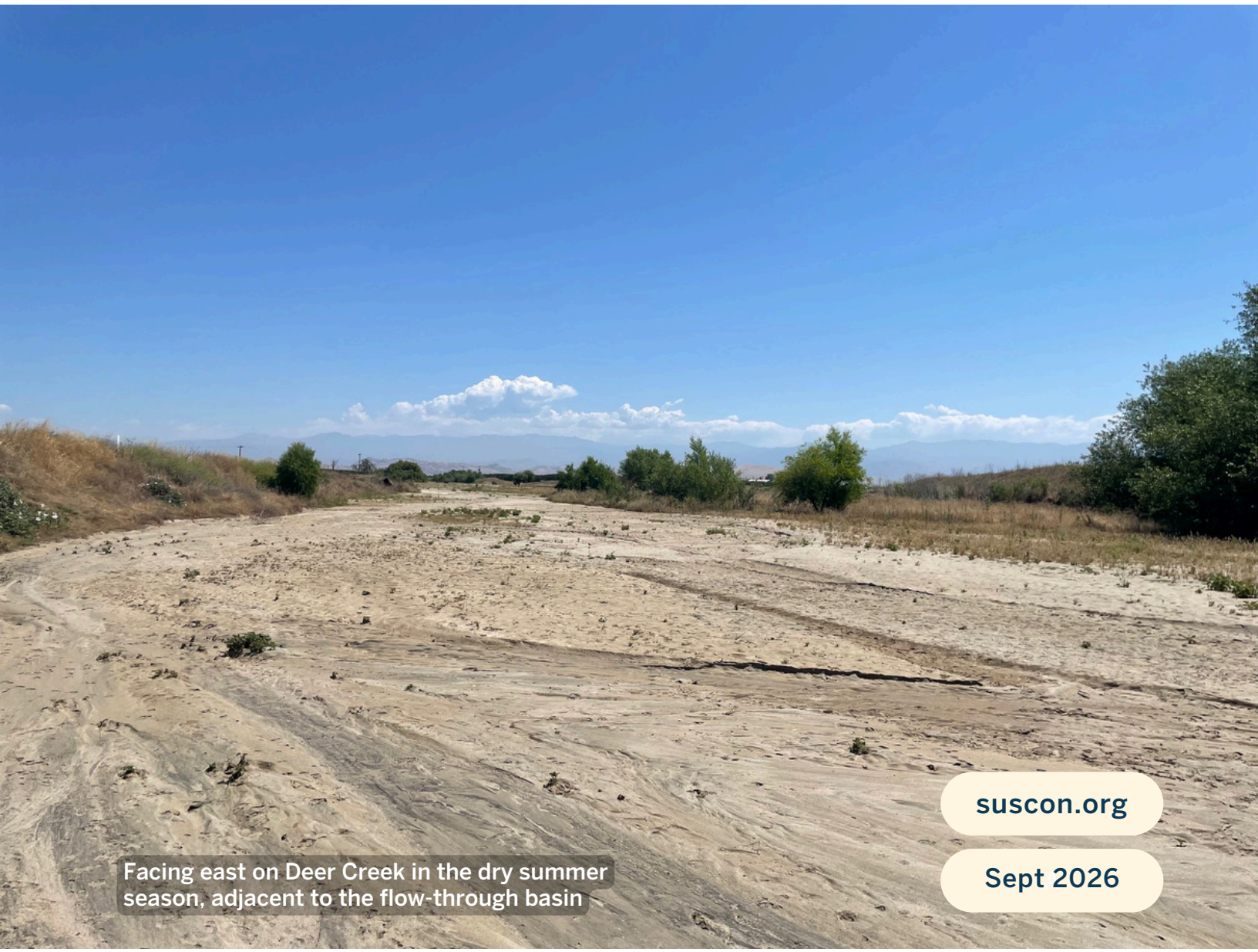




Flow-Through Basins

Fundamentals of design, permitting, and funding
and example projects



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Sept 2026

Facing east on Deer Creek in the dry summer season, adjacent to the flow-through basin

Flow-Through Basins

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Flow-Through Basins (FTBs)

A Flow-Through Basin (FTB) is a small floodplain or recharge basin located adjacent to small creeks and rivers. This feature can be thought of as the rural equivalent of a detention basin, which is often used in urban locations to reduce storm flows from urban runoff. FTBs can be envisioned as one or more small streamside detention basins that become inundated with flood flows. Water is held in the basin and percolates into the ground until the basin reaches full capacity, at which point water exits back to the creek or river. FTBs could be placed on agricultural fields or in undeveloped floodplains.

When properly sited and designed, FTBs can provide multiple benefits. For example, they divert some floodwater off small rivers and creeks, thereby attenuating peak flows and allowing the water to sit in the basin and recharge groundwater. FTBs also enhance habitat when designed with ecological benefits in mind.

The first half of this document (**Part A**) describes FTBs and their design, hydrology, and suitable locations. It also covers permitting considerations, funding resources, and potential research partners. The second half of this document (**Part B**) presents the results of two interviews – one is with a Groundwater Sustainability Agency (GSA) manager who is interested in implementing FTBs as part of their basin’s overall Sustainable Groundwater Management Act (SGMA) compliance strategy, and the other is with irrigation district staff who help to manage a longstanding recharge basin that functionally serves as an FTB.

Part A: Fundamentals of FTBs

FTB Design

FTBs were included in the [San Joaquin Basin Flood-MAR Watershed Studies](#) (the Watershed Studies) led by the California Department of Water Resources and released in 2025. This section describes the parameters of FTB design within the modeling study. However, actual FTB design will vary based on local site conditions and landowner preferences.

FTBs in the Watershed Studies were designed to have an average inundation depth of 1.5 feet. This was done for two reasons: (1) to minimize engineering work in constructing berms around basins, and (2) to maximize the potential for groundwater recharge while also providing habitat benefits for a variety of animals and plants that depend on a range of water depths. Each FTB ideally would have heterogeneous topographic features such as

gradual side slopes, in-basin channels, or bars to serve the type of wildlife expected to use the basin, subject to local conditions and landowner preferences.

Because of the intermittent and irregular flooding of FTBs and their proximity to agricultural fields, pollinator habitat may be the most suitable and valuable ecosystem type that could be improved or supported by the FTB approach, although the potential exists to restore riparian forests and scrub. Pollinators like honeybees, native bees, butterflies, and beetles prefer a diversity of native vegetation that flowers throughout the year, which could be planted within the basin itself or in vegetation buffer zones around the basin perimeter. Variable topography within FTBs can provide different soil moisture and flooding levels to support a variety of plants. In addition, the amount and frequency of flooding can vary. Depending on stream hydrology and the elevation of inflow structures, some FTBs would receive only periodic flood waters or would be regularly inundated by winter rain, whereas others would flood more regularly. These varying conditions would influence planting palettes. In some cases, landowners may prefer to allow natural recruitment of vegetation; in those cases, control of noxious weeds would be an important maintenance operation.

Hydrology of FTBs

Many of the main rivers in California are significantly incised due to historical modifications, such as the installation of dams that restrict sediment transport from the upper watersheds to the lower watersheds and the construction of levees or berms that constrict water pathways to a channel that continues to be scoured by flood flows. As a result, inundating historical floodplains with floodwaters can be difficult as high storm flows continually deepen the river bottom while the surrounding land remains at the same elevation.

In contrast to the major rivers, many locations along smaller creeks and rivers are not as disconnected from the surrounding topography, and floodwaters can more easily inundate adjacent land during storm events. Although smaller streams in agricultural areas are often artificially channelized and disconnected from adjacent lands, this disconnection can be more easily overcome.

As a result, the multi-benefit FTB approach is particularly attractive for potentially reducing local flood risks along small, flashy waterways. Ideally, FTBs should be passively activated (e.g. flooded) via inlets set to receive water at a certain flood stage. Passive activation will maximize rates of FTB inundation and avoid field work during storm events. Pumps could be used to help activate FTBs and ideally would be operated remotely since accessing the field site could be risky or impossible during floods, and electrical outages during storm events remain a risk.

In the Watershed Studies, the modeled activation of FTBs occurred at the 2-year flood event and higher, which is the 50% probability that a flood of that magnitude or greater would occur in any given year. The 2-year flood event is the design frequency of larger floodplain restoration since it closely models natural processes. The 2-year flood is typically an ecologically-significant flood event and represents a time when flood risk may be present in the area; therefore, reducing peak storm flows from creeks during these storms might help to reduce duration and volume of destructive flood events.

Many smaller creeks and rivers lack stream gauges that record water levels and flood conditions. These data help establish water levels corresponding to flood events such as the 2-year event, as well as validate hydraulic modeling of watersheds. In the absence of stream gauge data, models such as the U.S. Army Corps of Engineers' Hydrologic Engineering Center River Analysis Software (HEC-RAS), the USGS StreamStats tool, or even general watershed runoff formulas (such as the Rational Method) can estimate peak creek flows during storm events. Further investigation would be needed to correlate the creek flow rates, typically in cubic feet per second (cfs), with the creek stage (water height) at any given creek reach; this would inform understanding of local flood conditions and potential for FTB inundation. Local knowledge of flood history can provide valuable assessments of flood conditions where models are not sufficient or available.

Suitable Sites for FTBs

FTBs could be installed anywhere there is a suitable site and a willing landowner.

Primary considerations for potential FTB sites include:

- Immediately adjacent to small rivers and creeks
- Locations with natural topography conducive to inundation
- Near or upstream of known and probable flooding areas
- Areas upstream of known bottlenecks in creeks and conveyance infrastructure
- Proximity to flood-vulnerable communities
- Proximity to areas with dry wells, lowered groundwater levels, or degraded groundwater quality

Other important site suitability considerations include:

- Nearby groundwater dependent ecosystems (i.e., GDEs)
- Terrestrial habitat connectivity along stream reaches
- Suitable SAGBI soil types
- Value of land

Permitting FTBs

FTBs serve as small floodplains adjacent to creeks and small rivers; therefore, permitting is likely required due to strict state and federal regulations when disturbing natural floodplains. The following section outlines some of the major permits that may need to be obtained before constructing FTBs. Since FTBs are a newer concept and may require multiple permits, enlisting the support of a permitting expert is advisable. For more information about what actions might trigger state and federal regulatory requirements and to get a general sense of project permitting in or near aquatic and riparian areas, go to <https://acceleratingrestoration.org/>.

The California Environmental Quality Act

The California Environmental Quality Act (CEQA) is typically triggered for projects that receive state or local government funding, discretionary permits, or are carried out by a state or local agency. If an individual landowner wants to install an FTB, they must find a “CEQA Lead Agency”, who will lead the compliance process, as it is local and state agencies that must do the CEQA compliance, not individuals. The easiest path may be for a local Groundwater Sustainability Agency (GSA) or other state or local agency to do a programmatic CEQA document that covers FTBs within their jurisdiction and include standard mitigation measures and other design considerations. With this approach, a CEQA analysis can be completed for particular project types (such as FTBs) on a programmatic basis, for the entire area. Agencies can use the analysis done in the programmatic document and complete a “memo to file” for CEQA compliance for each subsequent FTB project that falls under the programmatic description. If there is no programmatic document in place, another option would be to pursue a project-specific “mitigated negative declaration” under a CEQA Lead Agency determination.

For more information about CEQA, go to: <https://lci.ca.gov/ceqa/>

The California Native Plant Society has some simple informational materials for those new to CEQA. <https://ct.cnps.org/ceqa-101/the-ceqa-process/> and <https://ct.cnps.org/ceqa-101/types-of-ceqa-documents/>

Tribal Cultural Resources (AB 52 under CEQA)

AB 52 requires public agencies to consult with tribes during the CEQA process. California tribes have many cultural resources and artifacts throughout the landscape that could be damaged by excavation activities or flooding. It is important to consult with tribes in advance of designing and permitting to avoid and mitigate potential damage.

For more information about AB52, go to: <https://www.lci.ca.gov/ceqa/tribal/>

*California Department of Fish and Wildlife (CDFW) – **Section 1600** (Lake and Streambed Alteration); California State Water Resources Control Board – **Clean Water Act Section 401** (Water Quality Certification); Army Corps of Engineers – **Clean Water Act Section 404***

These three permits can be triggered if alterations to a creek or river are included with the project design or construction activities. When possible, designing projects with minimal impacts to waterways is most advisable. Early and clear contact with agencies helps to avoid protracted design and permitting issues.

Find more information at the following links:

- Section 1600, Lake and Stream Alteration
 - <https://wildlife.ca.gov/Conservation/Environmental-Review/LSA>
- Clean Water Act Section 401
 - https://www.waterboards.ca.gov/water_issues/programs/cwa401/
- Clean Water Act Section 404:
 - <https://www.epa.gov/cwa-404/permit-program-under-cwa-section-404>

California Endangered Species Act (CESA)

Some landowners are concerned that by improving habitat on their land, endangered species may move in and thereby make it difficult for future management or alterations to the landscape. CDFW's Safe Harbor Agreements (SHAs) and/or USFWS Conservation Benefit Agreements (CBA, formerly known as an SHA) aim to protect landowners who want to improve habitat.

It is anticipated that a joint USFWS and CDFW CBA will be in place by 2027 for 10 different pollinator species on agricultural land in California. This is a voluntary agreement in which growers who participate devote a percentage of their land to safe habitat for pollinator species. In exchange, they receive legal protection during agricultural operations even if endangered pollinators show up on their land.

There may be potential for counties or other large entities to develop regional Habitat Conservation Plans/Natural Community Conservation Plans (HCPs/NCCPs) to provide umbrella coverage for smaller projects that fit into their overall plan.

For more information about these plans, go to:

- <https://wildlife.ca.gov/Conservation/CESA/Safe-Harbor-Agreements>
- <https://www.fws.gov/service/conservation-benefit-agreements>
- <https://scv-habitatagency.org/149/What-is-an-HCPNCCP>

Local permits

Construction projects may require local permits, primarily focused on mitigating runoff and nuisance dust during construction of the project. In some counties, basin construction may be considered an agricultural activity and exempt from grading and building ordinances. It is also possible that FTBs' construction and operation activities trigger other local county ordinances that could require a Conditional Use Permit (CUP) and a local public approval process. Those interested in FTBs should contact their local planning department for guidance.

Recharge Permitting/Water Rights

Projects that divert surface water from a creek or river for beneficial use require water rights permitting. There are some ambiguities on water rights for FTBs, since the primary benefit and purpose of the project determine whether or not a right is needed. To address this when embarking on an FTB project, make sure local and state agencies understand the primary purpose of the project so that they can give sufficient guidance on whether a water right is needed. More information on expedited permitting for groundwater recharge can be found on the [Water Board's](#) website.

Sources of Funding for FTBs

Funding for design, permitting, and installation of FTBs could come from a variety of sources, as listed below. Long term maintenance, which is essential for the functionality of FTBs, is typically harder to fund but can sometimes be built into design and construction budgets. Landowners and districts might consider partnering with non-profit organizations that are well-versed in applying for funding opportunities and managing projects to meet funding obligations.

State, Federal, and Local Agency Resources and Funding Programs

State and federal government grants offer substantial funding opportunities for on-the-ground projects. However, some of the larger grants can be laborious in their application processes and reporting requirements, and they can also be relatively inflexible for any changes needed during the course of the project. Typically, individuals are not eligible applicants – so individuals who are interested in tapping into these funding sources will need to partner with a local agency or non-profit organization. This partnership adds considerable administrative support to manage projects and maintain budgets.

California state grants tend to be linked to bond funds, so they can be cyclical in terms of availability. Most recently in 2024, voters approved Proposition 4, which authorizes the state to issue \$10 billion of bonds for the purposes of climate resilience, safe drinking

water, wildfire prevention, drought preparedness, and protecting natural lands and coastal ecosystems. These funds are typically rolled out over several years and are funneled through various state entities. For more information on available California grants, go to: <https://www.grants.ca.gov/>

The federal government also offers a range of competitive grants. Most of these require the involvement of large institutions or state/local agencies as eligible applicants. However, some federal programs, such as the Natural Resources Conservation Service's Environmental Quality Incentives Program (NRCS EQIP), are targeted to individual farmers and ranchers to help improve natural resources on working lands.

NRCS EQIP practices

While FTBs are not recognized by that name in NRCS EQIP materials, it is possible to use existing practice standards under NRCS EQIP to assemble the pertinent features of an FTB. Reference the webpage below for a list of all EQIP practices. Practices that could be used to design the basin include Groundwater Recharge Basin or Trench (practice code 815), Pond (378), or Dike and Levee (356 – use “Dike”, low hazard or Class IV). Associated practices that could be used for conveying and controlling water flow into and out of the FTB include Diversion (362) and Structure for Water Control (587). Streambank and Shoreline Protection (580) could be used to reshape floodplain and streambank sites for the FTB, and Riparian Herbaceous Cover (390) or other planting practices could be used to establish appropriate vegetation after construction. Consult with your local NRCS field office for conservation planning assistance.

Go to this page for more information:

- <https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-standards>

Conservation Easements

Under California state law, a conservation easement is a voluntary, legally binding agreement in which private land is retained in its “natural, scenic, historical, agricultural, forested, or open-space condition”. This agreement is recorded on the land deed and binds all future owners. In exchange, landowners who enter into conservation agreements can receive a variety of incentives, such as income tax reductions, financial compensation, and reduction of taxable value of land. These agreements can be sought directly from state entities such as CDFW or mediated through entities like land trusts. For more information, go to <https://calandtrusts.org/> and <https://wildlife.ca.gov/Conservation/Environmental-Review/MPDA/FAQ>

Floodplain Easements

Under USDA guidelines, the purpose of floodplain easements is to restore, protect, maintain, and enhance the functions and values of floodplains, including associated wetlands and riparian areas. Specific conditions apply, such as flooding frequency. Similar to conservation easements, this agreement is legally binding for all future owners. For more information about this USDA program, go to:

<https://www.nrcs.usda.gov/sites/default/files/2022-09/EWP-FPE%20Factsheet.pdf>

Local Programs

Local flood agencies may be interested in the flood risk reduction effects of FTBs, especially along small, flashy creeks that have limited flood control options. Contact the local flood agency to see if they could support and even fund FTBs.

Counties or local water and irrigation districts may receive state grants, referenced above, such as the Multibenefit Land Repurposing Program (MLRP) administered by the Department of Conservation (DOC), which are then allocated to local, on-the-ground projects. Go to <https://www.conservation.ca.gov/dlrp/grant-programs/Pages/Multibenefit-Land-Repurposing-Program.aspx> for general information on this program and contact the county for available funding opportunities.

Many water districts offer a range of incentives for recharge projects. For FTBs that include recharge as a benefit, consult with the local water district to see what might be possible. See the 2026 [Groundwater Recharge Strategies and Incentives](#) guide for an overview of how irrigation districts across California incentivize recharge.

Corporate/Foundation Funding

Corporations and foundations might be valuable sources of funding for FTBs, since they are typically much more flexible than government grants, including how money is spent and reporting requirements. However, they are usually much smaller in dollar amounts and might serve best as supplemental, flexible funding for bigger projects.

Corporations are usually interested in projects that meet their annual sustainability metrics. For projects claiming recharge benefits, corporations do not need any water "right" associated with the project but do need annual volumetric accounting for their reports. These 5 to 10-year contracts tend to fund projects with assured water deliveries, but corporations might be interested in floodwater-sourced projects where co-benefits such as reducing flood risk for communities and improving habitat show a compelling conservation need. There are a couple of California-wide coalitions of corporations and non-profit organizations (e.g. the California Water Action Collaborative, CWAC, and the

California Water Resilience Initiative, CWRI) that leverage collective action for water sustainability. Neither coalition is a funder itself but helps raise awareness and identify funding opportunities for on-the-ground projects. If agencies or individuals want to pursue corporate funding, it is highly advisable to team up with a non-profit organization that is part of these networks.

Foundations offer a different type of funding source that is relatively flexible. They are driven by their mission statements and can change their strategy and goals with changing times. Projects that focus on communities and the environment are most suitable for these types of funders. Finding the right fit for project work can be challenging since many foundations fund efforts such as policy and strategic planning rather than building on-the-ground projects. This is another situation in which teaming up with a connected non-profit organization (e.g. members of CWAC or CWRI) is highly advisable, since relationships are built over many years and these non-profits understand trends in each foundation's strategy and mission, and can help to find the right funding fit.

Potential Research Partners

FTBs are an interesting area of research because they have multiple outcomes, combine various disciplines, and are a relatively new concept. Projects with research partners help advance science, understanding, and best management practices, and may help fund FTB projects. Those interested in implementing FTBs might want to consider bringing in research partners to evaluate intended outcomes of FTBs and develop practical methods for implementation. Research partners are typically professors and students at universities and colleges, and a research team could include non-profit organizations, technical assistance providers, consulting firms, and local and state entities.

Part B: Examples of FTBs

This section records interviews with a Groundwater Sustainability Agency (GSA) that is interested in the FTB approach and a water district that utilizes an on-the-ground, functional FTB that was constructed many years ago. The following case studies document lessons learned from each of the examples.



Facing east on Deer Creek in the dry summer season, adjacent to the flow-through basin

Pixley Irrigation District (PIXID)

Interviewees: Travis Millwee, Resources Manager, PIXID; Kirk Masters, Water Resources Superintendent, PIXID

PIXID is in the Tule subbasin, which is facing a growing crisis of depleted groundwater reserves, leading to dry wells and ongoing subsidence. The larger Tule groundwater basin is comprised of 12 GSAs and 8 GSPs, which makes collective management of the common groundwater resource particularly challenging.

PIXID has relatively secure water rights – including Deer Creek water rights in high flow years and contract water from the Central Valley Project’s Cross Valley Canal Division. But even so, their surface water only covers about one quarter of their irrigation demand, making them heavily reliant on groundwater pumping. PIXID is willing to think creatively and collaboratively to chart a future path that leads to groundwater sustainability. However, they note that it is hard to find feasible projects that both growers and communities want.

Part of PIXID’s work towards groundwater sustainability includes efforts under the Tule MLRP, a collaborative effort that includes partners from other GSAs, the local land trust, conservation groups, and community representatives. This group has commissioned two floodplain studies (one for Deer Creek and White River and the other for the Tule River) to evaluate areas where they can direct water during flood events to reduce flood risk while recharging groundwater. These floodplain studies will be available sometime in later 2026 for further review.

Deer Creek FTB



Vegetation at the edge of the FTB, with bulk of basin in the background

PIXID is part of a group of irrigation districts that contract with Terra Bella Irrigation District (TBID) (with occasional assistance from Lower Tule River ID) to manage and operate a recharge basin adjacent to Deer Creek, an ephemeral drainage that is dry in the summer. Constructed in 1995, this basin is about 80 acres and is functionally equivalent to an FTB by reducing flood risk and recharging groundwater. Habitat, including exotic weeds and native grasses and trees, exists in and around the basin, though the basin was not designed for habitat. PIXID would like to construct more FTB-style recharge basins to achieve its goal of groundwater sustainability.

Before the rainy season, PIXID staff ensures that the FTB is prepared to receive water through a culvert along the banks of Deer Creek. After flooding, the basin usually takes about 2-3 weeks to fully dry down. Management activities to reduce vegetation include discing the bottom of the basin and spraying for weed control along the intake ditch.

PIXID has gauging stations along Deer Creek. They note that 300-500 cfs is a standard winter stream baseflow with a common storm peak of about 1,500 cfs. However, in 2023 the peak flow was 3,000 cfs. Floods occur about 4 or 5 years out of 10 and typically in the months of March and April, especially with rain-on-snow events.



Travis Millwee (Resources Manager, PIXID) and Kirk Masters (Water Resources Superintendent, PIXID) on the creek bank.

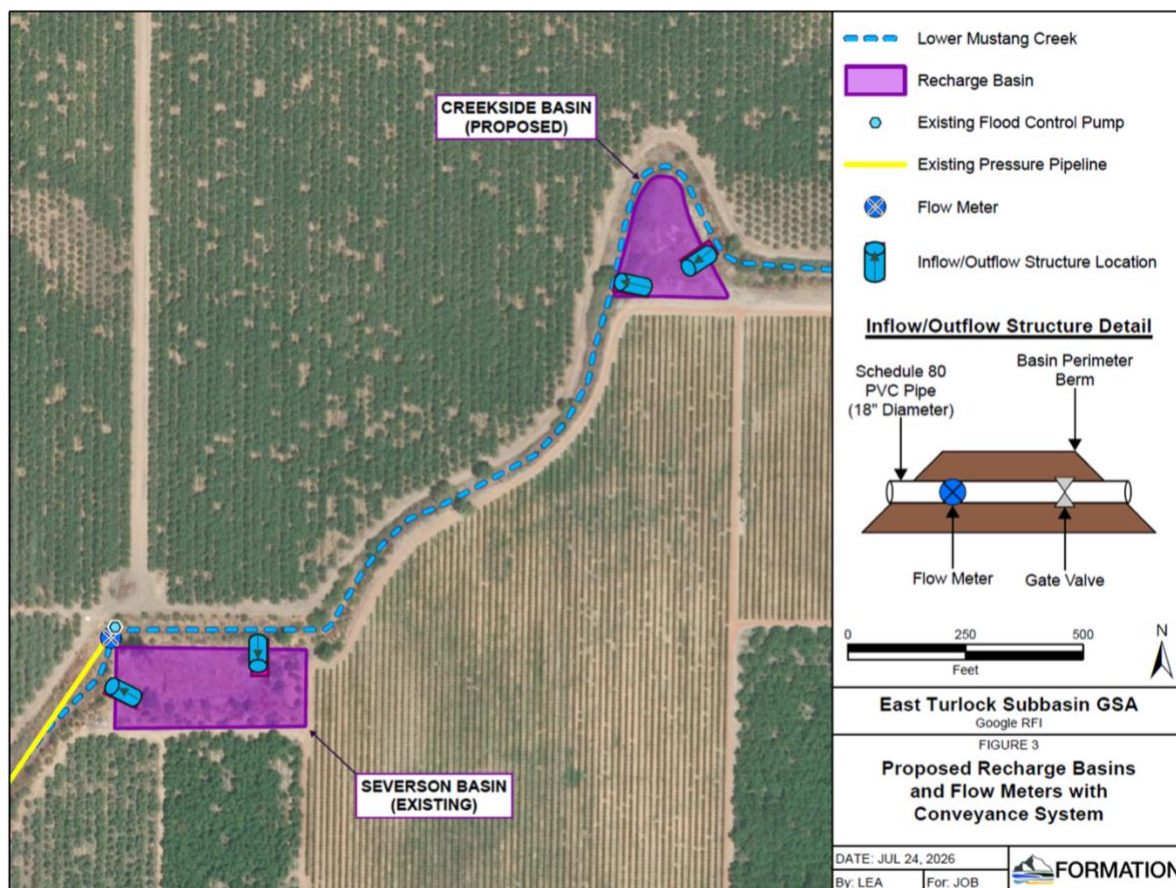
East Turlock Subbasin GSA (ETSGSA)

Interviewee: Mike Tietze, General Manager of ETSGSA

Why FTBs?

ETSGSA is interested in FTBs for their potential benefits to recharge groundwater, attenuate floods, and improve habitat. ETSGSA anticipates that FTBs will help restore the hydraulic function of degraded ephemeral creeks in the GSA. They hope to use FTB projects to benefit disadvantaged communities and create a stronger bond between agriculture and communities by promoting learning partnerships with schools and other local organizations.

Where to site FTBs?



ETGSA design for the proposed Creekside Basin and the existing Severson Basin along Lower Mustang Creek

The ETSGSA area includes three creek drainages: Sand Creek, Mustang Creek, and Dry Creek. Some of these streams are highly modified under existing conditions. The upper two-thirds of Sand Creek currently functions as an agricultural ditch that is not considered

a “Water of the United States” but does fall under state jurisdiction. Lower Mustang Creek is essentially severed from its upper watershed by the Highline Canal. Both Sand Creek and Mustang Creek terminate on agricultural lands or in Turlock Irrigation District (TID) drainage infrastructure. Dry Creek is less modified by human activity than the other two creeks and drains into the Merced River.

ETSGSA’s planned approach will be to restore some of the hydrologic function of these streams, which are largely disconnected from their floodplains under current conditions. ETSGSA will purchase surface water from TID in the West Turlock Subbasin GSA and deliver that water via a proposed pipeline to both Sand Creek and Mustang Creek. During the growing season, FTBs would be used to hold water temporarily for irrigation delivery. In the winter, the pipeline and other side gates would be used to convey flood management releases from TID’s canals and release water into the FTBs and creek drainages. This use of the FTBs during the winter is expected to result in flood risk reduction and incidental recharge benefits. In essence, this represents a creative way of utilizing FTBs for both winter recharge and summer irrigation.

FTB Incentives for Growers

ETSGSA offers technical assistance in designing and constructing MLRP projects, and offers the following incentive payment structure for MLRP-funded projects, all of which reference NRCS EQIP practices and other considerations to set a base rate:

- Payment based on acre per year to operate and maintain each eligible practice
 - Practices can be stacked, leading to more payments per acre
- Reimbursed construction costs
 - Payments based on acre-foot capacity or per acre for basins and ponds

For projects that are pursuing recharge credits: When ETSGSA pays for construction of an MLRP project, they take a portion of the recharge credit for the first 3 years. This is in addition to a mandatory “leave behind” of 12.5% for all recharge projects. Some growers prefer to take the full available recharge credit rather than accepting MLRP funding for their recharge or FTB projects while others benefit from the funding assistance. However, growers are offered technical assistance from ETSGSA in designing and constructing their projects regardless of whether they choose to participate in the incentive payment program.

FTB Project Example

Through their MLRP efforts, ETSGSA has selected a couple of projects for funding that function as FTBs. One project highlighted here is still in the planning stages, and so the details of the project sites are not yet ready for public release.

Pilot project: A low-lying agricultural field is regularly flooded by the adjacent creek. The grower wants to repurpose that field from irrigated agriculture to a 20-acre recharge basin. The grower is also considering upland habitat improvements, including cover crops, rewilded orchard swales and pollinator hedgerows. ETSGSA hopes this project can serve as a model that will inspire many more.

ETSGSA Strategy

In addition to simpler projects funded under MLRP, ETSGSA is looking for high habitat value projects that require more permitting in this pilot phase, so that they can gain experience with these types of projects. They are looking at projects that can combine land repurposing strategies, such as rewilded orchard swales connected to a series of FTBs. To help project proponents navigate the complicated world of riparian restoration, ETSGSA is continuing discussions and partnerships with the local Resource Conservation District, environmental consultants, and non-profit groups such as River Partners, The Nature Conservancy, Audubon, and Sustainable Conservation.