for the confining layer reported in USDA Soils Reports. Vineyards had long periods of standing water and elevated soil moisture content from early April through early June without damage reported to the 2010 or 2011 crops (Figure 4).

DIRECT V IN LIEU RECHARGE. Crop evapotranspiration rates are very low during the winter and then become relevant in March for field crops but not till later for deciduous crops like grapes. During winter and early spring months, most applied flood flows are expected to go towards direct recharge once soil moisture exceeds field capacity. However, as crop ET demand increases, an increasing fraction of applied flood flows will go towards in lieu recharge. For this study, approximately half the applied water was calculated as going towards direct recharge and half towards in lieu recharge.

COSTS AND PROGRAM SUSTAINABILITY WHEN SUPPLEMENTING IRRIGATION WATERS. The cost of capturing and applying flood flows was calculated as $36/ac-ft during this project. Captured water offsets irrigations costs when used for in lieu recharge and provides future waters when used for direct recharge. Groundwater is the irrigation source in this region and the groundwater table is 200 feet below the surface. Costs to use groundwater are approximately $88 – 95 per acre-ft.

At Terranova Ranch, we calculate that if 25% or more of the captured flood flows can be used for in lieu recharge, then the savings in groundwater costs will support an active flood flow capture program.

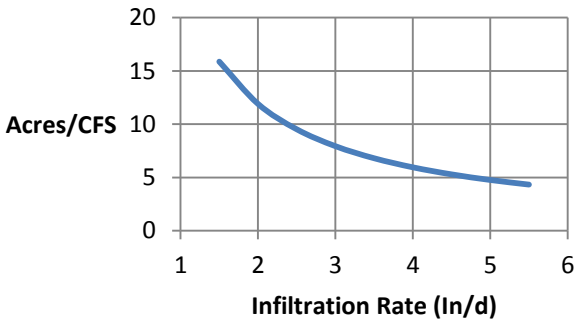

Figure 3. At the long-term infiltration rates of 2 – 2.5 in/d measured in this study, approximately 10 acres are required to infiltrate 1 CFS. That relationship corresponds to pumping water at 3,500 gpm onto a 70 acre field.

WATER QUALITY. Kings River flood flows are pristine waters derived from Sierra snowmelt and have salt and nitrate concentrations one or more orders of magnitude lower than pumped groundwater. Applied flood flows flushed salts and nitrate from the root zone. With implementation of this program, legacy salts and nitrate are expected to be flushed from the vadose zone into groundwater. A simplified conceptual model predicts 11 kg/m^2 of salts will be flushed into groundwater, displacing 12 m^3/m^2 of pore water. This flux is predicted to increase groundwater salinity levels in the near term but continued flood flow capture will improve groundwater salinity levels thereafter.

AVOIDING FLOOD FLOW COSTS THRU LARGE-SCALE IMPLEMENTATION. Local efforts have been underway to create the capacity to divert 500 CFS of flood flows onto agricultural lands. A project of this scale would greatly reduce downstream flood risks. USGS data (Figure 1) suggests a 500 CFS capacity would have eliminated periods in which flood flows exceeded system design capacity downstream. Flood damage since 1980 have been in excess of $1B in 2012 dollars. If a 500 CFS project would have eliminated those damages, the cost avoided through implementation of the project would have been over $1000/ac-ft.

REGIONAL AND LOCAL LOGISTICS. A 500 CFS program could capture nearly 90,000 ac-ft, over 50% of the annual overdraft in the Kings Basin. Median flood flows past the James Bypass during years in which flows occur are 1,500 CFS. Those flows exceed the annual groundwater overdraft in the Kings Basin. The primary motivations for farmers to implement this program are access to high quality, lower cost surface water and actions to address chronic and severe groundwater overdraft. Regional logistical issues for implementing these programs are having soils with sufficient infiltration rates; addressing issues of conveyance; providing sustainable funding mechanisms for system operation and maintenance (O&M); and working within water rights constraints. For participating farmers, challenges include integrating flood flow capture infrastructure and practices with farming operations; developing methods of funding including through selling easements and irrigation cost savings; developing appropriate cropping mix to facilitate the flood flow program and promote dual purpose use (i.e., flood capture and agriculture); and working with water managers to rapidly mobilize when needed. We expect central premises of these plans will be sustainable cost structures; farm operational flexibility; integration of agronomic and flood capture management practices and cropping practices; and regional coordination.

Figure 4. Grape fields had standing water to a depth of 6 – 12” for weeks at time. Infiltration rates were higher than those published for the soils series confining layer and attributed to field preparation and roots fracturing areas of the confining layer.

NEXT STEPS

A number of issues will need to be addressed for wide-scale implementation of this approach:

- Documenting longer-term water quality impacts to groundwater through data collection or modeling.
- Identifying suitable funding mechanisms and governance structures to enable long-term sustainable funding and implementation in the Kings Basin.
- Identifying appropriate areas for implementation including assessing soils, conveyance, regional governance.

CA Department of Water Resources has awarded a grant to Kings River Conservation District for implementation of a flood flow capture program in partnership with Terranova Ranch (McMullin On-Farm Flood Capture and Recharge Project). This project is expected to start in 2013 and is a currently scheduled as a five-year project to establish a 150 CFS capacity program, as well as the governance and local collaboration to expand the program to over 15,000 acres of agricultural land and a 500 CFS capacity.

TO LEARN MORE

The technical report **"Implications of Using On-Farm Flood Flow Capture To Recharge Groundwater and Mitigate Flood Risks Along the Kings River, CA."** is available from NRCS in Fresno (559) 276-7494 and online from www.bachandassociates.com.

The report citation is as follows:

Bachand, P.A.M., W.R. Horwath, S. Roy, J. Choperena, and D. Cameron. 2012. Implications of Using On-Farm Flood Flow Capture To Recharge Groundwater and Mitigate Flood Risks Along the Kings River, CA. Report to NRCS, Fresno, CIG Agreement No. 68-9104-0-128.

Information on the CIG project can be found through contacting:

Dave Krietemeyer, Area Engineer USDA-NRCS
Email: Dave.Krietemeyer@ca.usda.gov

Philip Bachand, Principal Engineer, Tetra Tech
Email: Philip.Bachand@tetratech.com

Don Cameron, General Manager, Terranova Ranch
Email: dcameron@terranovaranchinc.com

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