Incremental Recycled Water Program
Seasonal Storage Project

DRAFT ENVIRONMENTAL IMPACT REPORT

VOLUME 3 OF 5

Draft Engineering Report

December 2007

Prepared for

City of Santa Rosa

Utilities Department
69 Stony Circle
Santa Rosa, CA 95401

Prepared by

WINZLER & KELLY
CONSULTING ENGINEERS
495 Tesconi Circle
Santa Rosa, CA 95401

In Association with

CH2MHILL

TABLE OF CONTENTS

Incremental Recycled Water Program
Seasonal Storage Project

Draft Engineering Report

Prepared for

City of Santa Rosa

Utilities Department
69 Stony Circle
Santa Rosa, CA 95401

December 2007

WINZLER & KELLY
CONSULTING ENGINEERS

Table of Contents

List of Tables

List of Figures

Attachments (Technical Memoranda)

Acronym List

AVR	Alexander Valley Road
BF	Brown Farm
BPU	Santa Rosa Board of Public Utilities
CTS	California Tiger Salamander
CY	Cubic Yards
DSOD	Division of Safety of Dams
EIR	Environmental Impact Report
GPL	Geysers Pipeline
HPS	High-Pressure Reuse System
IDF	Inflow Design Flood
IRWP	Incremental Recycled Water Program
KF	Kelly Farm
LPS	Low-Pressure Reuse System
MGD	Million Gallons per Day
MG	Million Gallons
PHR	Petaluma Hill Road
PMP	Probable Maximum Precipitation
RW	Recycled Water
RWQCB	Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SPM	Storage Planning Model
SSP	Seasonal Storage Project
TM	Technical Memorandum
WBM	Water Balance Model
WC	West College

EXECUTIVE SUMMARY

The IRWP Seasonal Storage Project would provide storage of recycled water generated by the Subregional Water Reuse System members in a manner that is reliable and in compliance with regulatory requirements. The volume of recycled water the Project must store is based on the IRWP Master Plan. Under the IRWP Master Plan, storage could be needed for both urban reuse and discharge compliance. The total seasonal storage volume that could be needed in addition to existing storage capacity, depending on the projects selected for urban reuse and discharge compliance and the outcome of RWQCB water quality regulation, could be up to 500 million gallons (MG).

A range of storage sites were investigated and evaluated for their feasibility and ability to meet the Project objectives. Potential storage sites identified for consideration included sites from previous studies, existing sites that could be expanded, and new sites. More than 100 sites were identified for consideration and their locations ranged from Alexander Valley to Cotati, and from Forestville to Oakmont. After screening the sites based on exclusionary and preferential criteria, and further eliminations after evaluating the sites based on technical considerations, the remaining three sites include:

- Kelly Farm Site (KF)
- Brown Farm Site (BF)
- Alpha Farm Site (AF)

The seven potential storage ponds that could be located at these three sites would have storage capacities between 105 MG and 282 MG each, and combined would have a total storage capacity of 944 MG. Table ES-1 provides a comparison of the alternative storage pond capacities and costs.

TABLE ES-1
Alternative Storage Pond Comparisons
IRWP Seasonal Storage Project – Draft Engineering Report

Site ID	Name	Capacity (MG)	PW Cost[a] ($1,000)	PW Cost per MG ($1,000)	Loss of Irrigation (AC)	CTS Mitigation (AC)
KF1	Kelly Farm Pond 1	282	$47,630	$170	61	61
KF2	Kelly Farm Pond 2	185	$37,110	$200	47	47
KF1&2	Kelly Farm Ponds 1&2	467	$82,310	$180	108	108
BF1	Brown Farm Pond 1	226	$39,420	$170	48	48
BF2	Brown Farm Pond 2	105	$44,640	$420	41	41

TABLE ES-1
Alternative Storage Pond Comparisons
IRWP Seasonal Storage Project – Draft Engineering Report

Site ID	Name	Capacity (MG)	PW Cost[a] ($1,000)	PW Cost per MG ($1,000)	Loss of Irrigation (AC)	CTS Mitigation (AC)
BF1&2	Brown Farm Ponds 1&2	331	$79,170	$240	88	88
AF1	Alpha Farm Site	146	$38,600	$260	46	46

Note: [a] PW is the 20-Year Present Worth at 4% interest.

About 500 MG of additional seasonal storage is required in the Subregional System to meet the Project need. Table ES-2 includes three possible combinations of storage ponds with the present worth costs and present worth cost per million gallons of storage provided for comparison. Of these three possible combinations, Combination C would have the lowest cost.

TABLE ES-2
Possible Storage Pond Combinations to Meet Additional Storage Capacity Need
IRWP Seasonal Storage Project – Draft Engineering Report

Combination	Storage Pond ID	Total Additional Capacity (mg)	PW Cost[a] ($1,000)	PW Cost[a] per MG ($1,000)
A	BF1&2, KF2	516	$116,280	$225
B	KF1,BF2,AF1	533	$130,870	$245
C	KF1, BF1	508	$87,050	$171

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

1. INTRODUCTION

IRWP History

The City of Santa Rosa operates the Santa Rosa Subregional Water Reuse System (Subregional System) to serve the wastewater treatment, reuse and disposal needs of the City of Santa Rosa, the City of Rohnert Park, the City of Cotati, the City of Sebastopol, the South Park County Sanitation District and portions of unincorporated Sonoma County. The City undertook the Incremental Recycled Water Program (IRWP) in 2001 to in response to planned additional wastewater flows to the Subregional System and increasingly stringent water quality regulations. In 2004, the City adopted the IRWP Master Plan as the blueprint for managing the anticipated additional recycled water flows in compliance with new regulations.

In 2005 the Subregional System began implementation of the IRWP Master Plan including conceptual design work on a Discharge Compliance Project (DCP) and a feasibility analysis for a Santa Rosa Urban Reuse Project (SRURP). In late 2006, the Subregional System elected to proceed with predesign of the SRURP. At the same time the City initiated conceptual design work for expansion of recycled water storage, as additional storage could be needed for the DCP and the SRURP.

IRWP Seasonal Storage Project Purpose

The IRWP Seasonal Storage Project (SSP) would provide storage of recycled water generated by the Subregional System members in a manner that is reliable and in compliance with regulatory requirements. The volume of recycled water the Project must store is based on the IRWP Master Plan. Under the IRWP Master Plan, storage is needed for both urban reuse and discharge compliance. The SSP would provide approximately 500 million gallons (MG) total seasonal storage volume in addition to existing storage capacity.

The Project objectives provide guidance for achieving the Project’s purpose: storage of recycled water in a reliable, practicable manner that encourages the best use of water resources, while protecting public health and the environment. Thus, the City’s purpose for the Project is consistent with the Program’s overall purpose: not only to dispose of recycled water, but to do so in a manner that facilitates reuse opportunities particularly where recycled water will increase the availability of potable water supplies. Although the need for the Project is driven by disposal requirements, Project elements that encourage reuse and conservation of water resources will serve the overall purpose and need of the Program.

Project Objectives

Primary Project Objectives

- Provide seasonal storage capacity for the Santa Rosa Subregional Water Reuse System of approximately 500 MG to carry out a portion of the IRWP Master Plan;
- Develop and operate the wastewater disposal system in ways that protect public health and safety, protect natural resources including the Russian River and its tributaries, promote use of recycled water, meet current regulatory requirements, and provide flexibility to meet future regulatory requirements; and
- Maintain a system and system components that can continue to be successfully financed and that are economically feasible.

Supporting Project Objectives

The supporting Project objectives are intended to further define the primary Project objectives and to provide guidance in the development, evaluation, and selection of Project alternatives.

- Maximize use of recycled water;
- Maximize reuse opportunities where recycled water will increase the availability of potable water supplies;
- Dispose of recycled water in a manner that protects beneficial uses of receiving waters;
- Optimize water conservation;
- Maintain the level of weather-independence (as defined by RWQCB policy) that is provided by the addition of the Geysers Recharge Project to the Subregional Reuse System;
- Maximize use of existing infrastructure;
- Maintain a disposal system that is manageable and reliable; and
- Provide flexibility to accommodate use of recycled water made available by neighboring agencies as deemed appropriate by the City of Santa Rosa.

New Information

The Board of Public Utilities adopted the Purpose and Need Statement for the Seasonal Storage Project on October 5, 2006. The Statement was confirmed by the City Council on October 17, 2006. After the City adopted the Purpose and Need Statement for the IRWP Seasonal Storage Project, new information and events relating to the Project have occurred that could impact the amount of additional storage needed. The new information and events include:

- Storage Planning Model (SPM) results showed that storage could be operated more efficiently than previous models, as represented in the IRWP Master Plan;

- The Geysers Expansion Project was approved, allocating additional recycled water to the Geysers in a fashion that reshaped the seasonality of demand for stored recycled water relative to that which was expected when the IRWP Master Plan was adopted in 2004; and
- DCP conceptual design and SRURP preliminary design provided new information about storage needs.

After conducting the contracted work, results of the SPM conclude that storage requirements, if any, vary substantially dependent upon the DCP project to be selected in mid-2008, the ultimate size of the SRURP, and how implementation of the remainder of the IRWP Master Plan will occur. This Project therefore has proceeded with provision of options for up to 500 MG of additional storage capacity, in conformance with the Purpose and Need Statement adopted by the City.

2. EXISTING SUBREGIONAL REUSE SYSTEM

Reuse Conveyance and Storage System

The Subregional System stores and conveys recycled water to approximately 68 users for agricultural reuse, approximately 46 users for urban reuse and one industrial customer for geothermal energy production. When evaluating potential storage sites an understanding of how water is moved around the system and the requirements of the end users is needed. Brief descriptions of the existing water reuse facilities and the requirements of the users are provided below. A vicinity map of the existing water reuse facilities is provided in Figure 1.

Reuse facilities include pump stations, pressure pipelines and storage sites. The reuse facilities are classified into three general conveyance systems. These are:

- The low-pressure reuse system (LPS north and south) which delivers water to users at pressures ranging from 5 to 20 PSI;
- The high-pressure reuse system (HPS) which delivers water to users at pressures ranging from 75 to 110 PSI; and
- The Geysers Pipeline (GPL) which delivers water to the Geysers steamfields and currently pumps about at 175 PSI, but could be upgraded to pump at 250 PSI.

The LPS is the oldest portion of the three conveyance systems listed above. It encompasses the original agricultural reuse system served by the decommissioned West College Treatment Plant and includes all of the existing storage ponds except Gallo. The LPS provides irrigation water to agriculture customers, the Foxtail Golf Course and several other urban customers in Rohnert Park and a small network of urban customers in western Santa Rosa. The total connected storage capacity on the LPS is approximately 1,473 MG, the amount needed to accumulate recycled water during the wet weather season and just meet peak irrigation water demands during the summer. The Gallo Pond is connected to the HPS and provides an additional 100 MG of storage capacity. Table 2-1 indicates storage capacity and ownership for the existing storage facilities.

TABLE 2-1
Existing Reuse Storage Facilities
IRWP Seasonal Storage Project –Draft Engineering Report

Site Name	Operational Storage Capacity	Owner
Delta Pond	572 MG	City of Santa Rosa
Kelly Farm Pond	23 MG	City of Santa Rosa
Brown Farm Pond	165 MG	City of Santa Rosa
La Franconi Pond	5 MG	Private
Alpha Farm Ponds	31 MG	City of Santa Rosa
Meadow Lane Ponds	564 MG	City of Santa Rosa

TABLE 2-1
Existing Reuse Storage Facilities
IRWP Seasonal Storage Project –Draft Engineering Report

Site Name	Operational Storage Capacity	Owner
Ambrosini Pond	18 MG	City of Santa Rosa
West College Ponds	75 MG	City of Santa Rosa
A Place to Play Pond	20 MG	City of Santa Rosa
Gallo Pond	100 MG	Private

The HPS includes the existing Rohnert Park urban reuse system constructed in the mid-1990s. Currently, this system is fed solely from the Rohnert Park (Poncia) Pump Station near the southern end of the low pressure reuse system. Filtration and chlorination is provided at the pump station for algae control, but no additional treatment is currently provided. The high pressure system also feeds water to the Gallo Pond and serves as fire suppression water at Sonoma State University.

The GPL is the newest facility in the Subregional System network and continuously conveys recycled water to the Geysers steamfields in accordance with a contract with Geysers Power Company (Calpine), the primary operator of the Geysers geothermal field. Recycled water can be conveyed from the Geysers Pipeline to Delta Pond, where it can be stored, discharged or fed back into the LPS at the north end. Figure 2 provides a schematic of the water reuse facilities and how they are interconnected to convey water to the appropriate end users.

Seasonal Operation

The Geysers steamfields receives water continuously and the fire suppression water system at Sonoma State University is always charged and ready for use. Other end uses are seasonal in nature. Agricultural and urban irrigation demands typically occur outside of the wet weather season. Some industrial uses can occur year-round, but most of the agricultural and urban demands occur between the months of April and November. Discharge is permitted to occur only between October 1 and May 14, and only under allowable conditions in the receiving water. Seasonal storage is needed to provide storage when the water supply exceeds demands or the ability to discharge (winter), and to make the water available when demands for recycled water exceed the water supply (summer).

Agricultural Customers

Agriculture customers are served from both the LPS and HPS. These customers have historically received a combination of recycled water pumped directly from the Laguna Plant and recycled water from storage ponds. Operational experience indicates that algae has not been a problem for this use.

Urban Customers

The Subregional System has historically directed recycled water directly from the Laguna Plant through the southern leg of the LPS to the HPS in Rohnert Park. Recycled water delivery continues year-round because the HPS is kept charged during the winter to provide fire protection to Sonoma State University. In 2006, the Subregional System installed chlorination facilities at the Rohnert Park Pump Station to discourage algae growth in the HPS.

As noted above, the Subregional System serves a small number of urban customers from the LPS in west Santa Rosa. These customers receive recycled water from the West College Utilities Facility, and this has resulted in less than optimum performance of onsite irrigation systems. Filtration has been installed at the West College Facility to improve performance in response to these operational concerns.

Geysers Steamfields

In August 2007, the City and Calpine signed an amended agreement to increase the volume of recycled water being sent to the steamfield from an average of 11 MGD per year to as much as 20 MGD per year incrementally over time. Water is sent to the Geysers pipeline from the Llano Pump Station which receives water directly from the Laguna Treatment Plant or the LPS.

Discharge

Discharge to the Laguna de Santa Rosa is regulated by the State Regional Water Quality Control Board and is permitted only between October 1 and May 14 and is subject to restrictions dependent upon conditions in the receiving waters. Water is discharged only when it cannot otherwise be stored and/or reused.

3. SITE SELECTION SUMMARY

Selection Criteria

A range of storage sites was investigated, and sites were evaluated for their feasibility and ability to meet the Project Objectives. This evaluation was carried out using the exclusionary and preferential criteria listed below in Table 3-1. These criteria were accepted by the BPU on October 5, 2006. No environmental siting criteria were utilized in this evaluation, because environmental impacts will be evaluated in the SSP EIR. Mitigation land requirements for California tiger salamander (CTS) habitat were estimated for the potential storage sites for the purpose of estimating costs for mitigation land requirements.

TABLE 3-1
Engineering Evaluation Criteria
IRWP Seasonal Storage Project – Draft Engineering Report

Exclusionary Criteria	Preferential Criteria		
	Engineering	**Logistics**	**Cost**
Minimum Site Acreage	Reliability	Construction permitting	Construction
Active Fault Zone	Flexibility	Property acquisition	Annual O&M
	Constructability	Schedule compliance	
	Geotechnical considerations		
	Hydraulics/Operations		
	Proximity to RW Users		
	Proximity to Infrastructure		
	Groundwater Quality		
	Flooding		
	Energy Use		

Exclusionary criteria were used to exclude sites without the need to further evaluate a site using preferential criteria. The exclusionary criteria utilized in this project included a minimum site acreage and active fault zones in the location of a proposed pond or reservoir. Preferential criteria listed in three main categories, cost, engineering and logistics were utilized to evaluate sites.

Identification of Potential Storage Sites

Potential storage sites were identified from previous studies, storage sites that might potentially be expanded, and new potential sites. The sites identified included potential pond sites from Alexander Valley to Cotati, and from Forestville to Oakmont. Figure 3 shows the approximate locations of the sites identified for consideration for additional seasonal storage.

Using the exclusionary criteria, sites within active fault zones and sites that were not a minimum of 20 acres aggregate (including adjoining parcels together comprising a "site") were eliminated. Also, the preferential flooding criterion was applied, and sites entirely within the 100-year floodplain were eliminated. Next, the preferential criterion *proximity to existing infrastructure* was applied to limit sites to within 5 miles of the existing reuse facilities (Figure 1). A total of 34 sites remained as potential seasonal storage sites covering the entire area. The remaining evaluation criteria included in Table 3-1 were then applied to the 34 potential seasonal storage sites.

The 34 potential storage sites include ponds in the Santa Rosa Plain and east of Rohnert Park, and ponds in the hills to the north (Alexander Valley) and east (Rohnert Park). The general guidelines used in developing preliminary layouts for each site include the following:

1. Avoid the 100-year floodplain, perennial streams and major utilities where feasible;
2. Provide space for treatment and pumping facilities in case they are required;
3. Balance cut and fill to the extent possible; and
4. Maximize storage capacity.

Screening of Potential Storage Sites

The next step was to evaluate and eliminate potential sites by applying the preferential evaluation criteria. Eliminating sites was appropriate if a site did not represent an advantage over the sites to remain for further consideration, or had distinct disadvantages.

Sites having limited storage capacity were considered infeasible compared with sites having greater storage capacity because they are less efficient in use of space and impact a greater area per unit of storage provided. Also, more storage ponds would be required and would be less efficient and more costly to maintain than a small number of large storage ponds. All ponds having less than 50 MG of total storage capacity were therefore eliminated from further consideration, and most of the remaining ponds had at least 100 MG or more capacity.

Sites that are significantly farther from existing infrastructure would require longer pipelines to convey recycled water to and from storage. This would result in increased areas disturbed by construction, more maintenance, and higher costs. Almost all of the sites that remained for further screening were located near existing reuse pipelines, including the Geysers Pipeline.

Sites were also eliminated for other factors, including:

- Inundation of residences;
- Constructability issues; and
- Residences located immediately below dams.

Six sites remained after the screening process having an aggregate storage capacity between 1,000 MG and 2,000 MG, which provides for a greater number of combinations from which to select in meeting the 500-MG need identified in the Project Objectives. The six sites were:

- Alexander Valley Road Site (AVR)
- West College Site (WC)
- Kelly Farm Site (KF)
- Brown Farm Site (BF)
- Alpha Farm Site (AF)
- Petaluma Hill Road Site (PHR)

The remaining sites were then evaluated for technical considerations including geotechnical, hydrological, groundwater, and hydraulic/operational considerations. The West College and Alexander Valley Road Sites have been eliminated and are not considered further because of findings from the geotechnical investigations related to potential impacts from liquefaction, fault zones, and/or landslides and the appropriate measures to mitigate for these potential hazards. Based on the geotechnical findings at these sites, both are considered infeasible (as defined by CEQA Guidelines), as described in the TM *Geotechnical Evaluation, November 2007*.

After additional engineering evaluations, the Petaluma Hill Road Site was eliminated due to cost considerations. Therefore, three potential sites remain (Figure 4) with a total of seven storage pond alternatives:

- Kelly Farm Site (KF)
- Brown Farm Site (BF)
- Alpha Farm Site (AF)

Recommended Storage Pond Alternatives

The seven recommended seasonal storage ponds would have storage capacity of between 105 MG and 282 MG each, and combined would have a total storage capacity of 944 MG. These sites are intended to provide a reasonable range of alternatives for the Seasonal Storage Project EIR. Table 3-2 provides a comparison of the capacities and costs for the recommended storage ponds. Cost advantages could occur by constructing more than one pond at a given site, and so costs are also provided where more than one pond could be constructed at a given site. Preliminary estimates of probable cost were completed for each of the alternatives and are included in the TM, *Basis for Costs, November 2007.*

TABLE 3-2
Alternative Storage Site Comparison
IRWP Seasonal Storage Project – Draft Engineering Report

Site ID	Name	Capacity (MG)	PW Cost[a] ($1,000)	PW Cost per MG ($1,000)	Loss of Irrigation (AC)	CTS Mitigation (AC)
KF1	Kelly Farm Pond 1	282	$47,630	$170	61	61
KF2	Kelly Farm Pond 2	185	$37,110	$200	47	47
KF1&2	Kelly Farm Ponds 1&2	467	$82,310	$180	108	108
BF1	Brown Farm Pond 1	226	$39,420	$170	48	48
BF2	Brown Farm Pond 2	105	$44,640	$420	41	41
BF1&2	Brown Farm Ponds 1&2	331	$79,170	$240	88	88
AF1	Alpha Farm Site	146	$38,600	$260	46	46

Note: [a] PW is the 20-Year Present Worth at 4% interest.

The adopted Purpose and Need Statement indicates about 500 MG of additional seasonal storage could be required in the Subregional System. Table 3-3 includes three possible combinations of storage ponds with the present worth costs and present worth cost per million gallons of storage provided for comparison. Of these three possible combinations, Combination C has the lowest cost.

TABLE 3-3
Possible Storage Pond Combinations to Meet Additional Storage Capacity Need
IRWP Seasonal Storage Project – Draft Engineering Report

Combination	Storage Pond ID	Total Additional Capacity (mg)	PW Cost[a] ($1,000)	PW Cost[a] per MG ($1,000)
A	BF1&2, KF2	516	$116,280	$225
B	KF1,BF2,AF1	533	$130,870	$245
C	KF1, BF1	508	$87,050	$171

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

4. CONCEPTUAL DESIGNS

Kelly Farm - Pond 1 (KF1)

The Kelly Farm Site is located north of Highway 12, just west of Llano Road. The Subregional System uses the site for seasonal storage in an existing 23-MG pond, and for irrigation of hay fields. The site, bisected by the Sonoma County Water Agency (SCWA) Aqueduct and the GPL, includes the following parcels:

- APN 060-020-081
- APN 060-020-082
- APN 060-020-083
- APN 060-020-084
- APN 060-020-085

KF1 would have a capacity of 282 MG and would be located near Highway 12 at the south end of the site. Constructing the pond would require excavating up to 10 feet below existing grade and using the native materials to construct an embankment around the perimeter of the pond. The embankment would be approximately 5,600 linear feet creating a 46-acre pond. Removal of the existing irrigation piping within the pond footprint would be required. An existing Low Pressure Reuse Line would be relocated around the footprint of the new pond. The layout and location of storage pond features are shown in plan view in Figure 5.

Without the need of additional pumping, KF1 would fill from the Low Pressure Reuse Line, but a pump station would be required to drain the pond back into the Subregional System. The 7-MGD inboard pump station would be located on the embankment at the northeast end of the pond. A 30-inch diameter pressure pipeline would be required to fill and drain KF1. This pipe will tie in to the existing Low Pressure Reuse Line on site. Providing a standpipe spillway and emergency outlet discharging to an existing drainage to the north of the pond would be required to meet DSOD requirements. Energy dissipaters would reduce the velocity of flows discharging from the spillway, and the existing drainage would be lined with riprap to protect the banks from erosion.

An access road would be required from Highway 12 and extend along portions of an existing gravel road along the outside of the pond, and up onto the top of the embankment for access to the pump station. Table 4-1 summarizes the estimate of present worth cost for KF1.

TABLE 4-1
Estimate of Present Worth Cost for KF1
IRWP Seasonal Storage Project – Draft Engineering Report

Description	Total Cost
Site Preparation	$1,460,000

TABLE 4-1
Estimate of Present Worth Cost for KF1
IRWP Seasonal Storage Project – Draft Engineering Report

Description	**Total Cost**
Excavation/Foundation & Lining	$3,180,000
Embankment	$4,540,000
Drainage/Stabilization	$100,000
Drainage & Containment	$230,000
Pump Stations/Treatment	$1,000,000
Piping	$220,000
Site Improvements	$390,000
Subtotal, Construction Costs	$11,100,000
Engineering, Admin & Legal (23%)	$3,320,000
Construction Contingency (30%)	$3,330,000
Subtotal, Admin & Contingency	$6,660,000
CTS Mitigation	$18,300,000
Land Acquisition	$0
Land Contingency	$9,150,000
Subtotal, CTS Mitigation & Land	$27,450,000
TOTAL CAPITAL COST	**$45,220,000**
ANNUAL O&M COST	$180,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$47,630,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Kelly Farm – Pond 2 (KF2)

KF2 would have a capacity of 185 MG and would be located at the north end of the site. Constructing the pond would require excavating up to 10 feet below existing grade and using the native materials to construct an embankment around the perimeter of the pond. The embankment would be approximately 4,800 linear feet around creating a 33-acre pond. Removal of the existing irrigation piping within the pond footprint would be required. The layout and location of storage pond features are shown in plan view in Figure 6.

Without the need of additional pumping KF2 would fill from the Low Pressure Reuse Line, but a pump station would be required to drain the pond back into the Subregional System. The 7-MGD inboard pump station would be located on the embankment at the southwest corner of the pond. A 30-inch diameter pressure pipeline would be required to fill and drain KF2. This pipe would tie in to the existing Low Pressure Reuse Line on site. Providing a standpipe spillway and emergency outlet discharging to an existing drainage to the south of the pond would be required to meet DSOD requirements. Energy dissipaters would reduce the velocity of flows discharging from the spillway, and the existing drainage would be lined with riprap to protect the banks from erosion.

An access road would be required from Highway 12 and extends around the toe of the embankment slope outside of the pond, and up onto the top of the embankment for access to the pump station.

Table 4-2 summarizes the estimate of present worth cost for KF2.

TABLE 4-2
Estimate of Present Worth Cost for KF2
IRWP Seasonal Storage Project – Draft Engineering Report

Description	Total Cost
Site Preparation	$1,230,000
Excavation/Foundation & Lining	$2,210,000
Embankment	$3,470,000
Drainage/Stabilization	$100,000
Drainage & Containment	$230,000
Pump Stations/Treatment	$1,000,000
Piping	$160,000
Site Improvements	$390,000
Subtotal, Construction Costs	$8,800,000
Engineering, Admin & Legal (23%)	$2,630,000
Construction Contingency (30%)	$2,640,000
Subtotal, Admin & Contingency	$5,270,000
CTS Mitigation	$14,100,000
Land Acquisition	-
Land Contingency	$7,050,000
Subtotal, CTS Mitigation & Land	$21,150,000
TOTAL CAPITAL COST	$35,210,000
ANNUAL O&M COST	$140,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$37,110,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Kelly Farm – Ponds 1 & 2 (KF1 and KF2)

If KF1 and KF2 were to be constructed together they would have a combined storage capacity of 467 MG. Construction of both ponds at this site could create a cost advantage through economies of scale. Table 4-3 provides the estimated costs for both ponds.

TABLE 4-3
Estimate of Present Worth Cost for KF1 and KF2
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Site Preparation	$2,070,000
Excavation/Foundation & Lining	$5,390,000
Embankment	$7,530,000
Drainage/Stabilization	$100,000
Drainage & Containment	$460,000
Pump Stations/Treatment	$2,000,000
Piping	$370,000
Site Improvements	$730,000
Subtotal, Construction Costs	$18,660,000
Engineering, Admin & Legal (23%)	$5,580,000
Construction Contingency (30%)	$5,600,000
Subtotal, Admin & Contingency	$11,180,000
CTS Mitigation	$32,400,000
Land Acquisition	-
Land Contingency	$16,200,000
Subtotal, CTS Mitigation & Land	$48,600,000
TOTAL CAPITAL COST	$78,440,000
ANNUAL O&M COST	$280,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$82,310,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Brown Farm – Pond 1 (BF1)

The Brown Farm Site would be located south of Highway 12, just west of Llano Road. The Subregional System uses the site for seasonal storage in an existing 165 MG pond, and for irrigation of hay fields. The Subregional System also has a maintenance yard and building on site at the northwest corner of the existing pond. The site, bisected by the SCWA Aqueduct and the GPL, includes the following parcels:

- APN 060-060-059
- APN 060-060-060

BF1 would have a capacity of 226 MG and would be located near Llano Road at the northeast end of the site, and immediately north of the existing pond. Constructing the pond would require excavating up to 10 feet below existing grade and using the native materials to construct an embankment around the perimeter of the pond. Existing fill material located in this area would also be excavated and used for the embankment construction. The embankment would be approximately 4,900 linear feet around creating a 34-acre pond. Disposal of approximately 36,000 CY of excess material would be required off-site. Removal of the existing irrigation piping within the pond footprint would be required. The layout and location of storage pond features are shown in plan view in Figure 7.

BF1 would fill from the Low Pressure Reuse Line without the need of additional pumping, but a pump station would be required to drain the pond back into the Subregional System. The 5-MGD inboard pump station would be located on the embankment at the northeast end of the pond. A 30-inch diameter pressure pipeline would be required to fill and drain BF1. This pipe would tie in to the existing Low Pressure Reuse Line on site. Providing a standpipe spillway and emergency outlet discharging to an existing drainage to the west of the pond would be required to meet DSOD requirements. Energy dissipaters would reduce the velocity of flows discharging from the spillway, and the existing drainage would be lined with riprap to protect the banks from erosion.

A new access road would be required from Llano Road from the existing gate and extends around the toe of the embankment slope outside of the pond, and up onto the top of the embankment for access to the pump station. The access road would be paved from Llano Road, around the south edge of BF1, to the existing maintenance yard at the toe of the embankment at the southwest corner. Table 4-4 summarizes the estimate of present worth cost for BF1.

TABLE 4-4
Estimate of Present Worth Cost for BF1
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Site Preparation	$1,300,000
Excavation/Foundation & Lining	$2,300,000
Embankment	$4,510,000
Drainage/Stabilization	$100,000
Drainage & Containment	$230,000
Pump Stations/Treatment	$800,000
Piping	$190,000
Site Improvements	$430,000
Subtotal, Construction Costs	$9,900,000
Engineering, Admin & Legal (23%)	$2,960,000
Construction Contingency (30%)	$2,970,000
Subtotal, Admin & Contingency	$5,930,000
CTS Mitigation	$14,400,000

TABLE 4-4
Estimate of Present Worth Cost for BF1
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Land Acquisition	-
Land Contingency	$7,200,000
Subtotal, CTS Mitigation & Land	$21,600,000
TOTAL CAPITAL COST	$37,420,000
ANNUAL O&M COST	$150,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$39,420,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Brown Farm – Pond 2 (BF2)

BF2 would have a capacity of 105 MG and would be located at the southwest end of the site, and immediately west of the existing pond. Constructing the pond would require excavating up to 10 feet below existing grade and using the native materials to construct an embankment around the perimeter of the pond. The embankment would be approximately 5,000 linear feet around creating a 29-acre pond. Removal of the existing irrigation piping within the pond footprint would be required. Approximately 257,000 CY of imported fill material would be required to complete the construction of the embankments. The layout and location of storage pond features are shown in plan view in Figure 8.

Without the need of additional pumping BF2 would fill from the Low Pressure Reuse Line, but a pump station would be required to drain the pond back into the Subregional System. The 5-MGD inboard pump station would be located on the embankment at the northeast end of the pond. A 30-inch diameter pressure pipeline would be required to fill and drain BF2. This pipe would tie in to the existing Low Pressure Reuse Line on site. Providing a standpipe spillway and emergency outlet discharging to an existing drainage to the north of the pond are required to meet DSOD requirements. Energy dissipaters would reduce the velocity of flows discharging from the spillway, and the existing drainage would be lined with riprap to protect the banks from erosion.

An access road would be required around the toe of the embankment slope outside of the pond, and up onto the top of the embankment for access to the pump station.

Table 4-5 summarizes the estimate of present worth cost for BF2.

TABLE 4-5
Estimate of Present Worth Cost for BF2
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Site Preparation	$1,220,000

TABLE 4-5
Estimate of Present Worth Cost for BF2
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Excavation/Foundation & Lining	$1,840,000
Embankment	$9,930,000
Drainage/Stabilization	$100,000
Drainage & Containment	$230,000
Pump Stations/Treatment	$800,000
Piping	$240,000
Site Improvements	$460,000
Subtotal, Construction Costs	$14,820,000
Engineering, Admin & Legal (23%)	$4,430,000
Construction Contingency (30%)	$4,450,000
Subtotal, Admin & Contingency	$8,880,000
CTS Mitigation	$12,300,000
Land Acquisition	-
Land Contingency	6,150,000
Subtotal, CTS Mitigation & Land	$18,450,000
TOTAL CAPITAL COST	$42,150,000
ANNUAL O&M COST	$180,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$44,640,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Brown Farm – Ponds 1 & 2 (BF1 and BF2)

If BF1 and BF2 were to be constructed together they would have a combined storage capacity of 331 MG. Construction of both ponds at this site could create a cost advantage through economies of scale. Table 4-6 provides the estimated costs for both ponds.

TABLE 4-6
Estimate of Present Worth Cost for BF1 and BF2
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Site Preparation	$1,750,000
Excavation/Foundation & Lining	$4,170,000
Embankment	$13,050,000
Drainage/Stabilization	$200,000

TABLE 4-6
Estimate of Present Worth Cost for BF1 and BF2
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Drainage & Containment	$460,000
Pump Stations/Treatment	$1,600,000
Piping	$330,000
Site Improvements	$770,000
Subtotal, Construction Costs	$22,320,000
Engineering, Admin & Legal (23%)	$6,670,000
Construction Contingency (30%)	$6,700,000
Subtotal, Admin & Contingency	$13,370,000
CTS Mitigation	$26,400,000
Land Acquisition	-
Land Contingency	$13,200,000
Subtotal, CTS Mitigation & Land	$39,600,000
TOTAL CAPITAL COST	$75,290,000
ANNUAL O&M COST	$290,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$79,170,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Alpha Farm – Pond 1 (AF1)

The Alpha Farm Site is located along the west side of Llano Road on parcel APN 060-060-051. The site currently contains two seasonal storage ponds with a combined capacity of 31 MG. This project proposes replacing the existing ponds with one new pond that has greater storage capacity, achieved by increasing the area of its footprint.

AF1 has a capacity of 177 MG and would be located over and to the north of the two existing ponds. Constructing the pond would require excavating up to 10 feet below existing grade and using the native materials to construct an embankment around the perimeter of the pond. The embankment would be approximately 5,800 linear feet around creating a 45-acre pond. Approximately 13,000 CY of imported material would be required from off-site to construct the embankments. The layout and location of storage pond features are shown in plan view in Figure 9.

Removal of the existing irrigation piping within the pond footprint would be required. A temporary pipeline running from the Low Pressure Reuse Line in Llano Road to the southwest corner of the site would be required, with temporary trailer-mounted pumps, to provide irrigation to a neighboring farm during pond construction. Removing the existing irrigation pump station would be required to construct the new pond.

Temporarily removing and then reinstalling the existing solar panels along the west side of the existing ponds would be also required to construct the new pond.

Without the need of additional pumping AF1 would fill from the Low Pressure Reuse Line, but a pump station would be required to drain the pond back into the Subregional System. The 5-MGD inboard pump station would be located on the embankment along the southern limit of the pond. A 16-inch diameter pressure pipeline would be required to fill and drain AF1. This pipe will tie in to the existing Low Pressure Reuse Line near the existing tie-in at Llano Road. Providing a standpipe spillway and emergency outlet discharging to Roseland Creek to the south of the pond would be required to meet DSOD requirements. Energy dissipaters would reduce the velocity of flows discharging from the spillway, and the existing drainage would be lined with riprap to protect the banks from erosion.

A new access road would be required from Llano Road from a new entry gate and would extend around the toe of the embankment slope outside of the pond, and up onto the top of the embankment for access to the pump station. AF1 has a total storage capacity of 177 MG, which represents a gain in seasonal storage capacity for the Subregional System of 146 MG over the existing storage capacity at this site. Table 4-7 summarizes the estimate of present worth cost for AF1, and the cost per million gallons would be based on the additional storage over and above the existing storage capacity of 31 MG.

TABLE 4-7
Estimate of Present Worth Cost for AF1
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Site Preparation	$1,490,000
Excavation/Foundation & Lining	$3,140,000
Embankment	$3,040,000
Drainage/Stabilization	$100,000
Drainage & Containment	$230,000
Pump Stations/Treatment	$900,000
Piping	$400,000
Site Improvements	$430,000
Subtotal, Construction Costs	$9,730,000
Engineering, Admin & Legal (23%)	$2,910,000
Construction Contingency (30%)	$2,920,000
Subtotal, Admin & Contingency	$5,830,000
CTS Mitigation	$13,890,000
Land Acquisition	-
Land Contingency	$6,950,000

TABLE 4-7
Estimate of Present Worth Cost for AF1
IRWP Seasonal Storage Project – Conceptual Design Development

Description	Total Cost
Subtotal, CTS Mitigation & Land	$20,840,000
TOTAL CAPITAL COST	$36,390,000
ANNUAL O&M COST	$160,000
PRESENT WORTH VALUE (20 years @ 4%)[a]	**$38,600,000**

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Cost Estimate Summary

Estimates of Probable Cost have been developed for each of the proposed storage ponds located at four storage sites, including combinations of ponds located at a given site to account for shared costs and economy of scale. The costs have been refined over the course of the site evaluation process and conceptual design development and are based on the most current information available. Cost estimates presented are "Class 5" estimates prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering, International (AACE). Table 1 provides a summary of the present worth costs for each pond and the present worth cost per million gallons for each pond

TABLE 4-8
Summary of Storage Pond Capacities and Costs
IRWP Seasonal Storage Project – Conceptual Design Development

Pond ID	Storage Capacity (mg)	PW Cost[a] ($1,000)	PW Cost per MG[a] ($1,000)
KF1	282	$$47,630	$170
KF2	185	$37,110	$200
KF1&2	467	$82,310	$180
BF1	226	$39,420	$170
BF2	105	$44,640	$420
BF1&2	331	$79,170	$240
AF1	146[a]	$38,600	$260

Note: [a] Present worth costs are for 20 years at 4% discount and an ENRCCI of 9100 for San Francisco.

Rights-of-Way

Conceptual designs for the proposed storage ponds were developed with the purpose of maximizing potential storage capacity while minimizing the cost per million gallons of storage. Site constraints, including seasonal high groundwater, flood plains, slopes, drainages, geologic hazards, existing facilities and existing easements, were all considered in developing the proposed conceptual designs.

Because the City of Santa Rosa owns the properties where the proposed storage ponds would be located, Preliminary Title Reports were reviewed for affected parcels to identify any existing easement constraints that could impact the conceptual designs and/or require mitigation measures. Existing easements exist at Kelly Farm, Brown Farm and Alpha Farm and license agreements, easement amendments, new easement agreements, and/or encroachment permits will be required for the proposed storage ponds. Agencies having existing easement rights at one or more of the sites include the Sonoma County Water Agency, the Sonoma County Agricultural Preservation and Open Space District, the County of Sonoma, and the State of California. Private easements are held by Pacific Gas & Electric and Fleet Oil Company. The Draft EIR will identify the environmental impacts, if any, to these existing easements and identify potential mitigation measures.

5. STORAGE OPERATIONS ANALYSIS

Background

The Water Balance Model (WBM) utilized during the IRWP Feasibility Study and master planning work identified the need for additional seasonal storage to support additional reuse projects. However, a more detailed simulation was needed to define better the operational interaction between existing and potential future storage ponds within the envelope of the IRWP demand and discharge scenarios developed in the IRWP. A Storage Planning Model (SPM) was developed under the SSP for this purpose.

The SPM was developed to conduct a screening-level evaluation of the Subregional System's seasonal storage options under alternative future storage location, sizing, and demand scenarios. The results of the model show how alternative storage site locations would perform if integrated into the Subregional System. The model simulates how the existing and future system would respond to changes in urban demands, agricultural demands, flow to the Geysers steamfields, and discharge disposal strategies.

The SPM was built in two phases, with the first consisting of an existing conditions model and the second, a future scenario model. The SPM was built on information provided by the City of Santa Rosa and the existing simulation model (WBM).

Conclusions

Storage operations analysis with additional seasonal storage provided in alternative locations in the Water Reuse System indicates that the location of the additional storage does not affect the total storage volume required. Analysis also indicates that the location of the additional storage does not affect the ability to convey water for reuse demands or for discharge.

The volume of additional storage required for the alternative scenarios simulated in the SPM future conditions scenarios is between 200 and 650 MG. Scenarios include five different hydrologic water years ranging from dry to wet, where a water year is defined as starting on October 1 and ending on September 30. The additional volume required is based on an existing maximum operational storage volume of 1,436 MG.

The capacities of existing pipelines and pump stations were assumed to remain within existing limitations, and the operational analysis did not indicate a need to replace existing facilities.

For additional information on the storage operations analysis see the TM, *Water Reuse System Storage Model Hydraulic and Operations Analysis, November 2007.*

6. GEOTECHNICAL ANALYSIS

Background

The constructability, cost, and feasibility of proposed recycled water storage facilities at the six originally considered sites are strongly influenced by geologic and geotechnical conditions. A geotechnical analysis was performed for the following six sites:

- Alexander Valley Road Site (AVR)
- West College Site (WC)
- Kelly Farm Site (KF)
- Brown Farm Site (BF)
- Alpha Farm Site (AF)
- Petaluma Hill Road Site (PHR)

At each site, proposed Project facilities, including embankments, pump stations, pipelines, and other associated structures and appurtenances, would need to be designed and constructed to accommodate a unique set of geologic conditions and mitigate potential geologic/geotechnical hazards. Potentially severe hazards, including fault surface rupture, land sliding and slope instability, could constrain storage pond development at some sites. Numerous geotechnical design, construction, and regulatory constraints could also affect the constructability and cost of potential storage development at the six sites.

Conclusions

Kelly (KF), Brown (BF), and Alpha (AF) Farm Sites

Based on review of available information and limited subsurface exploration, there are no adverse engineering conditions or potential geologic hazards that would preclude development of proposed storage facilities at the KF, BF, or AF sites. Aside from relatively minor deposits of sandy soil encountered in borings near Roseland Creek at the AF site, the geotechnical investigation did not encounter significant deposits of potentially liquefiable material at any of the three sites. The predominantly clayey soil underlying the sites should provide suitable borrow for homogeneous embankments and compacted clay liners.

It is expected that pond bottoms at the KF, BF, and AF sites could be located above maximum seasonal groundwater levels. Detailed site investigations would be needed to refine geotechnical design parameters for pond embankments and lining systems; however, there are no issues requiring special study to determine the feasibility of proposed Project facilities at these sites.

At the BF site, future design-level geotechnical studies should give special consideration to the character of previously stockpiled material (from original excavation of the existing Brown Farm pond) that might be utilized in the foundation or borrow, as well as appropriate setbacks for the new pond from existing pond slopes. At the AF site, further geotechnical studies should give special consideration to removal and reuse of portions of the existing AF pond embankments in the new larger embankment. At all of the sites, design-level studies should consider the potential for localized deposits of potentially liquefiable and/or permeable foundation materials, particularly near existing stream channels and drainage swales.

West College Site (WC)

Based on review of available information and limited subsurface exploration (six borings), potential liquefaction, lateral spreading, and seismically induced slope instability hazards have significant implications for the feasibility of constructing proposed storage facilities at the WC site. Results of preliminary, site-specific liquefaction susceptibility analyses indicate the presence of relatively widespread, potentially liquefiable deposits beneath the WC site. As a result, extensive and detailed subsurface exploration and liquefaction analyses will be needed to characterize better the continuity and extent of potentially liquefiable materials, evaluate the potential for ground failure due to liquefaction, and develop appropriate mitigation approaches. Potential hazards related to fault surface rupture, slope instability, shallow groundwater and seepage will also require additional detailed study at the WC site.

Ground improvement or other methods may be able to mitigate liquefaction and liquefaction-related hazards at the WC site. However, the uncertainty surrounding the ultimate need for, extent, and cost of such mitigation is large given the currently available data. Such mitigation would be particularly important in light of the proximity of a number of residences to this site. In light of these facts, such mitigation is likely to prove economically infeasible.

Other potential geotechnical challenges at the WC site that need to be evaluated as part of detailed, design-level site investigations include the following:

- The availability of suitable borrow materials for embankment construction and the need for import as well as offsite disposal of unsuitable materials
- Applicability and suitability of liner materials (both geosynthetic and soil products) and configurations

Determination of geotechnical feasibility at the WC site is not possible at this time. A final determination regarding geotechnical feasibility would require extensive additional geologic and geotechnical investigation and study. However, the significant magnitude, cost, and complexity of such an investigation, and uncertainties regarding the availability and cost of mitigating such hazards constitute an adequate basis to eliminate the WC site from further analysis under the California Environmental Quality Act (CEQA) definition of "feasibility".

Alexander Valley Road Site (AVR)

Based on review of available information and photographs, geologic reconnaissance mapping, and limited subsurface exploration (four borings), potential landslide and fault surface rupture hazards are present that could constrain or preclude development of storage ponds at the AVR site.

Proposed ponds have been configured to be at least 100 feet away from mapped fault traces; however, detailed investigations will be needed to confirm mapped fault locations and evaluate the ages of most recent movement. Such efforts will be required to satisfy Division of Safety of Dams (DSOD) design criteria.

In general, landslide hazards appear to be more severe at the AVR1 pond site than at the AVR2 pond site; however, landslides are present at both sites and will require detailed investigation to characterize the depth and lateral extent of slide materials and determine if and how they might be best mitigated.

As a result of potential fault and landslide hazards, determination of geotechnical feasibility at the AVR site is not possible at this time and will require extensive additional geologic and geotechnical investigation and study. Such investigation would include excavating trenches to identify the precise locations and activity of faulting in the area. The scope of such trenching cannot be predicted in advance; that determination is necessarily made in the field, based on data obtained as the investigation progresses.

Significant trenching would likely be required to investigate potential fault surface rupture hazards at the AVR site. Such trenching is very costly and may not provide conclusive evidence of fault locations and/or ages of most recent movement. Fault trenching also involves significant surface disturbance, both with respect to the trench itself, and with respect to providing heavy machinery with access to the testing locations. City botanists have determined that the area contains a number of populations of sensitive plant species, and that geotechnical investigations would likely result in disturbance of these populations.

Other potential geotechnical challenges at the AVR site that need to be evaluated as part of more detailed site investigations include the following:

- The availability of suitable borrow materials for embankment construction
- The presence of hard rock and difficult foundation conditions that may require extensive preparation, including grouting and dental concrete
- The potential for seepage losses through fractured rock
- The existence of chrysotile (asbestos) in serpentinite bedrock materials that may require special handling

Determination of geotechnical feasibility at the AVR site is not possible at this time. A final determination regarding geotechnical feasibility would require extensive additional geologic and geotechnical investigation and study. However, given the significant magnitude, cost and complexity of such an investigation, the disturbance caused by such an investigation, and the extent to which such disturbance may affect sensitive plant species, the City has determined that an adequate basis exists to eliminate the AVR site from further analysis because it is not “feasible” as that term is defined by CEQA.

Petaluma Hill Road Site (PHR)

Petaluma Hill Road—PHR1

Based on review of available information and photographs, geologic reconnaissance mapping, and limited subsurface exploration (electrical resistivity survey, but no borings or test pits), potential landslide and fault hazards are present that could constrain or preclude development of storage facilities at the PHR1 location.

The proposed PHR1 pond has been configured to be at least 100 feet away from mapped fault traces; however, detailed investigations will be needed to confirm the mapped fault locations and evaluate the ages of most recent movement. Such efforts will be required to satisfy DSOD design criteria.

Potential PHR1 pond configurations that incorporate the recommended 100-foot fault setback severely restrict storage capacity and may make the site economically infeasible. If further study determine that the fault is inactive, a larger pond might be considered; however, the impact of potential landslide hazards in the left abutment, and moderate liquefaction hazards in the valley bottom are of importance and will require detailed investigation to characterize the hazards and determine if and how they might be best mitigated.

As a result of potential fault, landslide, and liquefaction hazards, determination of geotechnical feasibility at the PHR1 location is not possible at this time and will require extensive additional geologic and geotechnical investigation and study.

Other potential geotechnical challenges at the PHR1 location that need to be evaluated as part of detailed site investigations include the following:

- The availability of suitable borrow materials for embankment construction
- The need for seepage cutoff and liquefaction mitigation for deeper granular soils in the valley bottom
- The potential for seepage losses through fractured rock
- The presence of hard rock and difficult foundation conditions that may require extensive preparation, including grouting and dental concrete

Petaluma Hill Road—PHR2

Based on review of limited available information, potential liquefaction and lateral spreading hazards may constrain or preclude development of storage facilities at the PHR2 location. Site soils are mapped as having moderate to high liquefaction potential, but without more detailed exploration, the presence or significance of this hazard cannot be confirmed. Further investigation and analysis are needed to evaluate the potential for liquefaction and liquefaction-related ground failure and develop appropriate approaches for mitigation of these hazards.

Based on available information, soils underlying the PHR2 location appear to consist of predominantly granular material and that groundwater may fluctuate seasonally from a depth of approximately 10 to 15 feet below the ground surface (bgs) to within 1 or 2 feet of the ground surface. The presence of seasonal groundwater levels at such shallow depths may affect the ability to balance cut and fill earthwork quantities, potentially affecting the economic feasibility of proposed storage facilities at the site. With the expected lack of native low-permeability soils, the pond bottom and embankments will require imported geosynthetic and/or soil liner materials.

As a result of potential liquefaction and lateral spreading hazards, as well as potential constraints due to shallow groundwater conditions, determination of geotechnical feasibility at the PHR2 location is not possible at this time and will require extensive additional geologic and geotechnical investigation and study.

Other potential geotechnical challenges at the sites that need to be evaluated as part of detailed, design-level site investigations include the following:

- The availability of suitable borrow materials for embankment construction and the need for imported low-permeability embankment materials and liner/subgrade/cover soils
- The applicability and suitability of liner materials (both geosynthetic and soil products) and configurations for proposed storage facilities at the site
- Anticipated groundwater levels after installation of proposed pond lining systems and potential needs for a groundwater management system, including an interceptor drain on the upgradient (eastern and northern) sides of the pond and/or pond underdrain system to maintain groundwater levels below the elevation of the pond bottom
- The potential need for riprap and/or other erosion protection measures against flows in Copeland Creek, located along the southern edge of the proposed PHR2 pond location

More detailed discussion of site conditions, potential geologic and geotechnical hazards, geotechnical design and construction considerations, preliminary geotechnical design recommendations, and recommendations for further study are provided in the TM *Geotechnical Evaluation*, *November 2007* and the attachments.

7. SITE HYDROLOGY ANALYSIS

Background

The site hydrology analysis includes preliminary evaluation of the inflow design flood for the potential storage locations identified during the screening process. Ponds were investigated for potential flood impacts; determination of the embankment hazard or risk; and conceptual design of outlet works, spillway, and freeboard. The analytical methods were based on existing information, published precipitation data and flood studies, and approximate methods to determine the inflow design flood (IDF), runoff frequency curves, downstream flood impacts, and preliminary hydraulic structure dimensions. Site surveys were completed to develop accurate topography of each potential storage location.

Conclusions

Each of the potential storage ponds was evaluated for design capacity of outlet works, spillway, and local runoff. The IDF was determined using local precipitation data for the Probable Maximum Precipitation (PMP).

The design capacity for the spillways was developed from the IDF plus the maximum fill rate as determined in the TM, *Water Reuse System Storage Model Hydraulic and Operations Analysis*, *November 2007*. The IDF for ponds includes direct rainfall (where appropriate), local runoff (if any), and maximum fill rate. The spillways consist of an overflow standpipe, conveyance pipeline, and impact energy dissipater.

The design capacity for the pipe was based on the maximum flow rate, the operational filling rate, draining rate, and the DSOD evacuation requirement. The normal outlet discharge would be to the Subregional System. Outlet discharges would be pumped at pond sites except where gravity discharge can be utilized. Pumped outlet facilities would always include a gravity backup gate or valve for compliance with DSOD drain-down requirements.

More detailed discussion of the pond locations, new storage capacities, recommended spillway design flows, maximum operational drain rates, and recommended DSOD evacuation drain-down flow rates is provided in the TM *Site Hydrology Evaluation, November 2007*, and attachments.

8. GROUNDWATER ANALYSIS

Background

The potential impacts of the proposed ponds on groundwater at the site and at nearby properties, wells, and surface water bodies were assessed. The groundwater analysis focused on determining which wells or surface water bodies might be impacted and assessed the timing of these impacts. To evaluate the impacts, a groundwater model was used to forecast the following:

- Rate of any potential seepage from the ponds under specified liner conditions
- Change in groundwater levels that may be caused by the ponds
- Direction, rate, and ultimate discharge point of water if it were to seep from the ponds
- Concentration of water pumped from existing and potential new wells that originate from the ponds

Conclusions

Potential impacts of the proposed ponds were evaluated using a numerical groundwater model that encompassed an area including all three sites. The groundwater model was developed and calibrated using existing data and new data collected as part of this evaluation. The identified impacts associated with the proposed ponds reflect groundwater model results. The impacts are estimates used for the conceptual design of the proposed ponds, and as with any model have some associated uncertainty.

The scenarios evaluated include various combinations of proposed ponds to meet the additional storage requirements. Table 8-1 summarizes the ponds in use for each scenario that was simulated to account for the possibility that the effect of multiple ponds could be different than individual ponds. The proposed Alpha Farm (AF), Brown Farm (BF), and Kelly Farm (KF) ponds would be lined with a typical compacted native clay liner. The hydrogeology of the AF, BF, and KF sites is characterized by strong downward vertical gradients near AF, BF, and KF. At all three sites, the model predicts that if water seeps from the proposed ponds, it would travel downward and toward the municipal wells in the area. Water from the ponds would not ultimately discharge to the Laguna de Santa Rosa or other creeks. Travel times to the wells are forecasted to be on the order of 50 years or greater, and in all cases, the percent of water pumped at the wells that originated from the ponds would not exceed about 3 percent.

TABLE 8-1
Scenario Summary
IRWP Seasonal Storage Project - Draft Engineering Report

		Scenario										
Pond Identification	**Pond Volume (MG)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Kelly Farm (KF1 south)	185					●	●	●			●	
Kelly Farm (KF2 north)	282										●	
Brown Farm (BF1 northeast)	226					●	●					●
Brown Farm (BF2 southwest)	105											●
Alpha Farm (AF1)	177				●	●		●				

Note: • = Potential Pond in Use

Potential seepage from the ponds under the different scenarios is provided in Table 8-2. Potential seepage from the proposed AF pond is estimated to be about 29 gallons per minute (gpm). The predicted rise in groundwater levels beneath the proposed AF pond relative to current conditions is about 4 to 5 feet. Predicted groundwater level rise beyond the property boundary is generally less than 2 feet. Most of the water that would seep from the proposed pond would flow toward the SCWA Todd Road and Sebastopol Road municipal wells and would reach the Todd Road well in about 50 years. Under steady-state conditions, about 3 percent of water extracted at the Todd Road well would originate from the proposed AF pond if pumping continues at current rates.

Potential seepage from proposed BF1 is estimated to be about 18 gpm, and seepage from proposed BF2 is estimated to be about 10 gpm. Predicted rise in groundwater levels beneath the ponds relative to current conditions is about 8 feet. Predicted groundwater level rise beyond the property boundary is generally less than 2 feet. Water seeping from the proposed ponds would flow toward SCWA’s Sebastopol Road well, and is expected to reach the well in about 50 years. Under steady-state conditions, about 3 percent of water extracted at the Sebastopol Road well would originate from the existing and proposed storage ponds if pumping continues at current rates.

Potential seepage from KF1 is estimated to be about 4 gpm, and potential seepage from KF2 is estimated to be about 3 gpm. Groundwater levels below the two proposed Kelly Farm ponds are predicted to drop by about 2 to 6 feet because seepage from the pond is less than the amount of recharge currently occurring from infiltration of precipitation at the site. Water that would seep from the proposed ponds would flow toward SCWA’s Sebastopol Road and Occidental Road wells, and would reach both wells in about 50 years. Under steady-state conditions, about 3 percent of water extracted at the Sebastopol Road well and 0.1 percent of water extracted at the Occidental Road well would originate from the existing and proposed storage ponds if pumping continues at current rates.

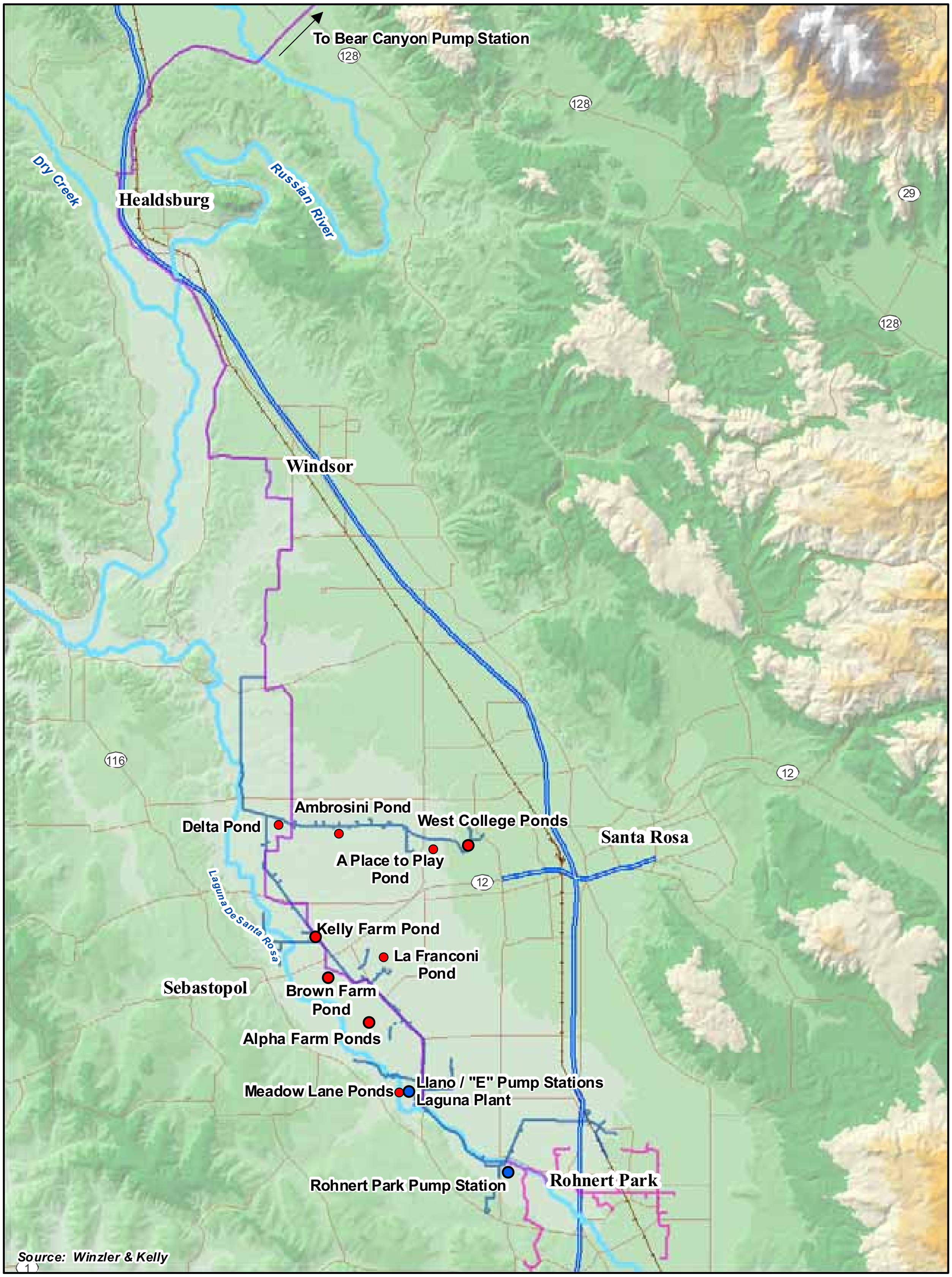
TABLE 8-2
Pond Seepage Estimate (gpm)
IRWP Seasonal Storage Project – Groundwater Evaluation

	Scenario											
Pond Identification	**Pond Volume (MG)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Kelly Farm (KF1 south)	185					4	4	4			4	
Kelly Farm (KF2 north)	282										3	
Brown Farm (BF1 northeast)	226						18	18				18
Brown Farm (BF2 southwest)	105											10
Alpha Farm (AF1)	177					29	29		29			

In addition to evaluating the potential for pond seepage to travel toward existing wells, the model was used to evaluate potential impacts to potential future municipal wells. Results suggest that a new municipal well could be installed anywhere in the modeled AF, BF, KF area and would have concentrations of less than 3 percent water originating from the proposed ponds.

More detailed discussion of the groundwater analysis and models is provided in the TM *Groundwater Evaluation, November 2007* and attachments.

Figures



Legend

- High Pressure Water Reuse System
- Low Pressure Water Reuse System
- Geysers Pipeline
- Storage Sites
- Pump Stations

0 2.5 5 Miles

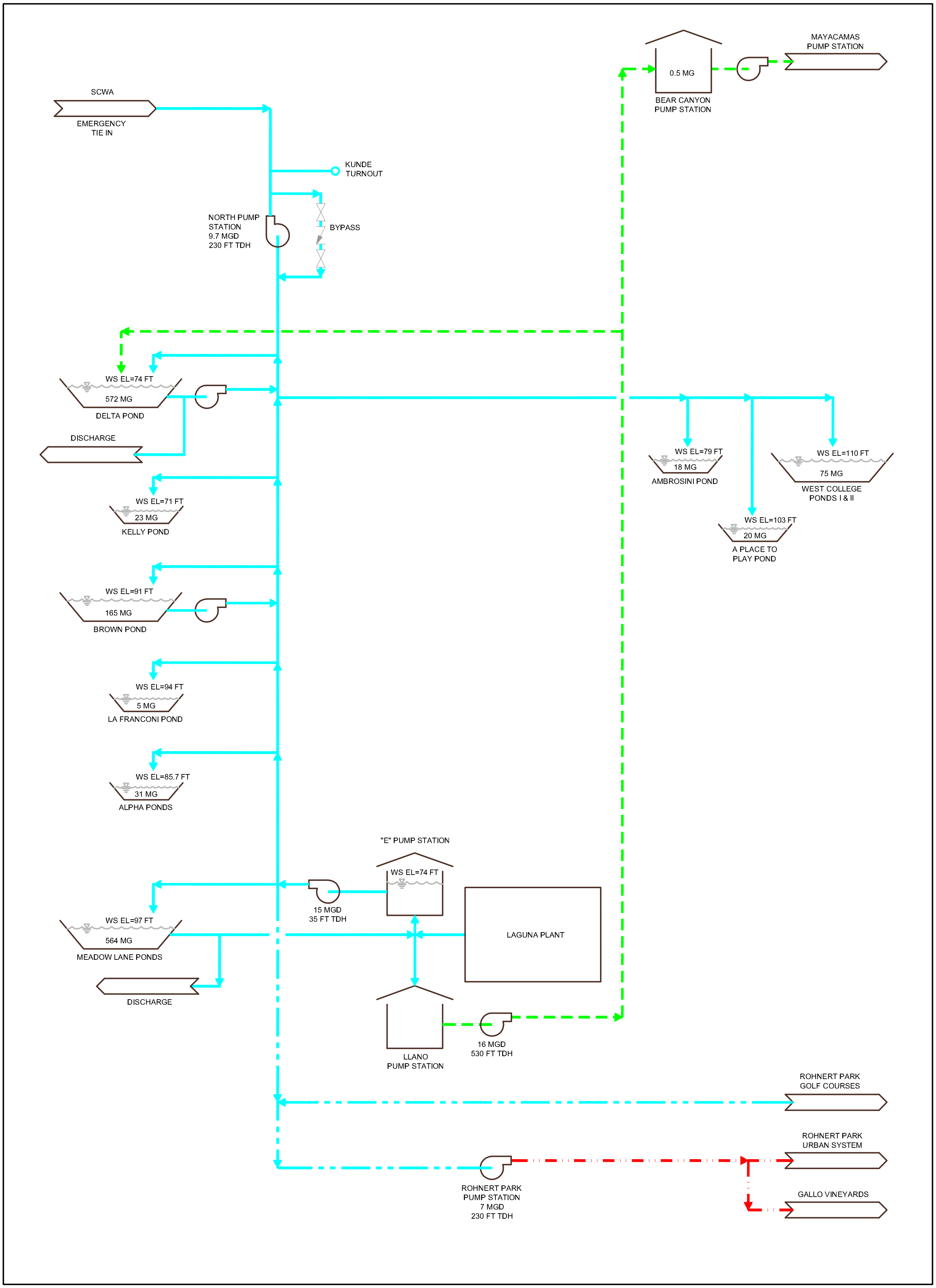
Existing Water Reuse System

IRWP MASTER PLAN

Seasonal Storage

Santa Rosa IRWP
Seasonal Storage Project

Figure 1



LEGEND:

- High Pressure Water Reuse System (HP)
- Low Pressure Water Reuse System - North (LPN)
- Low Pressure Water Reuse System - South (LPS)
- Geysers Pipeline (GPL)

Existing Reuse Conveyance Storage Schematic

IRWP MASTER PLAN
Seasonal Storage

Santa Rosa IRWP
Seasonal Storage Project
Sonoma County, California

Figure 2