COORDINATING FLOOD & GROUNDWATER MANAGEMENT

Considerations for Local Flood Managers

Headgates of a groundwater recharge project that divert water from the Kings River during high flows to agricultural lands for recharge.

COORDINATING FLOOD AND GROUNDWATER MANAGEMENT – CONSIDERATIONS FOR LOCAL FLOOD MANAGERS

Recent cycles of drought and flood, and the passage of the Sustainable Groundwater Management Act (SGMA), provide an enhanced opportunity to strengthen the nexus between the flood management and groundwater management communities.

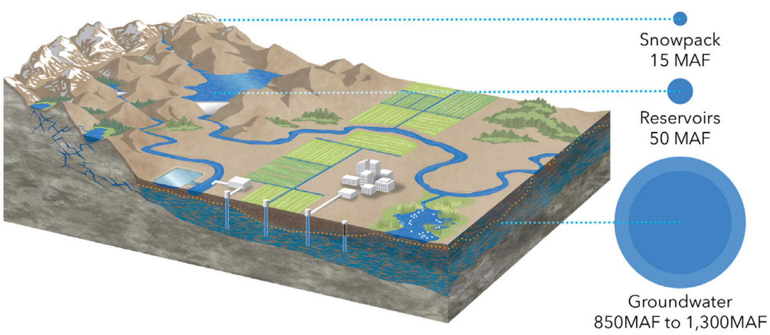
The need for using floodwaters for managed aquifer recharge, also known as Flood-MAR, is urgent and must become an important part of California's portfolio of water resource management strategies to help significantly improve water resources sustainability and climate resiliency throughout the state.

Developing a resilient flood system will require decision making that does not just manage the surface water, but rather the dynamic interchange of surface water and groundwater horizontally across floodplains and vertically through the subsurface.

The state's usable groundwater storage is approximately 8 to 12 times larger than the combined storage capacity (50 million acre-feet) of all major reservoirs in California (Figure 1). The available storage capacity in groundwater basins can be utilized to store wet-period surface water supplies. One of the benefits of Flood-MAR is to more fully integrate runoff from our snowpack and surface water storage in our reservoirs with the vast storage available in our groundwater aquifers.

The ability to move surface water to groundwater aquifers offers an opportunity to better manage water resources, increase water supply reliability and resiliency, reduce flood risk, and support natural ecosystems, including watersheds, wetland habitats and stream flows. Investing in replenishing groundwater will also improve the ability to manage droughts when the lack of precipitation and available surface water supplies creates a greater reliance on groundwater.

Figure 1. Relative Storage Volumes in Snowpack, Reservoirs, and Groundwater Aquifers



Flood-MAR is an integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snowmelt for groundwater recharge on agricultural lands, working landscapes, and managed natural lands, including but not limited to refuges, floodplains, and flood bypasses.

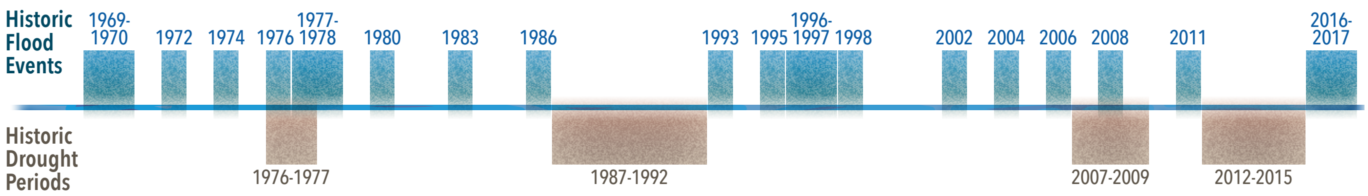
Recharge occurring on inundated dormant orchards.

Extreme Weather Requires Flood and Groundwater Managers to Work Together

Periods of extreme dry weather and wet weather put stress on California's water resources. Extreme dry periods can leave some communities without safe and clean drinking water, aggravate groundwater overdraft, accelerate land subsidence, and exacerbate poor ecosystem conditions. Extreme wet weather can cause local flooding and high water in major streams that can damage property and create hazardous conditions for Californians.

Recurring periods of extreme weather events are not new to California (Figure 2). The state will continue to experience recurring extreme weather events, intensified by climate change, that will exacerbate flood risks and lead to longer and more severe droughts, adding to challenges for water supply reliability.

Figure 2. California Flood and Drought Timeline

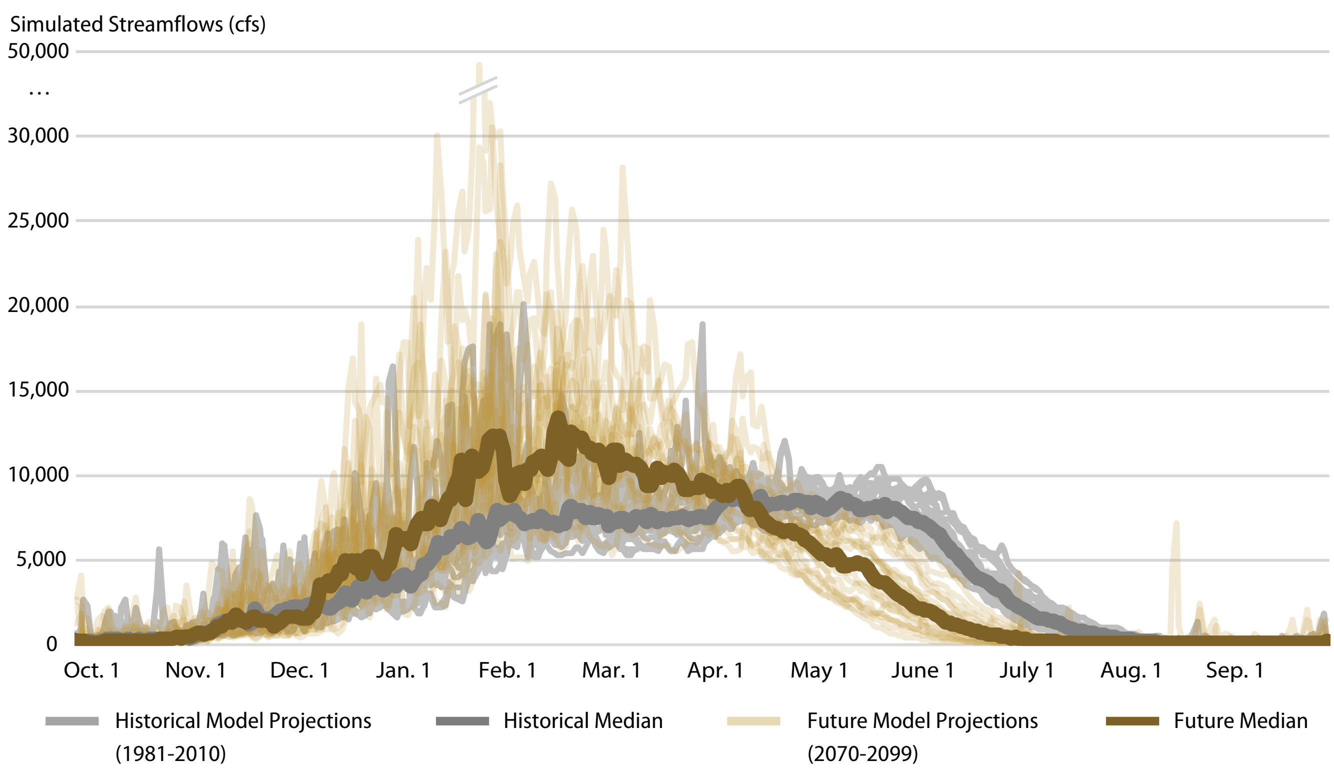


Folsom Dam releasing water down the 3,027-foot-long auxiliary spillway on March 10, 2023 that transports the water into the American River in Sacramento County, California.

A flooded field on January 11, 2023 due to heavy storms near the Cosumnes River in Wilton, California.

The effects of climate change are necessitating wholesale changes in how water is managed in California. Climate change is expected to continue contributing to changing weather patterns, snowpacks, sea level rise, and river flows. More precipitation will likely fall as rain instead of snow. The example hydrograph in Figure 3 illustrates a change in the timing and volume of peak flows for the American River. Future projections (brown lines) illustrate higher peak flows earlier in the season as more precipitation falls as rain instead of snow, whereas historical runoff flows (gray lines) persisted later into the spring as snow melted. These types of hydrologic changes are expected to occur throughout the State, but changes will be particularly severe in high-elevation, snowmelt-driven watersheds, such as the San Joaquin River Basin, and will result in increased flood risk.

Figure 3. Example of Recorded and Projected Streamflow Models Simulating American River Flows near Folsom, CA



Coordinating Flood and Groundwater Management to Reduce Flood Risk

Partnerships between the flood and groundwater management communities will help reduce the impacts of swings between high- and low-flow periods while helping to meet water supply and flood risk management objectives, with the bonus of improving floodplain ecosystems, preserving working landscapes, and engaging California's agricultural community in needed solutions, among other benefits.

Aging infrastructure, deferred maintenance, and climate change have intensified the flood risk to people and property. Flood-MAR can reduce peak river flow and stage, and reduce downstream flood risk by diverting flows from river channels onto working landscapes (including floodplains and flood bypasses).

The reduction of flow and stage also provides reservoir operators with additional flexibility to manage flood releases to increase flood space in reservoirs — providing greater potential for flood risk reduction benefits. Alternatively, Flood-MAR strategies coupled with reservoir reoperation and improved forecasting can further reduce flood risk by allowing reservoirs to release water ahead of precipitation or snowmelt to increase flood storage space in reservoirs.

A flooded field on January 11, 2023 due to heavy storms near the Cosumnes River in Wilton, California.

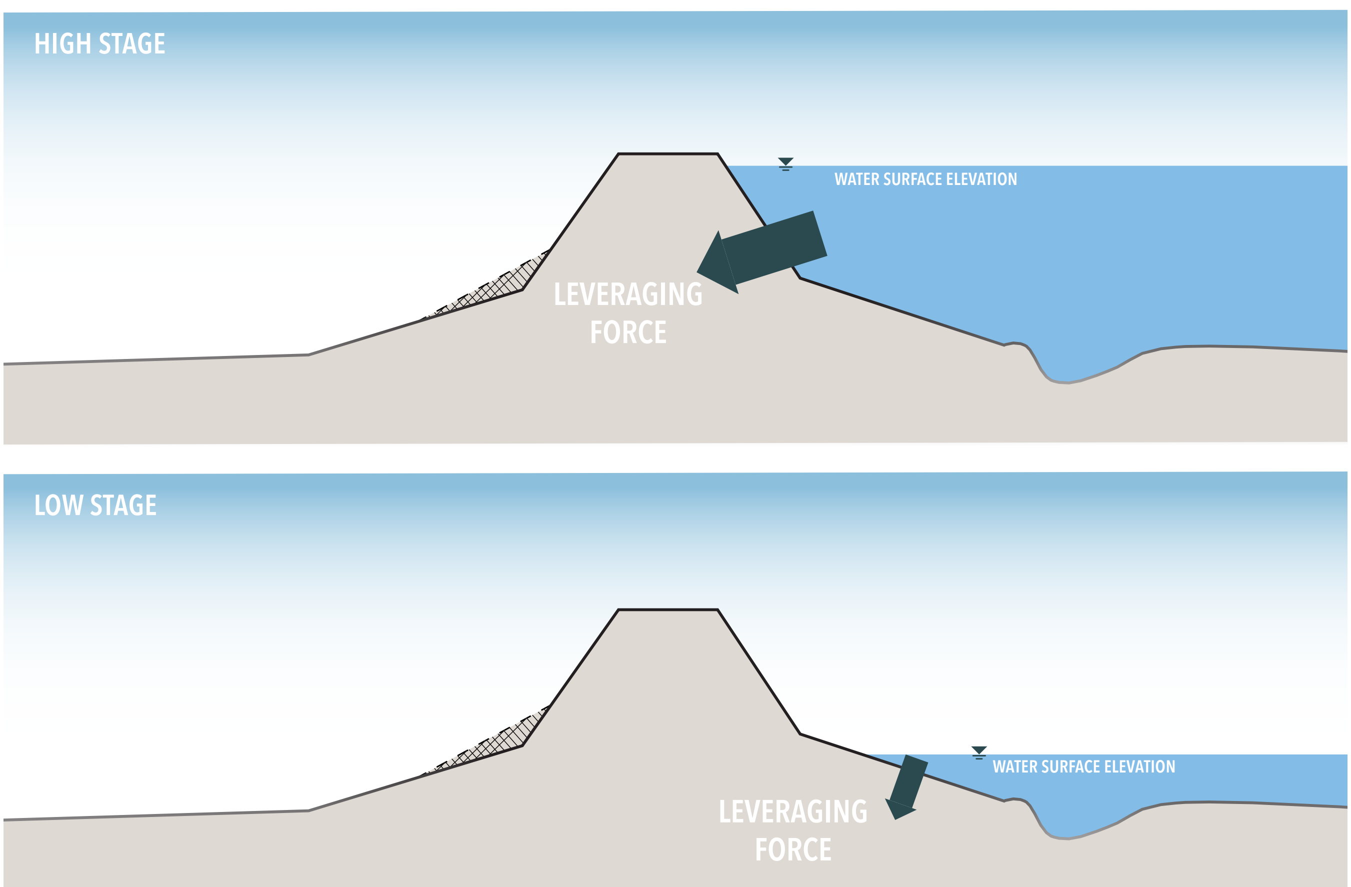
Flood-MAR Projects that Reduce Stage or Flow or Change Timing of Peak Flows

By implementing Flood-MAR projects, flood risk reduction benefits are attained in multiple ways:

1. Diverting water off the channel during high-flow events (i.e., skimming peak flows) and purposefully delivering water to lands (through flooding or irrigation) to promote groundwater infiltration. This methodology requires flexibility and access to significant land area to achieve flood risk reduction benefits downstream of diversion points.
2. Lowering reservoir storage levels prior to, or during, the flood season or discrete storm events to vacate reservoir storage before anticipated precipitation/snowmelt, which can reduce flood risks downstream from the reservoir. The vacated water can be conveyed to specific areas for managed aquifer recharge.
3. Slowing runoff from properties to encourage groundwater infiltration on public and private lands and reduce runoff from entering swollen channels.

As illustrated in Figure 4, reductions in water stage can reduce the risk of levee failure by reducing seepage potential and leveraging forces on levees.

Figure 4. Reducing River Stage Decreases Levee Failure Modes

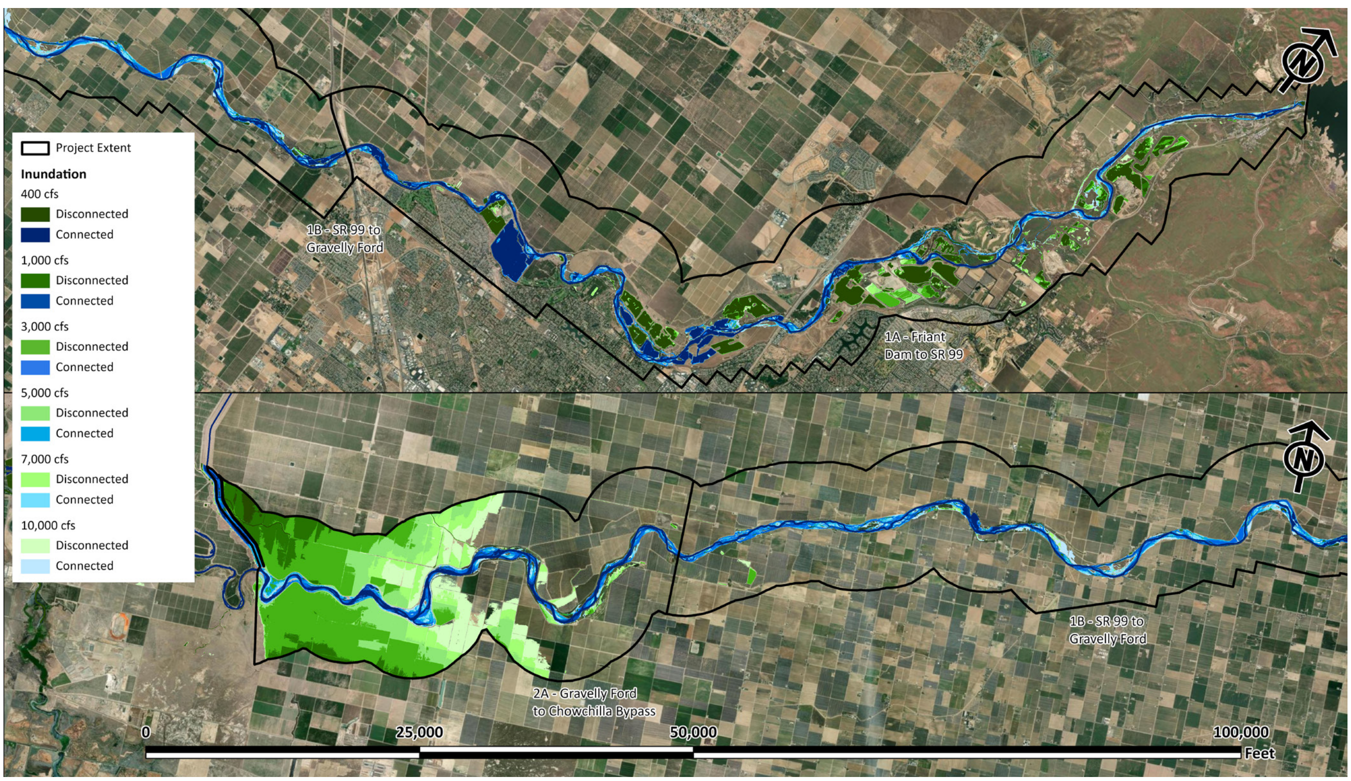


Flood-MAR Projects that Expand or Restore Floodplains and Flood Bypasses

Flood-MAR projects can also be utilized on floodplains and expanded flood bypasses to further reduce flood risk and increase groundwater recharge potential, as well as provide ecosystem benefits and potentially reconnect floodplains. Floodplains provide a natural "sponge effect" where floodplain soils can attenuate flood peaks through transient storage and infiltration into the aquifer. Floodplain restoration through levee setbacks and topographic modification can be optimized to promote recharge.

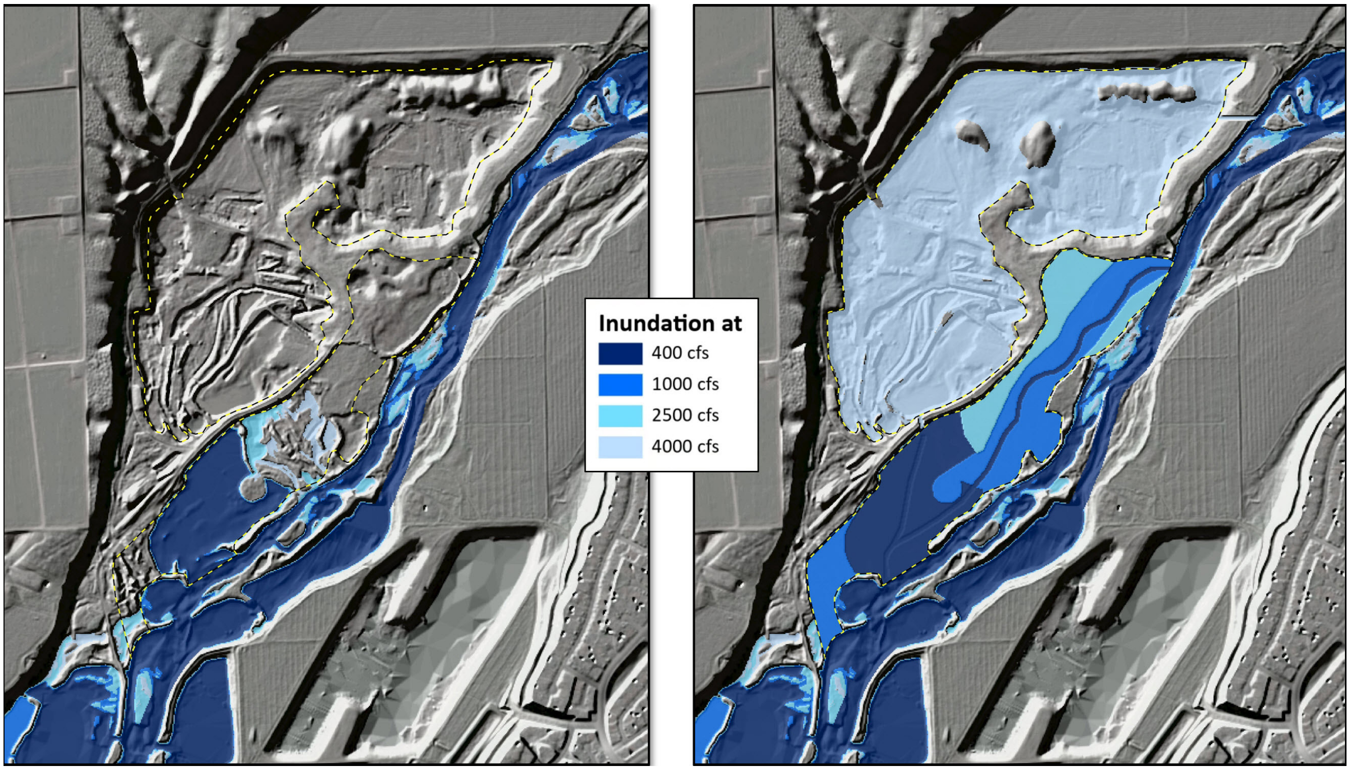
The California Department of Water Resources (DWR) and the San Joaquin River Conservancy are leading a pilot study along the Upper San Joaquin River to evaluate floodplain restoration and expansion and groundwater recharge potential. In the Upper San Joaquin, as in other areas of California, solutions are needed to simultaneously sustain ecosystem functions, address flood risk, and secure water for municipal and agricultural uses. Floodplain expansion and restoration opportunities are being identified, prioritized, and designed to increase naturally occurring groundwater recharge and provide multiple benefits including aquifer replenishment, climate resilience, and ecosystem enhancement. Figure 5 shows the pilot study reach and illustrates potential connected and disconnected floodplain areas that may inundate at various flow rates along the Upper San Joaquin River.

Figure 5. Example of Connected and Disconnected Floodplain Potential at Multiple Flow Rates along the Upper San Joaquin River



The Upper San Joaquin pilot study also includes a set of high-level restoration concepts that illustrate how floodplain areas could be reconnected to the river at priority locations. Each floodplain restoration concept includes a specific set of actions to increase connectivity to the river corridor at a specific range of flows. These actions include floodplain lowering, floodplain raising, creating side channels and alcoves, levee structure or revetment modification, habitat reconnection, and flood attenuation basins. Figure 6 shows existing floodplain inundation and expanded floodplain inundation under an example restoration concept. In this example, with a 96% increase in floodplain, inundation habitat benefits increase by 141% and recharge increases by 117% over existing conditions.

Figure 6. Floodplain Inundation in Existing and Potentially Expanded Conditions



Inundation of floodplain areas can increase groundwater recharge and provide other benefits such as ecosystem enhancement or agricultural lands preservation in areas where land uses are compatible with seasonal flooding. DWR continues to look for partnerships to study and implement these types of multi-benefit projects.

A Flood-MAR project on January 18, 2023 diverting surface water for recharge onto agricultural fields in Yolo County.

Floodwater Available for Recharge and Water Rights

A water right is needed whenever water is diverted from a surface water body for a beneficial use. Beneficial uses include domestic, irrigation, municipal, industrial, fish and wildlife preservation and enhancement, recreation, water quality, and others. Diversion or management of water to reduce flood risk are actions to reduce a hazard and not a beneficial use of water. Flood operations alone do not require a water right. But flood operations that intend to provide multiple benefits may require a water right. For example, if intentional actions are taken to increase infiltration of floodwaters, such as "ripping" soils to increase infiltration, and recharged floodwaters will be put to beneficial use later, a water right may be needed.

While diversion or management of water to reduce flood risk are actions to reduce a hazard, these actions may still provide incidental recharge benefits. Flood diversions to unlined canals or spread out over working landscapes can reduce pressure on leveed systems or reduce peak flows and flood risks downstream of the diversions. These diversions can also result in substantial recharge and increase groundwater levels in the local area. For example, DWR is working on a district-scale Flood-MAR opportunities study in partnership with the Merced Irrigation District. Study results indicate that an annual average of 79,000 acre-feet of additional water can be recharged using existing unlined canals and compatible agricultural lands. The recharged floodwaters can later be allocated by groundwater sustainability agencies through their annual allocations process.

Flood and groundwater managers should also work together on multiple benefit projects that provide flood risk reduction, groundwater recharge, and other benefits. These partnerships will allow project proponents to better utilize streamlined pathways for water rights applications that require understanding of high flow events and "flood thresholds" for local creeks and streams to estimate water available for recharge.

On March 12, 2023, Kings River water is diverted for recharge onto a dormant orchard in Fresno County.

What Can Local Water Managers Do to Better Coordinate Flood and Groundwater Management?

1. Begin coordination before the flood season. Flood events can happen quickly, overwhelming local capacity to respond and hampering real-time coordination between flood and groundwater managers.
2. Work together to identify landowners willing to divert water to their working lands ahead of or during high flow events.
    a. Target or prioritize lands with soils with high recharge rates whenever possible.
        i. Use best available subsurface information, such as **airborne electromagnetic surveys**.
    b. Maintain contact lists with diversion capacities, land area, land uses, total volume/depth landowner is willing to divert, and appropriate windows for diversion (i.e., when inundation would not risk crops and other land operations).
    c. **Local groundwater managers** can help coordinate with potential diverters during high-flow events to support flood managers that are monitoring flood forecasts and responding to potential flood emergencies.
    d. Maximize flood management benefits by first diverting water in more upstream portions of the watershed (i.e., coordinated management at a watershed or regional scale).
3. Local and regional flood managers can identify flow rates (i.e., thresholds) on local creeks and streams that would trigger local flood response actions. They can also notify potential diverters to help take water off the system ahead of, or during, high-flow events.
4. Identify potential areas for floodplain expansion that can provide flood risk reduction and groundwater recharge benefits. Contact DWR for information on ongoing pilot studies and toolsets that are available to support local decision-making.
5. Flood and groundwater managers should work together to navigate the **streamlined water rights process** for multiple benefit recharge projects. Local managers should also utilize technical and regulatory assistance provided by DWR, the State Water Resources Control Board, and the California Department of Fish and Wildlife.

Snow Geese congregate in Sutter County on January 12, 2023.

For More Information

DWR Contact: Jenny Marr, Flood-MAR Program – Jennifer.Marr@water.ca.gov

DWR Flood-MAR Program

Flood-MAR Hub

CA Data Exchange Center

CA NV River Forecast Center

DWR Statewide Groundwater Management Webpage

SGMA Data Viewer

SWRCB Water Rights Division

CDFW Water Rights

CDFW Lake and Streambed Alteration Program