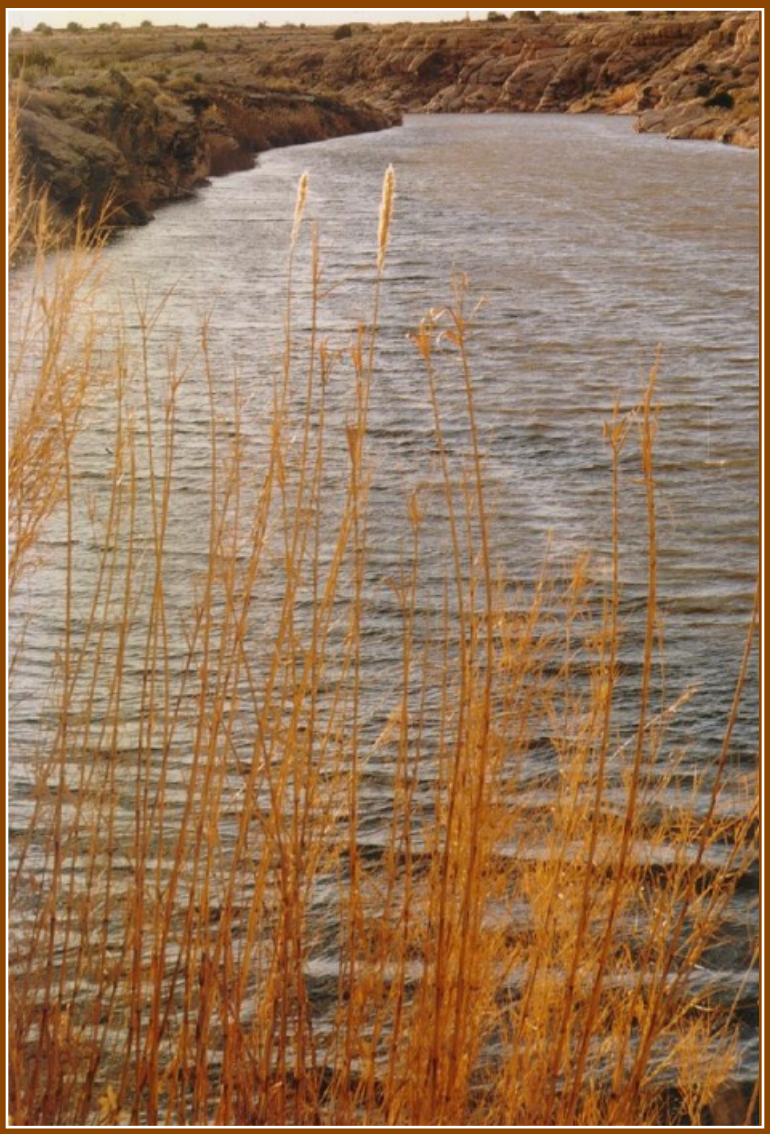
Northeast San Joaquin County
Groundwater Bank



System Plan
Components Inventory

Northeast San Joaquin County Groundwater Banking Authority

April, 2002

The Northeast San Joaquin County Groundwater Banking Authority is a Joint Powers Authority formed to facilitate development of locally supported groundwater banking projects that improve water supply reliability in Northeastern San Joaquin County, protect Delta water quality, and provide benefits to project participants and San Joaquin County as a whole. The Authority's member agencies are:

- Central Delta Water Agency
- Central San Joaquin Water Conservation District
- City of Lodi
- City of Stockton
- North San Joaquin Water Conservation District
- San Joaquin County Flood Control and Water Conservation District
- South Delta Water Agency
- Stockton East Water District
- Woodbridge Irrigation District

Associate Members:

- California Farm Bureau
- California Water Service Company

For more information on the Groundwater Banking Authority or this System Plan, please contact:

San Joaquin County Department of Public Works
Water Resources Division
P.O. Box 1810
Stockton, CA
209-468-3000

System Plan Prepared by:

Calaveras River, Eastern San Joaquin County

INTRODUCTION AND BACKGROUND

This document describes a groundwater banking system being studied in Northeast San Joaquin County, a portion of which is currently being implemented. Components are summarized from the Mokelumne Aquifer Recharge and Storage Project, Final Report (MARS Report) by East Bay Municipal Utility District (EBMUD) and East San Joaquin Parties Water Authority (1996) and is consistent with the San Joaquin County Water Management Plan (SJCWMP) (CDM 2001). The system is intended to assist in addressing San Joaquin County's future water supply needs and protect the underlying groundwater basin from continuing overdraft and saline intrusion.

Properly managed, the groundwater basin will provide for San Joaquin County's water needs for many years. In addition, the basin offers potential for providing substantial volumes of regulatory storage that could be used for regional and statewide benefit.

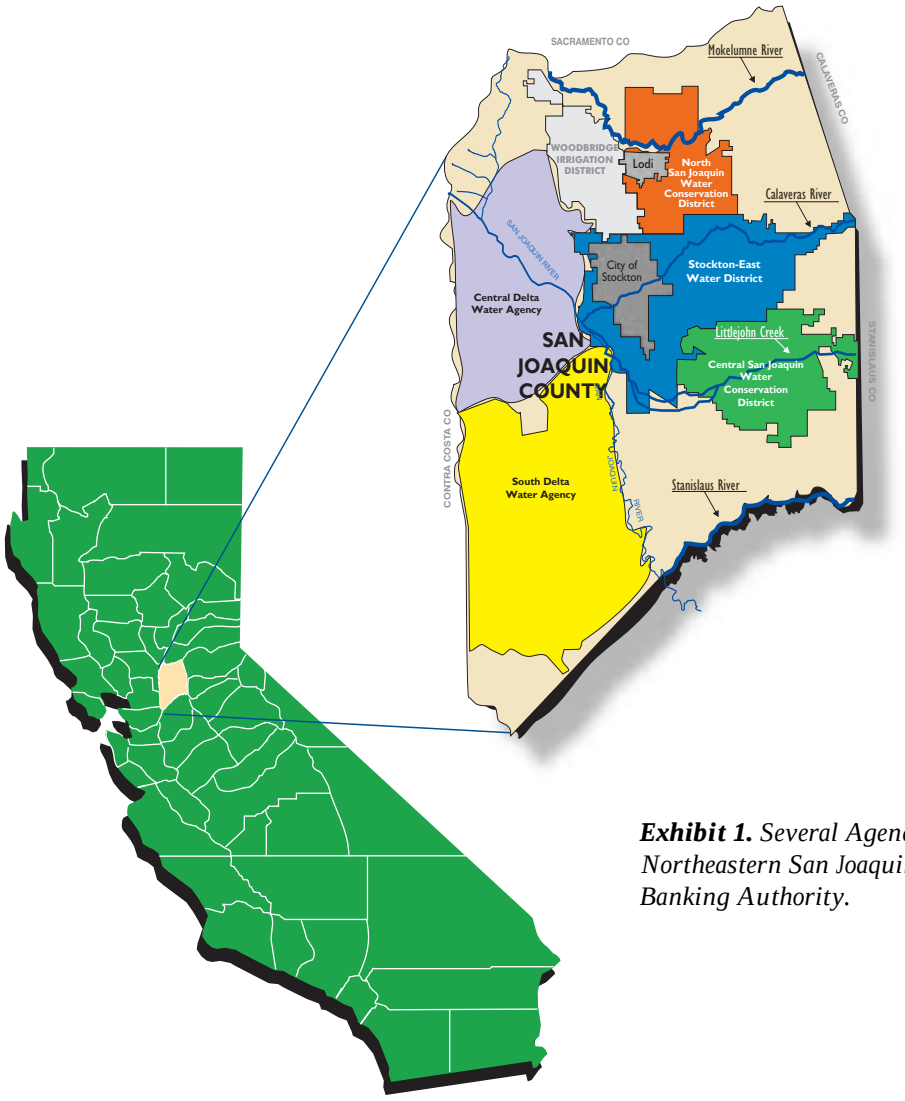


Exhibit 1. *Several Agencies Comprise the Northeastern San Joaquin County Groundwater Banking Authority.*

San Joaquin County, shown on **Exhibit 1,** is home to about 600,000 people and a vital agricultural economy. The population is expected to increase to over 1,000,000 by 2030. Water demand in the county is about 1,600,000 acre feet per year. About 60 percent of the demand is currently satisfied by groundwater pumping and 40 percent is satisfied by surface water supplies. The California Department of Water Resources has declared the groundwater basin underlying Eastern San Joaquin County "critically overdrafted," indicating that the current rate of groundwater pumping is not sustainable over the long term[1]. Specifically, the Department determined that groundwater pumping over the years has generally lowered the groundwater surface, inducing intrusion of highly saline groundwater into the basin from the west, see **Exhibit 2.** Without mitigation, such intrusion will degrade portions of the basin, rendering the groundwater unusable for municipal supply and irrigation.

[1] California Department of Water Resources, Bulletin No. 146 (1967).

In addition to these problems, the long term overdraft has created opportunities for implementing a groundwater banking program to generate regional and statewide benefits. The overdraft has depleted a substantial portion of the Eastern San Joaquin County groundwater basin, making volume available for regulatory storage. San Joaquin County estimates that at least 1.2 million acre feet, a volume equivalent to Folsom Lake, could be used to store wet year water for use in subsequent dry years.[2] However, to do so, the groundwater basin should be protected from the continuing threat of saline intrusion.

San Joaquin County recently identified the need for additional surface water supply for the area is about 150,000 acre feet per year on an annual average basis[2,3]. This volume of water is needed to stabilize the groundwater basin at current elevations and repel the saline groundwater intrusion from the west. Additional supply in excess of 150,000 acre feet per year could be banked for later withdrawal.[3] Banked water withdrawn in dry years could be delivered to others for environmental protection or consumptive use. Various facility and supply options have been evaluated and the Northeast San Joaquin County Groundwater Banking Authority has identified potential facility/supply combinations that would assist in meeting these objectives. The facilities and supply sources needed to produce these additional surface water supplies are described in the following sections. Projects actually constructed may include variations of these projects or other projects.

[2] Derived from San Joaquin County Department of Public Works, San Joaquin County Water Management Plan (CDM, 2001).
[3] Does not include the approximately 50,000 acre feet per year Stockton East Water District/Central San Joaquin Water District Supply from New Melones Reservoir.

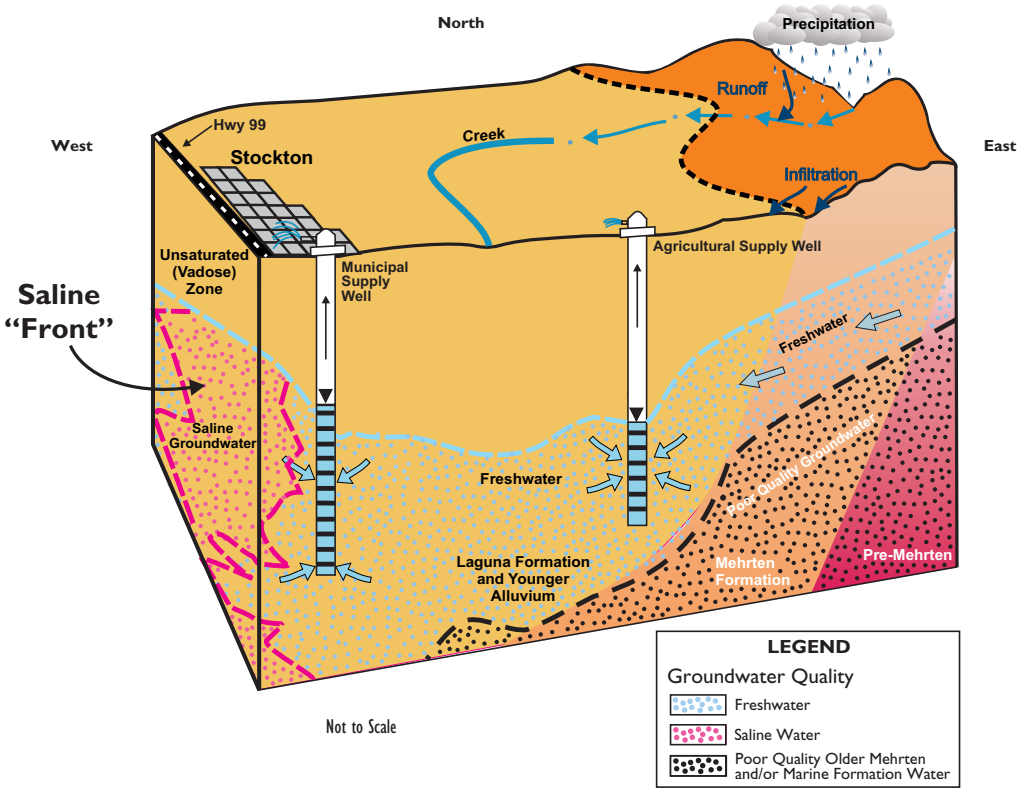


Exhibit 2. *Saline intrusion in the Stockton area.*

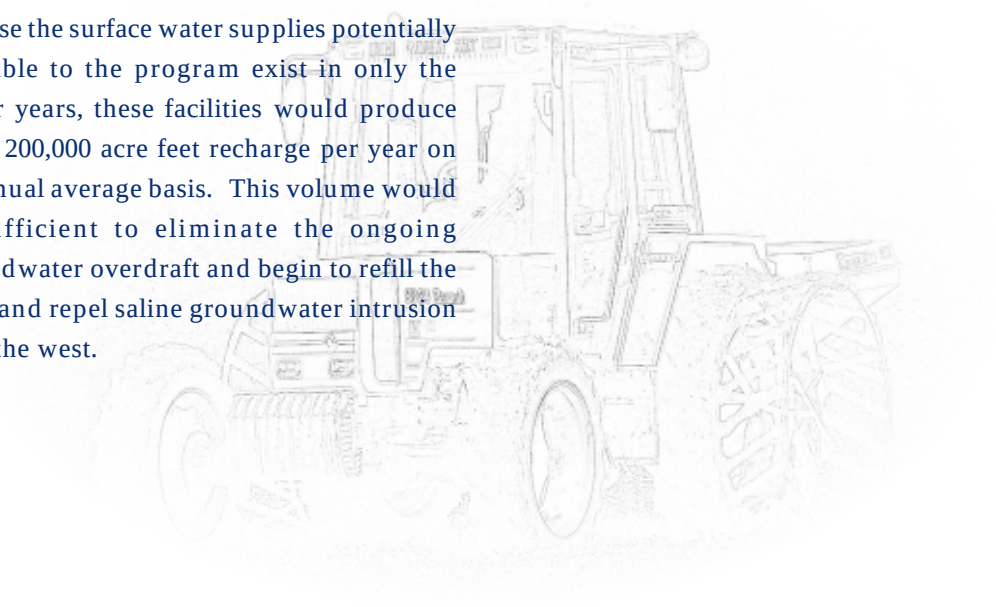
FACILITIES

Various planning efforts conducted over the years have investigated numerous individual projects designed to deliver additional surface water to Northeast San Joaquin County. The SJCWMP and the MARS Report identified a combination of individual projects with combined groundwater recharge capacity of over 300,000 acre feet per year shown on **Exhibit 3.**

Because the surface water supplies potentially available to the program exist in only the wetter years, these facilities would produce about 200,000 acre feet recharge per year on an annual average basis. This volume would be sufficient to eliminate the ongoing groundwater overdraft and begin to refill the basin and repel saline groundwater intrusion from the west.

CONVEYANCE COMPONENTS

"Conveyance Components" are needed to bring surface water supplies from multiple sources to the various recharge components. **Conveyance components include the Unlined Flat Canal and the Freeport Project.** New surface storage is not considered here, but could complement banking system operations and contribute to achieving other water resource management objectives.



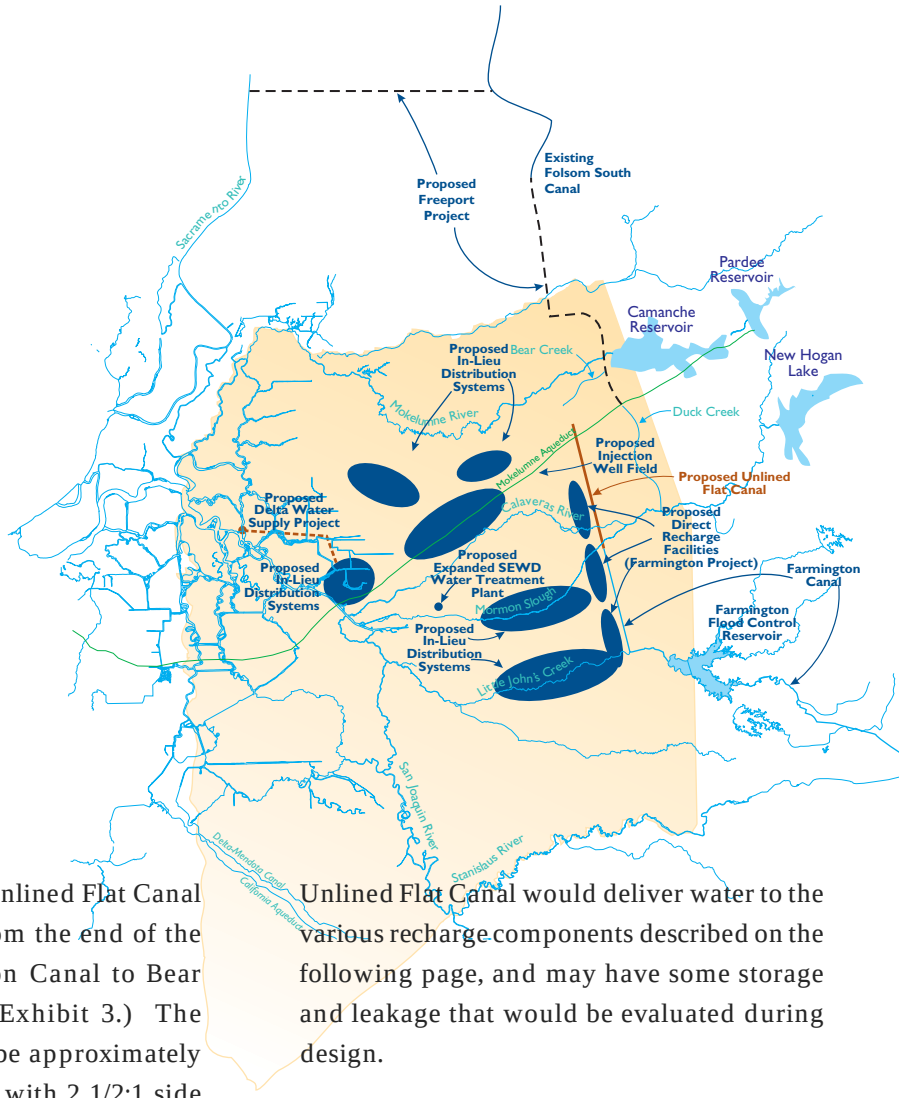


Exhibit 3. *Northeast San Joaquin County Groundwater Bank Facilities*

Unlined Flat Canal - The Unlined Flat Canal would extend northerly from the end of the existing Lower Farmington Canal to Bear Creek near Lockeford. (Exhibit 3.) The Unlined Flat Canal would be approximately 20 feet wide at the bottom with 2 1/2:1 side slopes. Water could be delivered to the Unlined Flat Canal from several sources including; the Stanislaus River and Littlejohn's Creek via the Farmington Canal, the Calaveras River via a new diversion facility, the Mokelumne River via Camanche as the MARS Report shows and/or the Mokelumne Aqueducts to Bear Creek, and the Sacramento River via the proposed Freeport Project. The Unlined Flat Canal would deliver water to the various recharge components described on the following page, and may have some storage and leakage that would be evaluated during design.

Freeport Project - The Freeport Project, currently being planned by the East Bay Municipal Utility District (EBMUD) and the Sacramento County Water Agency, would consist of a new diversion from the Sacramento River near the town of Freeport, a pipeline from the diversion to the existing Folsom South Canal, and a second pipeline with a capacity of 110,000 acre feet per year from the end of the canal to the Mokelumne Aqueducts near Camanche Reservoir. EBMUD plans to use its Freeport Project capacity only in about 35 percent of all years when needed to supplement its Mokelumne River supply during droughts.

Estimated Cost-Unlined Flat Canal

($ millions)

Capital Cost	Annualized Capital 5% @ 30 years	Recurring Cost	Total Annual Cost	Unit Cost $/AF*
66.2	3.71	0.17	3.88	$12.93

* Based on 300,000 AF/year wet-year capacity.
Reference: MARS Project Final Report (1996)

FACILITIES (cont)

Test Facility - Farmington Recharge Project

Therefore, Freeport Project capacity would potentially be available to the Northeast San Joaquin County Groundwater Banking Program in about 65 percent of all years. The cost of accessing this capacity is currently being discussed with EBMUD.

RECHARGE COMPONENTS

Exhibit 4 shows four types of recharge components; **In-Lieu Irrigation Deliveries, In-Lieu Municipal Deliveries, Direct Recharge, and Injection.** Any or all of these components could be used to recharge groundwater to stabilize the groundwater basin, repel saline intrusion, and/or bank water for future withdrawal for regional or statewide benefits. These components represent over 300,000 acre feet per year total recharge capacity.

In-Lieu Irrigation Deliveries - In-lieu recharge occurs when surface water is delivered to a water user who otherwise would have pumped groundwater. To implement in-lieu irrigation deliveries, distribution systems would be constructed to deliver surface water to growers who currently rely on groundwater pumping. Incentives in the form of reduced water costs would be required to encourage grower participation. In-lieu irrigation deliveries could take place in North San Joaquin Water Conservation District, Woodbridge Irrigation District, Stockton East Water District, Central San Joaquin Water Conservation District, and areas of the county outside these districts.

In-Lieu Municipal Deliveries - As with in-lieu irrigation deliveries, in-lieu municipal deliveries involve delivering new surface water supplies to municipal water users who would otherwise use groundwater. The City of Stockton's proposed Delta Water Supply Project would provide in-lieu municipal deliveries, as would a new surface water supply for the City of Lodi and any expansion of Stockton East Water District's Waidhofer Treatment Plant. Costs associated with these components have not yet been estimated.

Direct Recharge - Direct recharge occurs when water is applied to the land surface and percolates into the groundwater system. The U.S. Army Corps of Engineers Farmington project has demonstrated the feasibility of direct recharge using constructed basins and fields in Northeast San Joaquin County. Potential direct recharge opportunities have been identified in Stockton East Water District and North San Joaquin Water Conservation District.

Injection - The groundwater system can be recharged by treated water injected through new or existing wells. This method requires water relatively low in suspended solids to avoid clogging the well gravel pack.

Mokelumne Aqueduct water, and possibly Freeport Project water (if it is filtered) would be suitable for injection recharge. Because they are filtered, municipal water supplies would also be suitable for injection recharge. Injection recharge opportunities have been identified in Stockton East Water District and North San Joaquin Water Conservation District along the Mokelumne Aqueducts. Development of a potential injection well project, and other projects including the Mokelumne Aqueduct will require partnership arrangements with EBMUD. Injection well opportunities have also been identified in the City of Stockton as part of the Delta Water Supply Project.

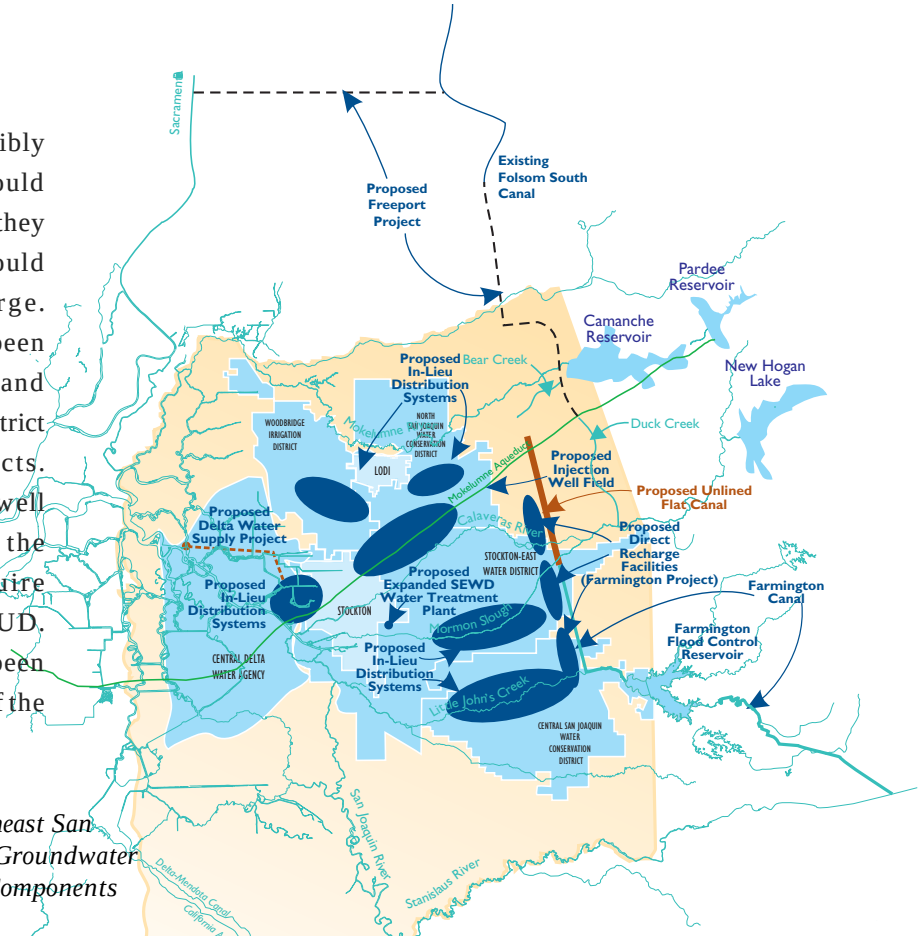


Exhibit 4. *Northeast San Joaquin County Groundwater Bank Recharge Components*

Estimated Recharge Component Costs

($ millions)

Component	Capital Cost	Annualized Capital Cost 5%@ 30 years	Recurring Cost	Total Annual Cost	Recharge Capacity (AF/year)	Unit Cost $/AF
Central San Joaquin Water Conservation District In-Lieu	16.4	0.92	0.01	0.93	83,000	11.20
Woodbridge Irrigation District In-Lieu	16.5	0.93	0.01	0.94	25,000	37.60
Stockton East Water District Injection	45.8	2.57	0.37	2.94	36,000	81.37
North San Joaquin Water Conservation District Injection	44.9	2.52	0.33	2.85	60,000	47.50
Stockton East Water District In-Lieu	8.2	0.46	0.04	0.50	12,000	41.37
North San Joaquin Water Conservation District In-Lieu	17.4	0.98	0.02	1.00	11,000	90.91
Farmington Project Direct Recharge	22.5	1.46	0.3	1.76	35,000	50.28

Reference: (MARS) Project, Final Report (1996); details from that report are reproduced in the Appendix. Annualized capital costs for the components pertaining to the Northeast San Joaquin County Groundwater Banking System were derived from Alternatives V(a) and V(b), by adjusting for 2001 construction costs.
The appendix includes maps and graphics for each alternative from the MARS Project Report (1996.) Costs for NSJWD injection include filtration; CSJWCD in-lieu includes current 3,000 AF/year New Melones use. The need for surface water storage will be assessed durring further analysis for individual components.

SURFACE WATER SUPPLY COMPONENTS

This section describes the various surface water supply sources potentially available to the Northeast San Joaquin County Groundwater Bank. Except for certain Stanislaus River supplies, San Joaquin County agencies do not hold water rights for any of these potential sources, although several water right permit applications are pending, as noted in the following sections.

The information from the graphs for each water source are summarized from the MARS Report (1996). For more information on frequency and water availability, refer to MARS Report graphs included in the appendix.

SACRAMENTO RIVER VIA THE PROPOSED FREEPORT PROJECT

EBMUD, in collaboration with the Sacramento County Water Agency, is planning to construct the Freeport Project, described earlier, that could potentially deliver water from the Sacramento River to Northeast San Joaquin County. Water could be delivered from the Freeport Project via Bear Creek to in-lieu recharge facilities in North San Joaquin Water Conservation District and to the Unlined Flat Canal which could deliver water to in-lieu recharge facilities in Stockton East Water District. The Freeport Project could also deliver water via the Mokelumne Aqueducts to injection facilities in North San Joaquin Water Conservation District or Stockton East Water District. The water right(s) or entitlement that would support such deliveries are unknown, but could consist of some combination of new water rights, Central Valley Project entitlements, and purchased water. **Exhibit 5** shows the potential availability of these sources, limited by Freeport Project capacity. Actual deliveries will depend on the entitlement(s) acquired.

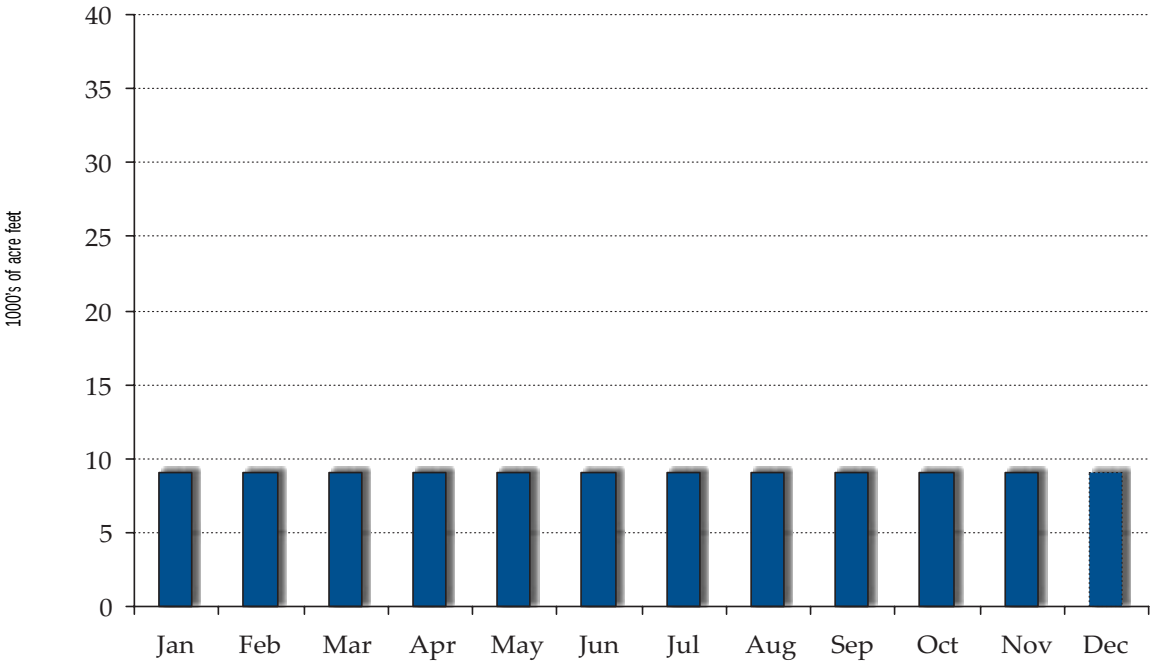


Exhibit 5. *Potential Sacramento River Wet Year capacity via Freeport Project (EBMUD Freeport Project capacity (150 cubic feet per second) unused in 65 percent of all years).*

MOKELUMNE RIVER

Exhibit 6 shows currently unused EBMUD Mokelumne River entitlement. EBMUD could choose to make this water available to the groundwater bank. This water could be delivered via the Mokelumne Aqueducts to injection facilities in North San Joaquin Water Conservation District and Stockton East Water District, or diverted from the Mokelumne River to in-lieu recharge facilities in North San Joaquin Water Conservation District and Woodbridge Irrigation District. Some unappropriated flows are also available on the Mokelumne in wet months of wet years, subject to the results of the Mokelumne River Water Rights Application. Woodbridge Irrigation District is entitled to certain wet year flows in excess of its quantified Mokelumne River entitlements.

Woodbridge Dam diverts Mokelumne River water to Woodbridge Irrigation District.

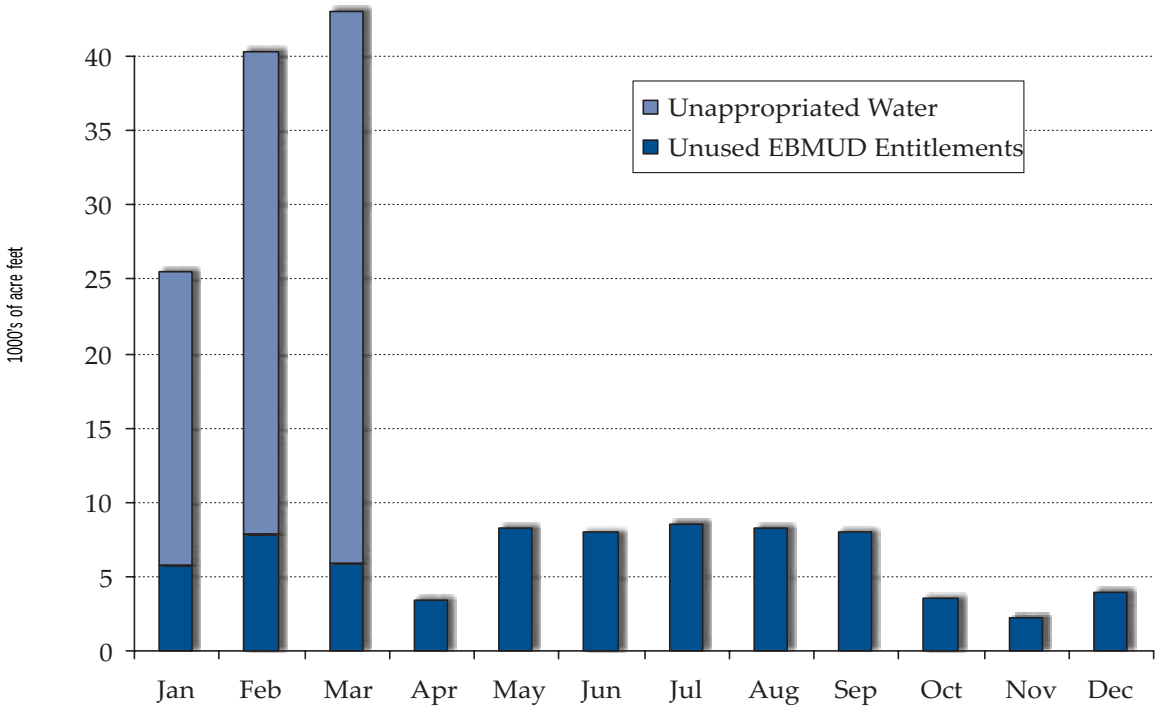


Exhibit 6. *Potential Mokelumne River Wet Year Supply, available in 30 percent of all years.*

Reference: MARS Final Report (1996). Supply is subject to State Water Resources Control Board's approval.

DELTA

The City of Stockton has filed an application to appropriate up to 126,000 acre feet per year from the Delta under California Water Code Section 1485 and various "Area of Origin" entitlements. This water will be treated and delivered to municipal water users within the City of Stockton's utility service area for municipal in-lieu groundwater recharge by the City's proposed Delta Water Supply Project. The city plans to implement the project in phases over the next 30 to 50 years. **Exhibit 7** shows the potential availability of this source.

The City of Stockton is entitled to divert water from the Sacramento – San Joaquin Delta under California Water Code Section 1485.

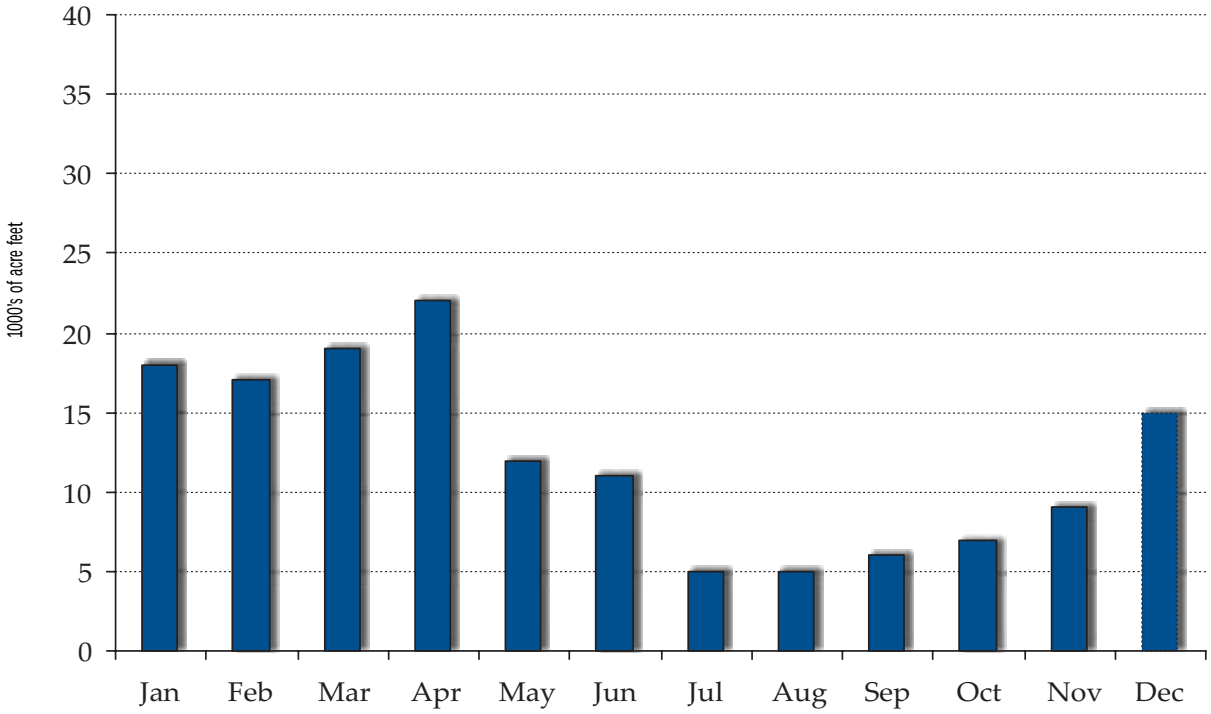


Exhibit 7. *Potential Delta Wet Year Supply via Delta Water Supply Project, 63 percent of all years.*

Reference: City of Stockton Municipal Utilities Department, Delta Water Supply Project - Unpublished working papers, analysis based on monthly DWRSIM operations modeling performed by CALFED for the CALFED Bay-Delta Program preferred alternative, model run no. 793 - low project delivery, no new storage.

CALAVERAS RIVER

Exhibit 8 shows unappropriated flows potentially available to the groundwater bank from the Calaveras River. These are primarily Flood Flows and New Hogan Reservoir releases that occur only in the wettest months of the wettest years. This water could be delivered via the Unlined Flat Canal to direct recharge facilities in North San Joaquin Water Conservation District, Stockton East Water District, and Central San Joaquin Water Conservation District.

Calaveras River

New Hogan Reservoir regulates Calaveras River flows.

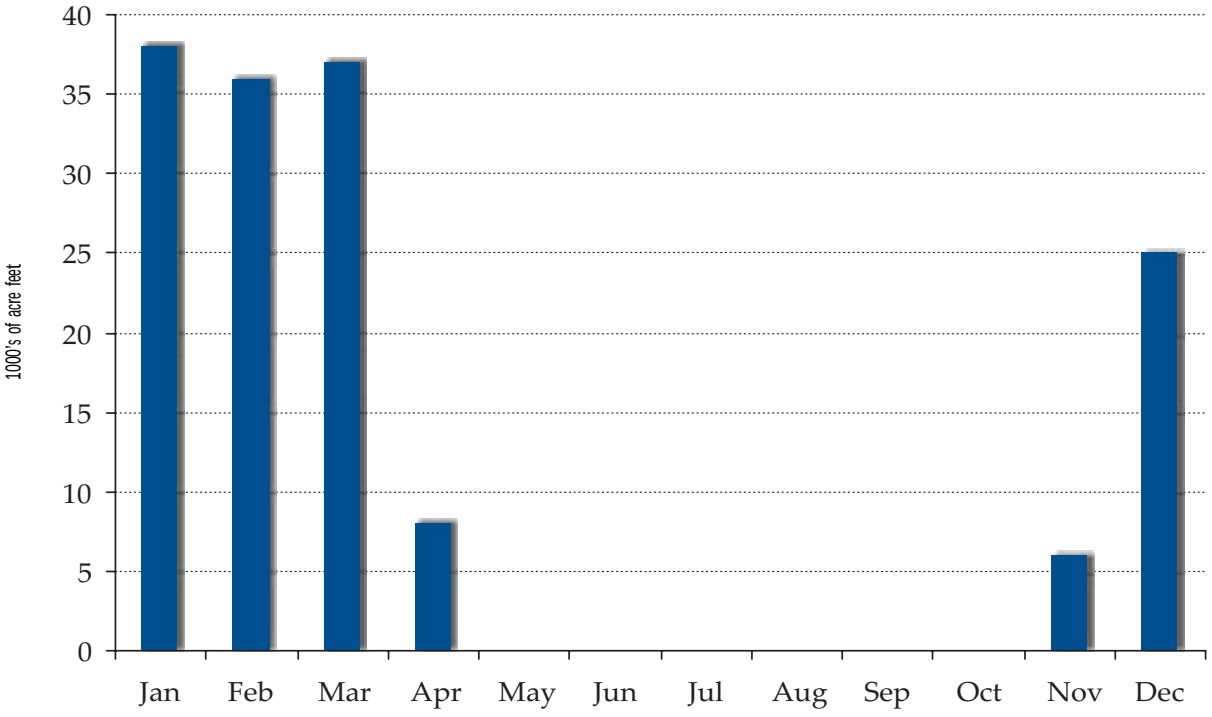


Exhibit 8. *Potential Calaveras River Wet Year Supply, available 30 percent of all years.*

Reference: MARS Final Report (1996), analysis based on daily historical flow data.

LITTLEJOHNS COMPLEX

Exhibit 9 shows unappropriated flows potentially available from the various streams that flow into the Farmington flood detention structure, limited by the initial capacity (300 cubic feet per second) of the Lower Farmington Canal. This source could be delivered, via the Lower Farmington canal, and existing creek capacity to the Unlined Flat Canal and direct recharge facilities in Central San Joaquin Water Conservation District, Stockton East Water District, and North San Joaquin Water Conservation District.

Farmington Dam provides flood control protection for areas downstream.

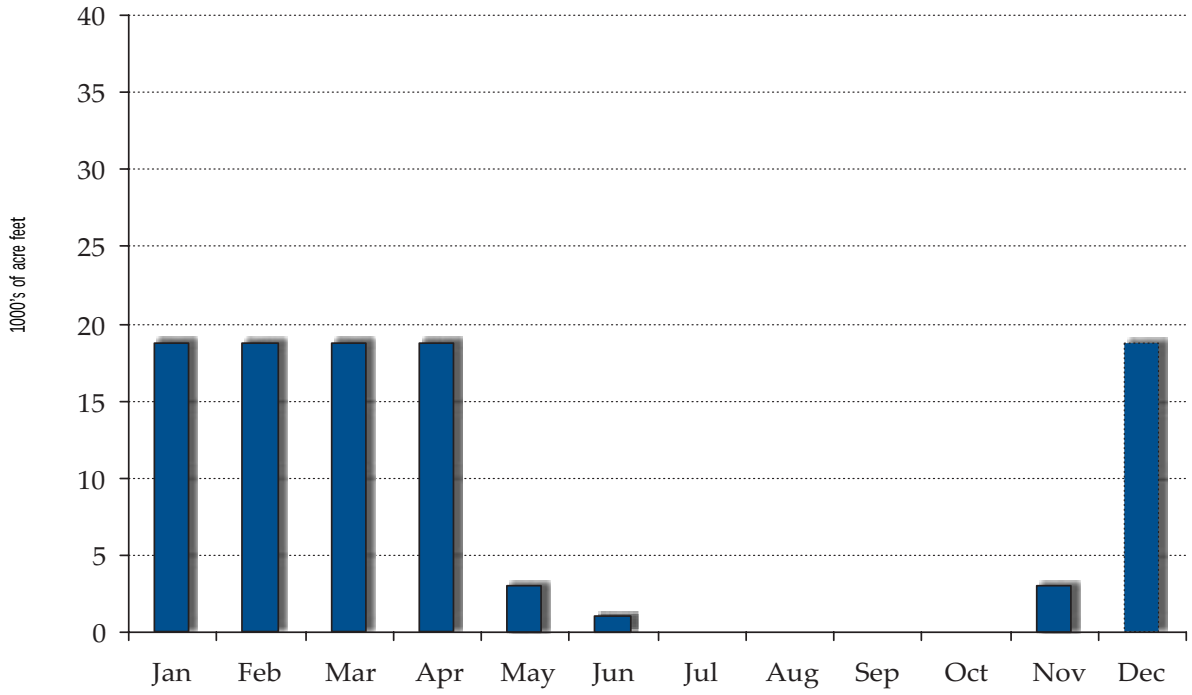


Exhibit 9. *Potential Littlejohn's Creek Wet Year Supply in Farmington Canal, available in about 30 percent of all years.*

Reference: MARS Final Report (1996), based on daily historical flow data.

STANISLAUS RIVER

Stanislaus River supplies are available under existing Stockton East Water District and Central San Joaquin Water Conservation District Central Valley Project contractual entitlements. South San Joaquin Irrigation District and Oakdale Irrigation District may choose to continue to sell conserved water to San Joaquin County water users. Also, unappropriated flows exist on the river in wet months of wet years. **Exhibit 10** shows Stanislaus River supply potentially available to the groundwater bank, assuming that supply sources can be identified and purchased to fill the Upper Farmington Canal Tunnel to capacity (850 cubic feet per second). This assumes that the Upper Farmington Canal would be lined to increase its capacity to 850 cubic feet per second.

Lower Farmington Canal conveys Stanislaus River water to Central San Joaquin Water Conservation District and Stockton East Water District.

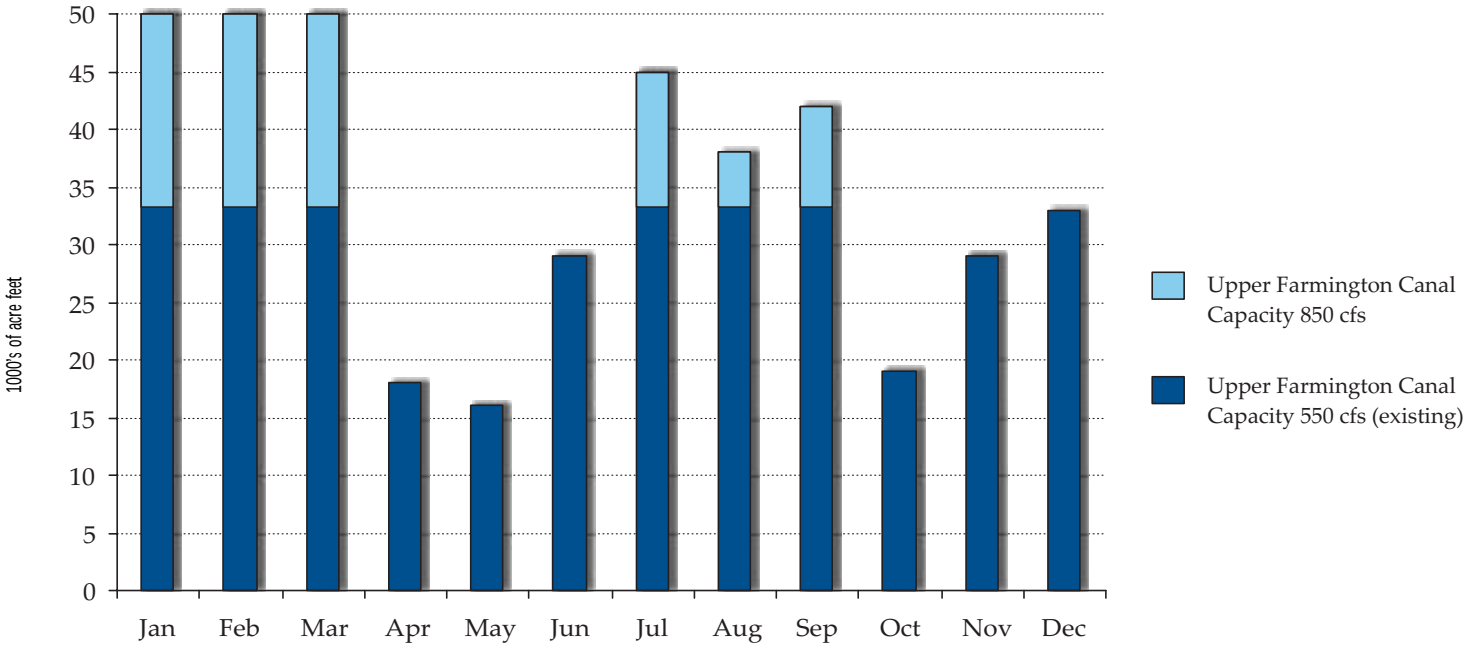


Exhibit 10. *Potential Stanislaus River Wet Year Supply via Farmington Canal, available in about 10 percent of all years, based on Upper Farmington Canal capacity.*

Exhibit 11 shows the average combined potential supply available from all of these sources in the wettest 30 percent of all years along with the combined recharge component capacities. The graph indicates that the water supplies shown, combined with the recharge component capacities, would recharge up to about 320,000 acre feet per year on average in wet years, which is consistent with the estimate in the San Joaquin County Water Management Plan (2001.) Although nearly 700 taf of water is potentially available, facility capacity limits the ability to recharge. The direct and injection recharge components are assumed to operate at a constant monthly rate year-round. In-lieu components are assumed to operate on an irrigation demand pattern. As shown, recharge is limited by supply availability in June (all recharge components cannot be operated at their full capacities) and recharge capacity in the other months.

Theoretically, this volume of groundwater recharge will facilitate in stabilizing Eastern San Joaquin county groundwater levels, repel saline intrusion, and provide stored water for subsequent dry year recovery and export. However, only actual operating experience will confirm the availability of the several potential surface water supplies, effectiveness of the various recharge mechanisms, and the response of the groundwater system to groundwater bank operations.

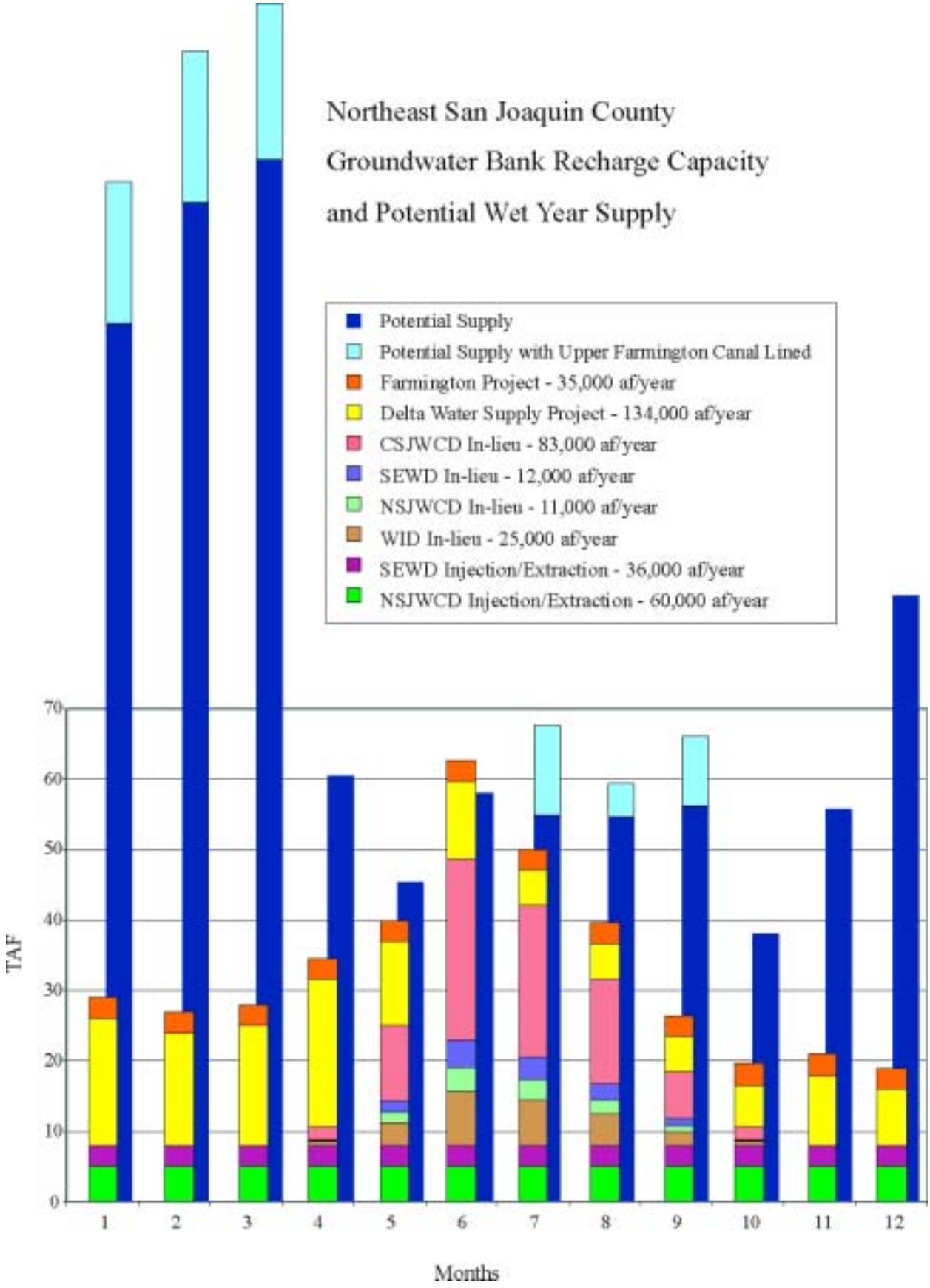


Exhibit 11. *Recharge Capacity and Potential Wet Year Supply - All Sources, available 30 percent of all years, reduced availability in other years, based on daily and monthly flow data as cited in individual supply source discussions and previous exhibits in this plan.*

COSTS

Exhibit 12 summarizes estimated costs for the groundwater bank components to the extent that cost information exists. Published data does not exist for either the Delta Water Supply Project or for an appropriate San Joaquin County share of Freeport Project costs. As indicated, supply costs related to potential water transfers and new entitlements are unknown.

Exhibit 13 on the following page arrays the known component costs in terms of unit recharge cost and recharge capacity. As shown, certain costs are still unknown. Estimated costs are based on previously published information summarized in the Appendix.

Supply Components	Potential Entitlements	Cost
Sacramento River	Unappropriated water, San Joaquin County's pending American River water right application, new CVP entitlement, water purchase(s).	unknown
Mokelumne River	Unappropriated water, Woodbridge Irrigation District Entitlements, North San Joaquin Water Conservation District entitlements, EBMUD entitlements.	unknown
Delta	Pending City of Stockton Water right application.	0
Calaveras River	Unappropriated water, unused Calaveras County entitlements.	0
Littlejohn's Complex	Pending Stockton East Water District water right application.	0
Stanislaus River	Unappropriated water, Stockton East Water District and Central San Joaquin Water Conservation District CVP entitlements, water transfers.	unknown

Conveyance Components	Capital Cost ($ millions)	Recurring Cost ($ millions per year)
Unlined Flat Canal	58.7	0.2
Freeport Project	unknown	unknown
Recharge Components		
NSJWCD Injection	38.7	0.3
SEWD Injection	39.5	0.4
WID In-Lieu	14.3	0.1
NSJWCD In-Lieu	15	0.1
CSJWCD In-Lieu	14.1	0.1
Delta Water Supply	unknown	unknown
Farmington Project	22.5	0.3

Exhibit 12. *Estimated Capital and Recurring Costs*

IMPLEMENTATION

The Northeast San Joaquin County Groundwater Bank faces several major implementation challenges including: implementing the entire plan, financing, and governance.

IMPLEMENTING THE ENTIRE PLAN

Exhibit 13 demonstrates that some recharge components are less expensive than other recharge components. However, all recharge components rely on a common, sustainable groundwater basin. The entire plan, including supply and conveyance components, should be implemented in order to provide sufficient means to reverse overdraft and protect the groundwater basin. Therefore, it may be appropriate to "levelize" the cost of all recharge components to reflect their reliance on the groundwater basin. Specifically, components that cost less than the average cost would be expected to generate revenue sufficient to fund supply and conveyance component implementation and above-average cost recharge components. **Exhibit 14** shows this conceptually.

By levelizing component cost, it is recommended that the plan could be implemented incrementally, with the lower cost components constructed first. These components would generate revenue that would be used to help finance future components.

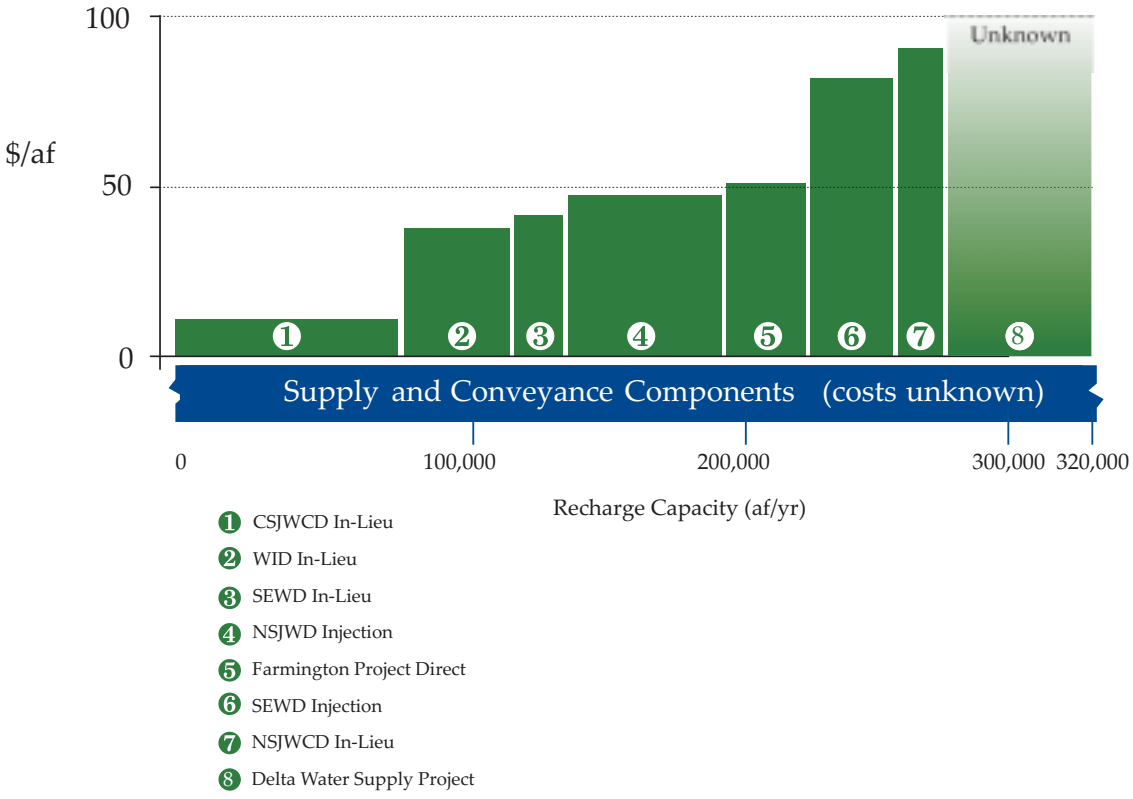


Exhibit 13. *Relative Recharge Component Cost and Capacity. Unknown recccurring costs are not included.*

FINANCING

Various forms of financing are potentially available including bonding, state and federal grants, and state and federal loans as described in the San Joaquin County Water Management Plan. Project revenues are required to retire the resulting debt. Both groundwater pumping assessments and surface water sales should be considered as potential revenue sources. Water sales to others outside the county may also be required to ensure that the Groundwater Bank is affordable to San Joaquin County water users. If so, previously banked water could be sold to others on a long-term contractual basis, or on the spot market by pumping groundwater to the Mokelumne Aqueducts or to rivers tributary to the Delta.

As described earlier, exports, even of previously banked groundwater, will not be sustainable unless the groundwater basin is stabilized and protected from saline intrusion. However, implementing the entire groundwater banking plan at once may not be practical. Therefore, it may be necessary to implement the plan incrementally, with the initial increments generating groundwater basin usage fees that would help fund subsequent increments.

GOVERNANCE

The many water agencies within San Joaquin County have most, if not all, of the powers and authorities needed to finance and construct the recharge components, assess user fees and operate facilities. The overarching function of levelizing recharge component costs and implementing supply components, conveyance components, and the more costly recharge components could be performed by the county or a new entity such as a joint powers authority or a new special district. Various governance options are described in the San Joaquin County Water Management Plan.

Several governance structures already exist in San Joaquin County, including the county government, the various water management agencies (districts and cities), and the Northeast San Joaquin County Groundwater Banking Authority. The County has enacted a groundwater management ordinance that establishes a permit requirement for any groundwater exports from the Eastern San Joaquin County groundwater basin. In general, the ordinance requires that an applicant demonstrate that the proposed export will not exacerbate the existing groundwater overdraft condition. The ordinance serves county interests by protecting investments in groundwater bank components.

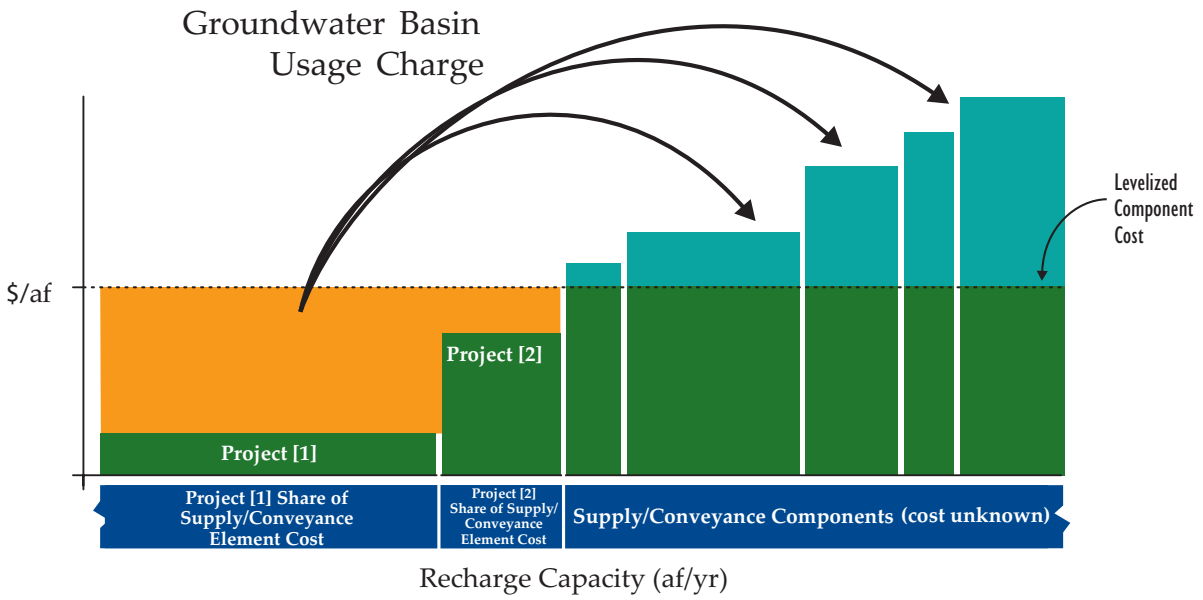


Exhibit 14. *Levelized Component Costs.*

NEXT STEPS

Many of the Groundwater Bank components described in this plan are also part of the San Joaquin County Water Management Plan (CDM, 2001). This System Plan is intended to be consistent with and complement the County-wide Plan and provide refinement in Northeast San Joaquin County.

Individual water agencies, with the support and facilitation of the Groundwater Banking Authority, will implement the various Groundwater Bank components over the next several years. **Exhibit 15** shows a potential sequence of events. A number of system components are currently being investigated and/or developed. Other components are in the preliminary stages of evaluation, and determinations to pursue specific projects will be based on the evaluation of additional technical and economic data. The actual schedule will depend on the development of supplies, analysis of Delta water quality issues, availability of funding, regulatory approval, and the progress of the Freeport Project. An implementation strategy will be developed to maximize water supply for Northwest San Joaquin County.

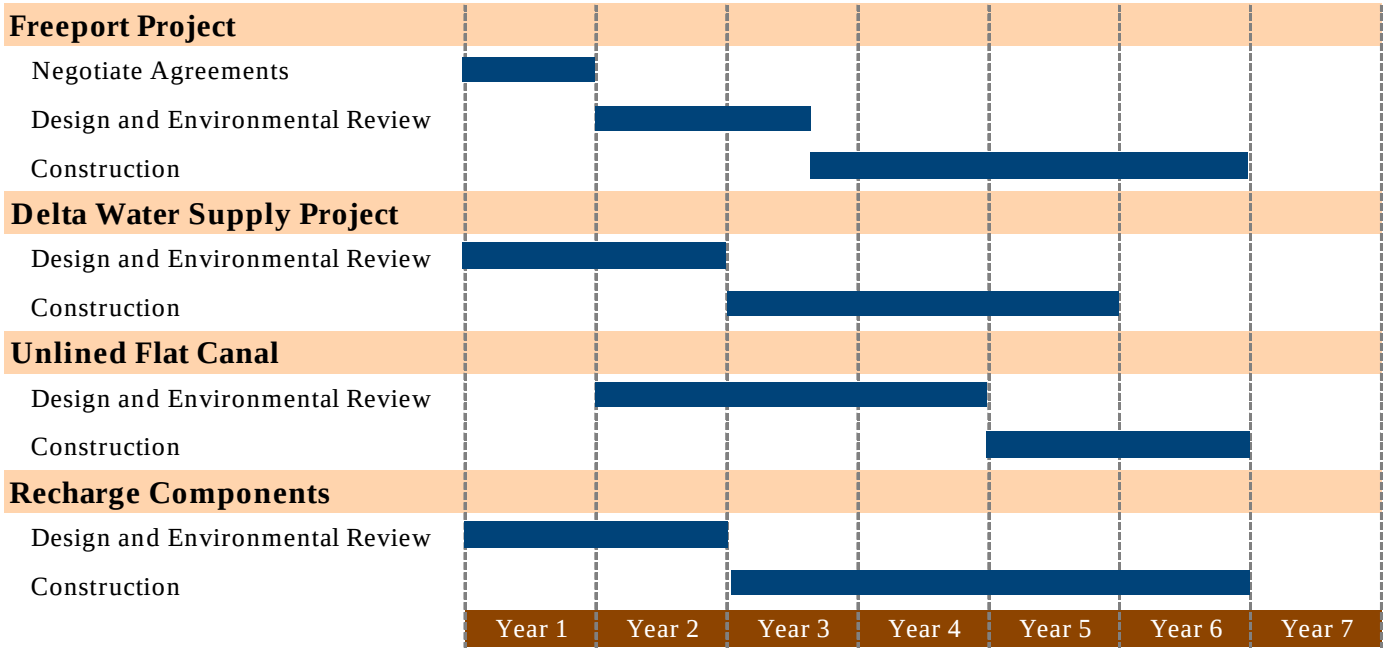


Exhibit 15. *Possible System Implementation Schedule.*

SYSTEM MAP

Exhibit 16 is a detailed map showing the major components of the Northeast San Joaquin County Groundwater Bank System.

APPENDIX

The **Appendix** contains system layout and cost information from EBMUD and East San Joaquin Parties Water Authority, Mokelumne Aquifer Recharge and Storage Project, Final Report (1995). Alternatives V(a) and V(b) were updated to current construction costs to develop cost information for this System Plan.

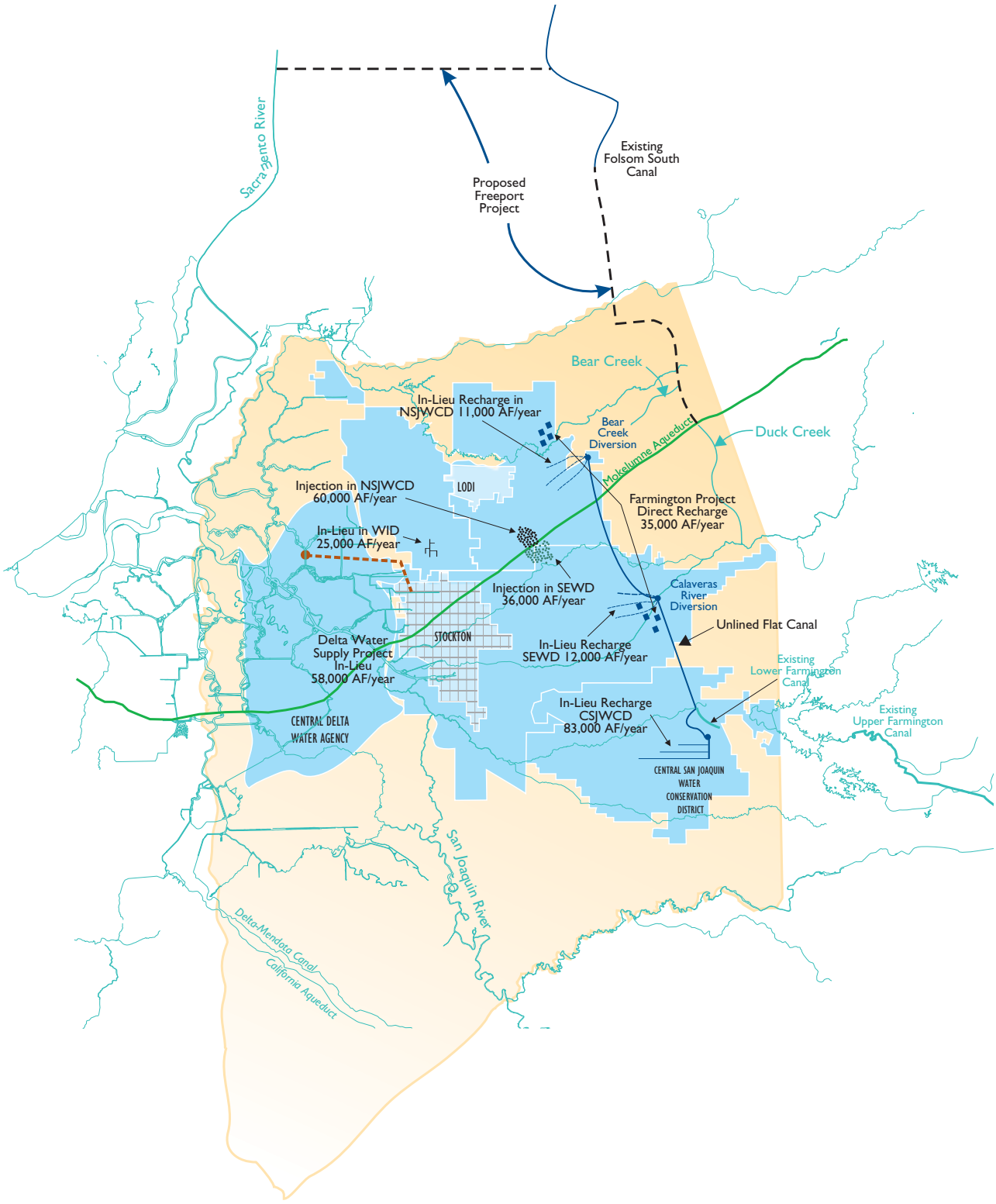


Exhibit 16. *Northeast San Joaquin County Groundwater Bank System.*

Northeast San Joaquin County
Groundwater Bank

System Plan
Components Inventory

San Joaquin County Groundwater Banking Authority

Prepared by: