Appendix 1 to Attachment 3

HEC-HMS Hydrologic Modeling Analysis of Memorial Park Detention Basin in Peak Flow Reduction

Stetson Engineers Inc.
November 5, 2012

The purpose of this analysis was to evaluate the effectiveness of Memorial Park Detention Basin in reducing peak flows. The Stetson-developed and calibrated HEC-HMS hydrologic model for the Ross Valley watershed was used as a tool to conduct the analysis. The December 31, 2005 flood event, an estimated 100-year flood event, was used as the design flood. It was found from the analysis that the proposed Memorial Park detention basin can effectively reduce 100-year peak flows (by about 200 cfs from 6,840 cfs to 6,640 cfs at the Ross streamflow gage) along San Anselmo Creek below the Sorich Creek confluence and Corte Madera Creek, including key breakout points in San Anselmo and Ross.

1.0 Description of Memorial Park Detention Basin

The proposed Memorial Park Detention Basin Project involves converting an existing eight acre public park into a duel purpose park and flood control detention basin. Sorich Creek, a tributary to flood-prone San Anselmo Creek with a drainage area of about 0.47 square miles, currently passes through the park in a deeply buried concrete culvert. The culvert will be removed and the creek will be day-lighted and restored using biotechnical treatments. To provide storage capacity for floodwater detention, the park floor will be excavated and lowered by an average of 10 ft below existing grade. The detention basin is formed by an excavated basin bounded along the southern and western sides by concrete wall structures and along the northern and eastern sides by cut slopes. The detention basin will be seeded with turf grass and the athletic play fields will be re-established. A large, gated culvert will penetrate the embankment at the southeast corner. The gate will normally be kept open to allow unimpeded passage of flows. When flooding downstream in San Anselmo is imminent, the gate will be closed for floodwater detention. In rare extreme floods (>100-year flood) when the basin becomes full, an internal semi-circular glory hole type spillway will pass floodwaters to the existing culverted reach of Sorich Creek below the basin and then on to San Anselmo Creek about 0.5 mile downstream of Memorial Park. An external emergency spillway will provide redundancy to pass any additional overflow that exceeds the capacity of the internal glory hole spillway.

The detention basin has a design top of dam elevation at 79 ft NAVD88 and a spillway crest elevation at 76 ft NAVD88. When full to the spillway crest, water depths will reach a maximum of 14 feet at the southern end and the basin will inundate 7 acres and detain 79 acre-feet of floodwater (refer to Figure 1 for the storage curve).

2.0 HEC-HMS Modeling Results

In order to test the flood control ability of the proposed Memorial Park detention basin, the calibrated HEC-HMS hydrologic model for the Corte Madera Creek watershed was used to simulate the following two scenarios for the December 31, 2005 flood event. The simulation period started at December 30, 2005, 0:00am and ended at January 1, 2006, 12:00pm. A time interval of 10 minutes was used in the model computation.

1) The designed low-level outlet open all time;

2) The designed low-level outlet open prior to the storm event but closed starting at the time of incipient flooding (t_1).

Under Scenario 1, the low-level outlet would be open all time. This scenario requires minimal operations to the low-level outlet.

Under Scenario 2, the low-level outlet would be open to evacuate the lake prior to the storm event and then kept open until the time of incipient flooding (t_1). At the time of t_1 the low-level outlet is closed and kept closed thereafter. This scenario requires real-time operation of the low-level outlet based on the real-time stage measurements at the Ross streamflow gage and the weather forecasts. In terms of flood detention modeling, the difference between Scenario 2 and Scenario 1 is that in Scenario 2 the low-level outlet is open until time t_1 but in Scenario 1 it is open during the entire storm event. The initial water level for Scenario 2 would be the invert elevation of the low-level outlet.

HEC-HMS is able to directly simulate the conditions that the low-level outlet is either open or closed during the entire storm event, but is unable to directly simulate the operational condition of Scenario 2. In order to simulate Scenario 2, the following three steps were taken:

(1) Run model with the low-level outlet open all time.

This was done in the simulation of Scenario 1. The simulated results for the time period from the beginning of the storm event to the time t_1 are the desired status prior to the close of the low-level outlet for Scenario 2. The simulated outflow hydrograph for the low-level outlet was exported to Excel and the outflows after t_1 were set to 0. This revised hydrograph would be the desired outflow hydrograph of the low-level outlet for Scenario 2. The outflow volume through the low-level outlet from the beginning of the storm event to the time t_1 was calculated to be approximately 65 acre-ft.

(2) Run model with the modified low-level outlet closed during the entire storm event.

During the simulation in this step, the outflow volume computed in step (1) above would be detained in the detention basin. This would cause a higher water surface

elevation at time t_1 in the basin than expected in Scenario 2. In addition, the flows in the Sorich Creek below the detention basin would be zero during the simulation for the time period from the beginning of the storm to time t_1. This is not the desired result for Scenario 2 because it would be expected that the flows for the time period for Scenario 2 would be the outlet outflows computed in step (1). Without correctly simulating the flows in the Sorich Creek below the detention basin, the computed hydrographs for all the reaches downstream of the detention basin would be incorrect.

The way to have the model achieve the expected water surface elevation at time t_1 is to create a hypothetical elevation-storage curve of the lake by adding the additional volume of 65 acre-ft to the actual storage curve.

The way to have the model achieve the desired flows is to add a source element to the Sorich Creek below the detention basin in the HEC-HMS model. This source flow would be the low-level outlet outflow hydrograph generated in step (1).

(3) Generate final results by combining the results from step (1) and step (2).

The final outflow hydrograph from the lake dam would be the combination of the low-level outlet outflow hydrograph generated in step (1) and the outflow hydrograph simulated in step (2). The final lake level hydrograph would be the combination of the lake level hydrograph simulated in step (1) for the time period from the beginning of the storm to time t_1 and the lake level hydrograph simulated in step (2) thereafter.

Modeling results for the Memorial Park detention basin are shown in Figures 2 through 5. Closing the low-level outlet at time t_1 would reduce the peak flow by 202 cfs at San Anselmo Creek below Sorich Creek confluence (from 5,252 cfs to 5,050 cfs in Figure 4) and 201 cfs at Ross Gage (from 6,836 cfs to 6,635 cfs in Figure 5). Figure 3 shows that the peak water surface elevation of the detention basin will be a little higher than the designed spillway crest, indicating the storage volume will be fully utilized and, thus, the detention basin has been appropriately sized.

3.0 Analysis of Routing Winter Baseflows (Inflow) through the Detention Basin with the Low-Level Outlet Open

Figure 6 shows the analysis results of routing winter baseflow through the dam with the low-level outlet open. The results indicate that it would take about 8 hours for the low-level outlet to drain the detention basin from the spillway crest level (76 ft NAVD88) down to the invert elevation of the low-level outlet.

Figure 1 Storage Curve of Memorial Park Detention Basin

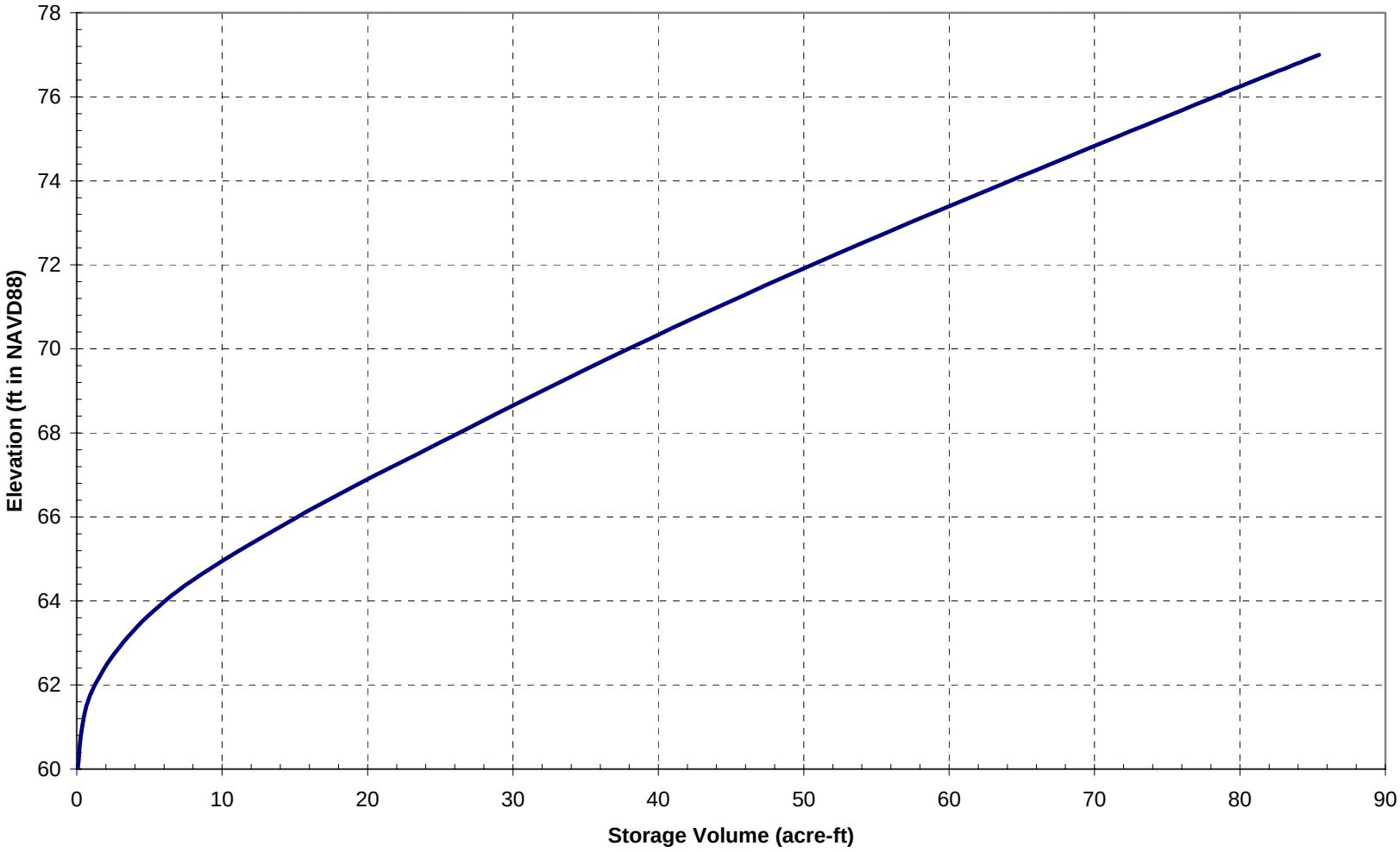


Figure 2 Simulated Results for Memorial Park Detention Basin – The Low-Level Outlet Open All Time

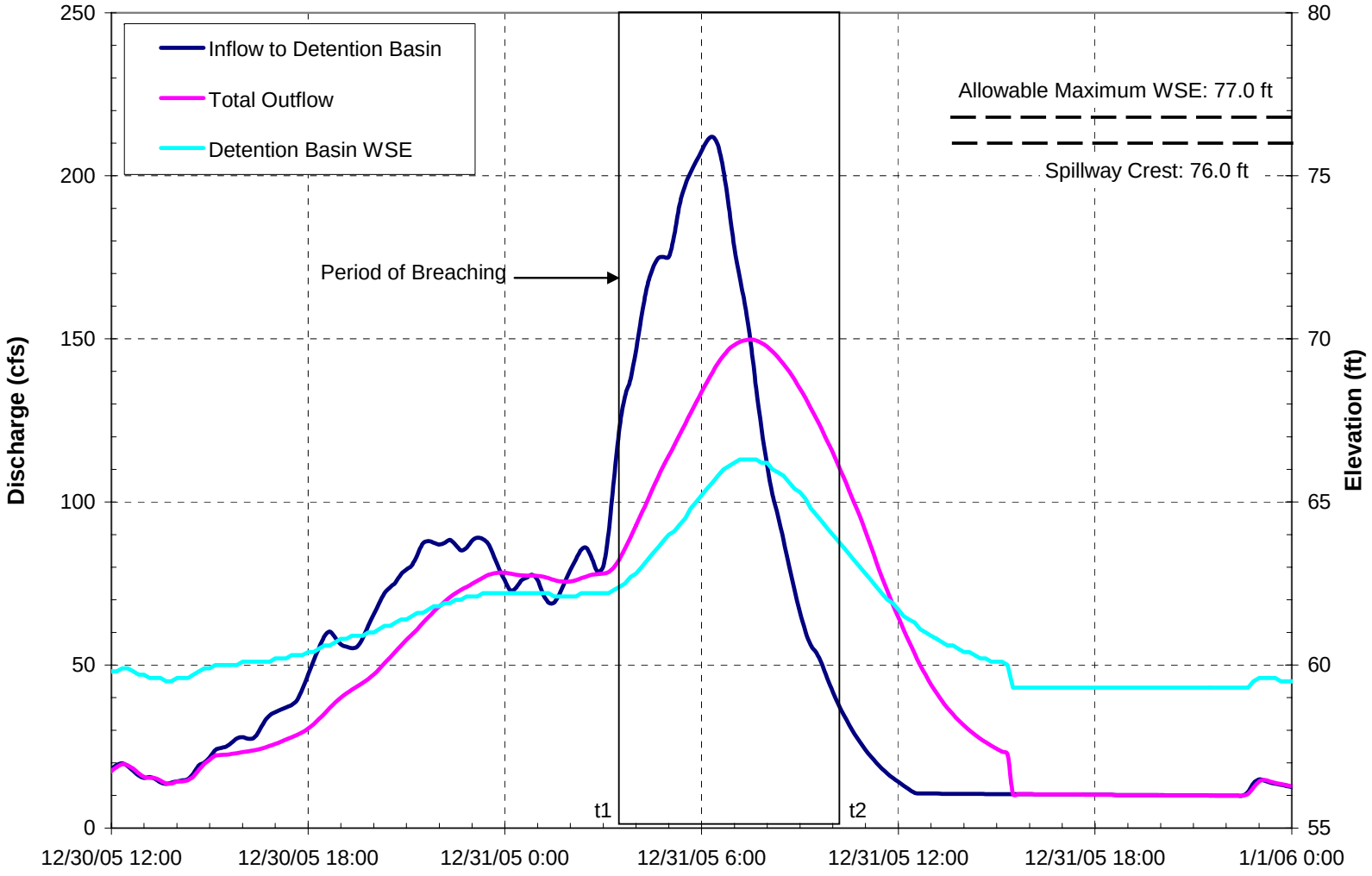


Figure 3 Simulated Results for Memorial Park Detention Basin – The Low-Level Outlet Closed at t_1

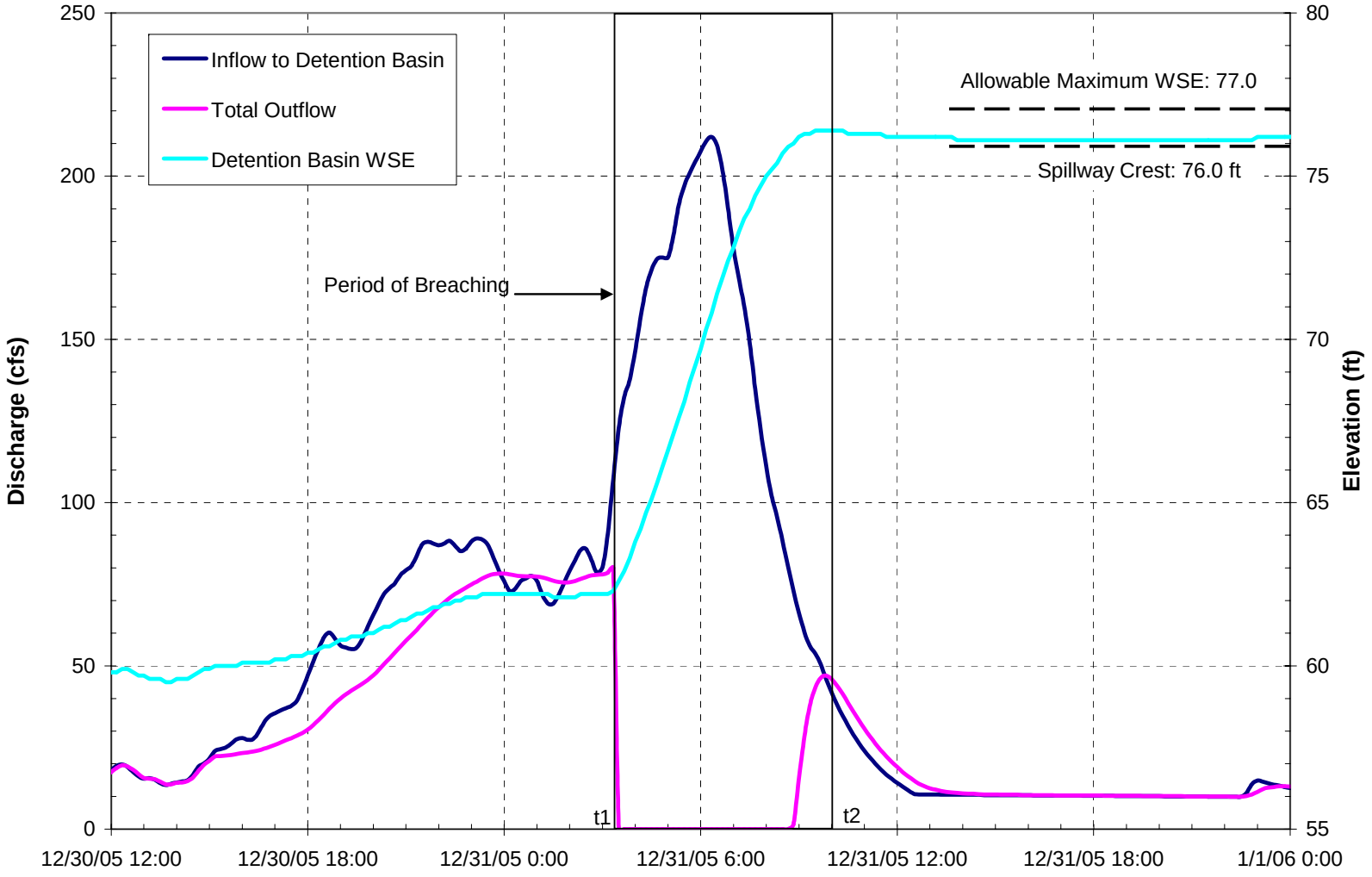


Figure 4 Comparison of Simulated Flows at San Anselmo Creek below Sorich Creek Confluence for Different Scenarios of Memorial Park Detention Basin

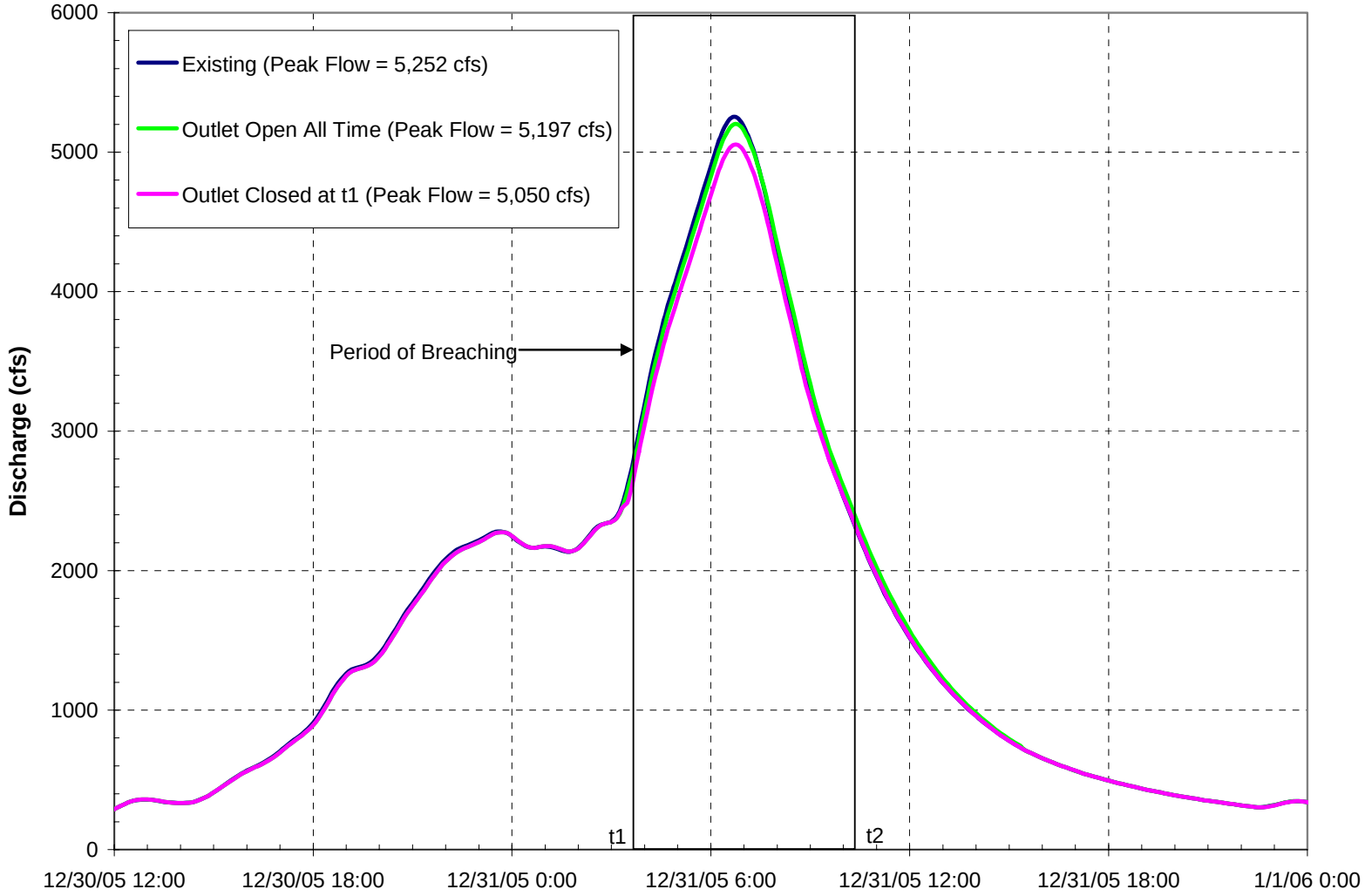


Figure 5 Comparison of Simulated Flows at Ross Gage for Different Scenarios of Memorial Park Detention Basin

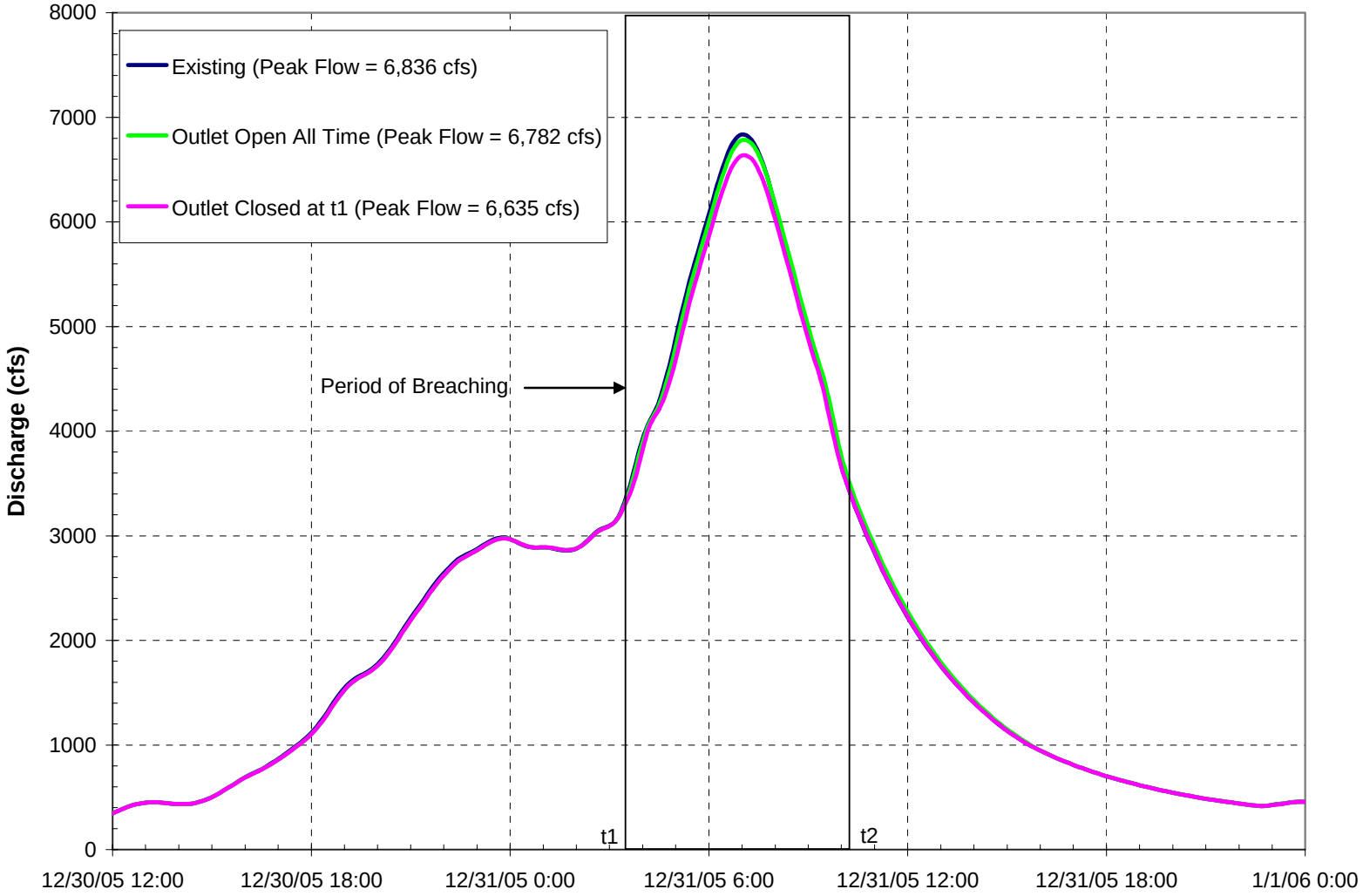
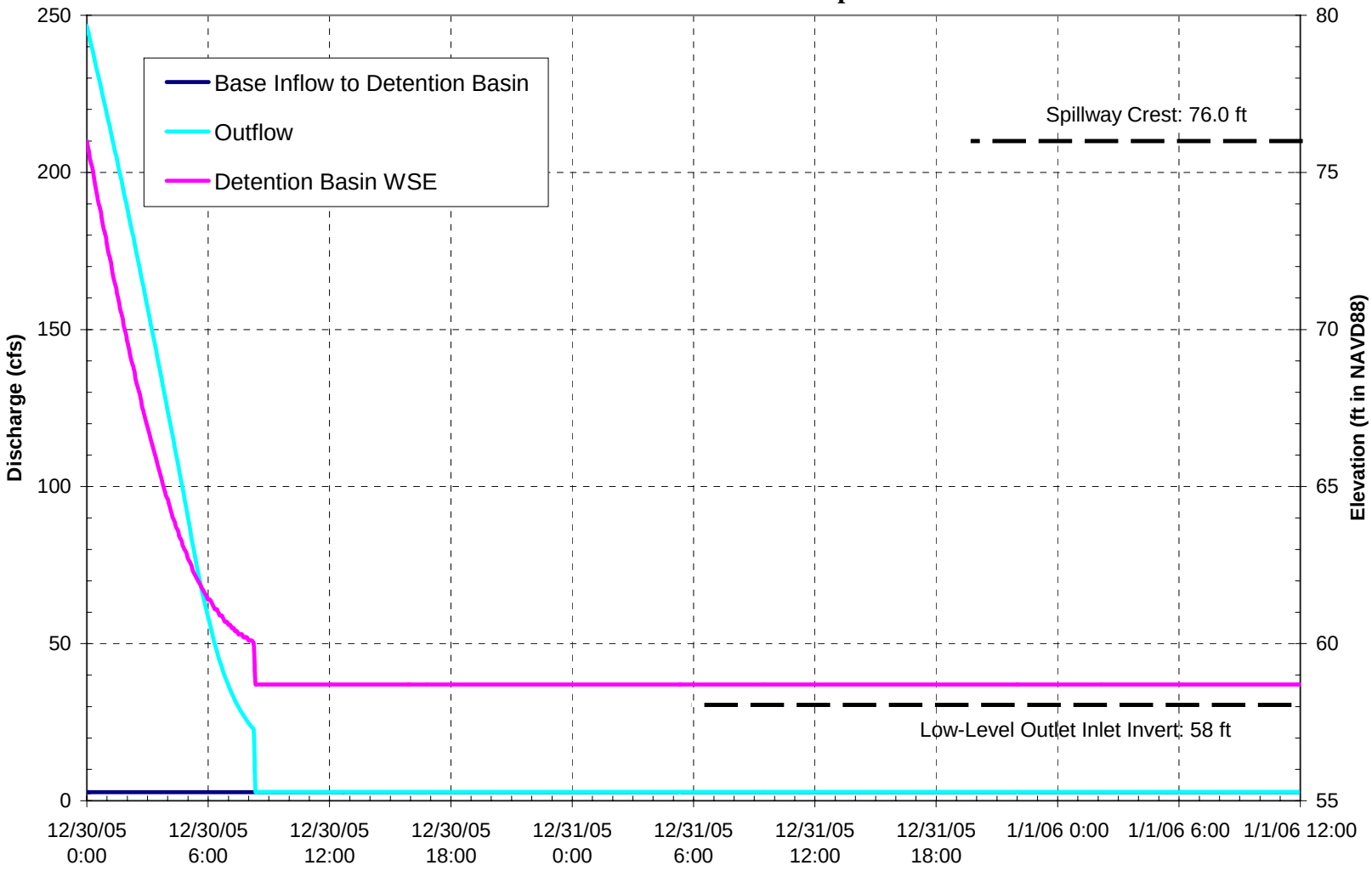


Figure 6 Analysis Results of Routing Winter Baseflow through Memorial Park Detention Basin with the Low-Level Outlet Open



Appendix 2 to Attachment 3

<u>Preliminary</u> Coordinated Operations Plan of Memorial Park Detention Basin

Stetson Engineers Inc.
November 26, 2012

This *Preliminary* Coordinated Operations Plan provides general rules and criteria for operating the Memorial Park Detention Basin to achieve its multi-purpose objectives. The objectives include flood damage reduction, irrigation water supply, water quality enhancement, ecosystem restoration, and public recreation and enjoyment. A Final Coordinated Operations Plan will be developed that is mutually acceptable to Town of San Anselmo and Marin County Flood Control and Water Conservation District, Flood Zone 9 (MCFCWCDFZ9).

1.0 Introduction

The proposed Memorial Park Detention Basin Project involves converting the existing eight acre public park into a duel-purpose park and flood control detention basin. The detention basin is formed by an excavated basin bounded along the southern and western sides by concrete wall structures and along the northern and eastern sides by cut slopes. To provide necessary storage capacity for floodwater detention, the park floor will be excavated and lowered by an average of 10 ft below existing grade. To accommodate the lower park floor, the Town's Alderney storm drain, Ross Valley Sanitation District's sewer line, and Marin Municipal Water District's water transmission line that currently pass beneath the park will be removed and relocated. To provide improved riparian and aquatic habitat as well as public access and recreational opportunities, Sorich Creek, which is now contained in a buried culvert, will be daylighted along its current alignment through the park.

A large, gated outlet culvert (i.e., low-level outlet) will be placed beneath the embankment at the southern end of the basin. This outlet will normally be kept open to allow unimpeded passage of a range of flows (less than 5-year flood peak flow), as well as sediment, woody debris, and wildlife. The basin will normally be kept empty to allow the park to serve as a public recreational facility. During unusually heavy storms when streamflow monitoring indicates that flooding downstream in downtown San Anselmo is imminent,[1] the gate on the low-level outlet will be closed and water will back-up and begin to fill the basin for floodwater detention. In extreme floods when the basin becomes full (approx. >100-year flood), flow will spill over an internal semi-circular glory hole type spillway and pass on through to the existing culverted reach of Sorich Creek below the detention basin (Note: Sorich Creek joins San Anselmo Creek about 0.5 mile downstream of Memorial Park). When full to the spillway crest, water depths will

[1] Downtown San Anselmo floods at flood magnitudes of about the 5- to 8-year recurrence interval.

reach a maximum of 14 feet at the southern end and the basin will inundate 7 acres and detain 79 acre-feet of floodwater.

In order to build the detention basin and allow for continued recreational use as a public park, the public playfield will need to be reconstructed. Tennis and basketball courts will be replaced at their approximate current location. The kids play area will be relocated on site. The historical Log Cabin will be unaffected. Since flood detention operations will occur only during very heavy storms, recreational activities at the site will rarely be affected.

Concomitant with the above-described flood damage reduction facilities are other physical and operational features that are needed to better utilize this valuable, multi-purpose public asset in ways that are compatible, and even synergistic, with flood damage reduction functions. An on-site subsurface drainage system will be constructed to keep the new playfield drier for public recreation during the wet season. A groundwater collection system will be installed to provide a reliable and self-sustaining water supply for irrigating the rehabilitated park and, in turn, reduce dependency on the water supplies from the local retail purveyor, Marin Municipal Water District (MMWD). A trash rack and storm water quality improvement device will be installed at the inlet of the replaced and rerouted Alderney storm drain to improve stormwater quality. The daylighted Sorich Creek will be vegetated to restore the creek ecosystem and improve stormwater quality and enhance the aesthetics of the creek environment. The park will be rehabilitated to extend wet-weather functionality and provide enhanced recreation and public access.

2.0 Preliminary Operations Plan

This preliminary operations plan describes general actions in response to a large storm event that has been predetermined or forecasted. The plan provides a strategy for operations before, during, and after a high storm event and defines how and when specific actions should take place. Main elements of the plan include:

a) Flood forecast and flood watch prior to a large storm event;
b) Flood detention operations during a large storm event; and,
c) Flood detention operations after a large storm event.

1) Flood Forecast and Flood Watch *Prior to* a Large Storm Event

A flood watch means that flooding is possible in the near future. The National Weather Service issues a flood watch when conditions that typically precede a flood are predicted, such as unusually heavy rain for several hours, substantial rain over several days, rains related to a hurricane or tropical system affecting the area. During a flood watch, operators will:

- Begin checking current weather predictions and flood forecasts;
- Continually monitor anticipated rainfall intensities and amounts;
- Inspect conditions of the detention basin gate;

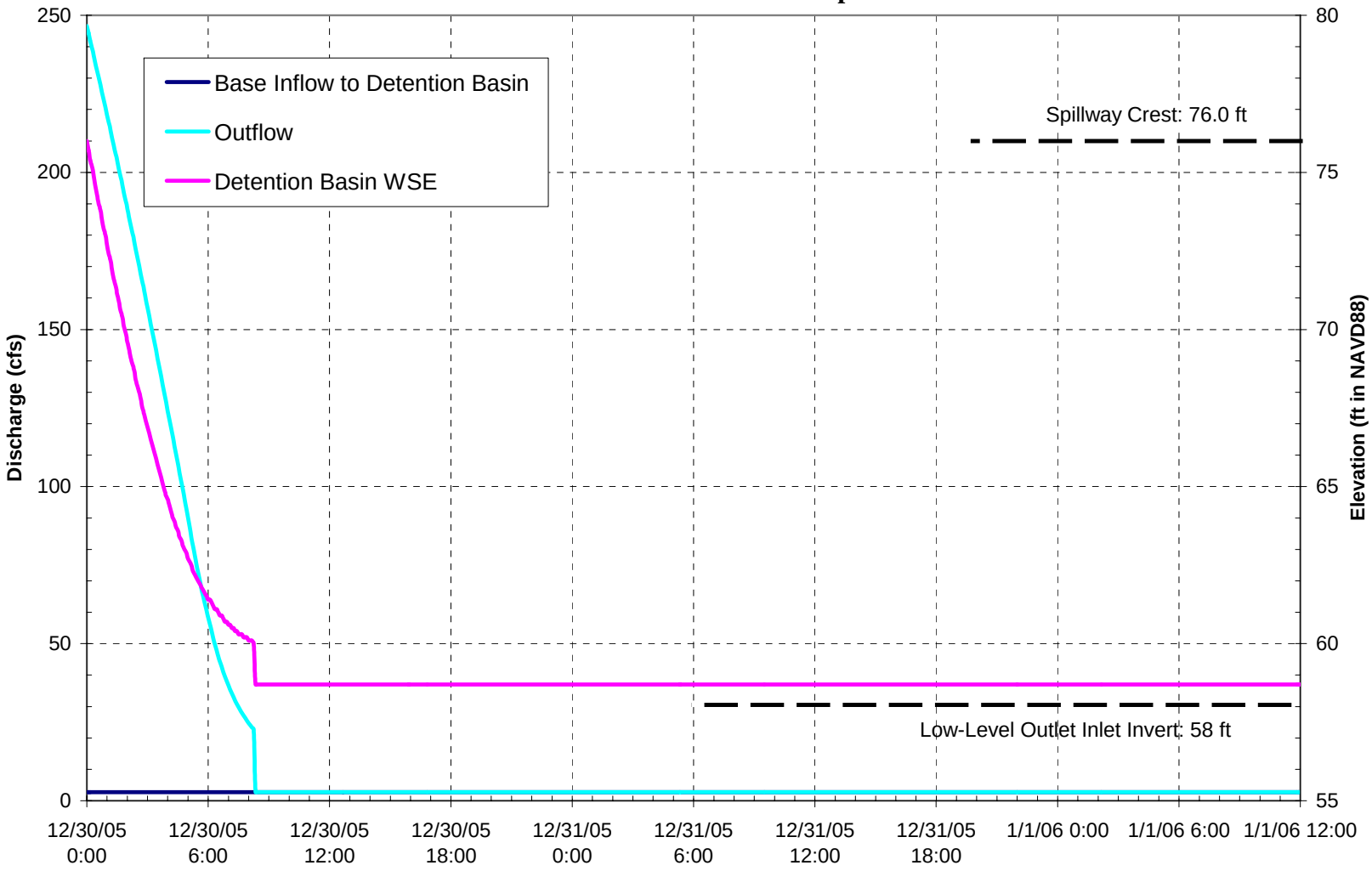
2) Operation Actions *During* a Large Storm Event

- Continually monitor anticipated rainfall intensities and amounts;
- Continually monitor stage readings at the Ross streamflow gage;
- Close the gate of the Memorial Park Detention Basin when the water level at the Ross streamflow gage reaches the flood threshold of 26.1 ft NGVD29 (or gage reading reaches 21.1 ft) and the water level is expected to be rising.

3) Operation Actions *After* a Large Storm Event

- Open the gate of the Memorial Park Detention Basin to drain the basin for detaining floodwaters for the next large storm, and control the outflow not to exceed downstream channel capacity during the draining. (Note: 8-hours is required for the low-level outlet to drain the detention basin; see Figure 1).

Figure 1 Analysis Results of Routing Winter Baseflow through Memorial Park Detention Basin with the Low-Level Outlet Open



Appendix 3 to Attachment 3

Lower Sorich Creek Culvert Assessment

THE TOWN OF
SAN ANSELMO

525 San Anselmo Avenue, San Anselmo, CA 94960-2682
www.townofsananselmo.org
(415) 258-4600 | Fax (415) 459-2477

January 28, 2013

To Whom It May Concern,

I certify that the 72-inch concrete culvert containing Sorich Creek was inspected downstream of Memorial Park and found to be in good condition.

The inspection was done by video on December 17, 2012. Beginning at the manhole on Sunnyhills Drive, the video inspection covered 380 linear feet downstream, through the Redhill Shopping Center parking lot towards Sir Francis Drake Boulevard. The defects found, such as root impingement, a void, and infiltration dripping, were minor and serviceable.

Sincerely,

Sean Condry P.E.
San Anselmo Director of Public Works

P.O. Box 3415
San Rafael Ca 94912-3415
Phone: 415-898-2700
Fax: 415-898-6074
www.rotorooter.com
Email: mendy@marin-rotorooter.com

Please follow us on:
twitter.com/marinrotorooter
facebook.com/marinrotorooter

Project Information

Project Name:	Project Number:	Date:
town of san anselmo		**12/17/2012**

client	**town of san anselmo**
Responsible:	**town of san anselmo**
Department:	**storm drain**
Street:	
City:	**san anselmo**
Telephone:	**415-264-8258**
Fax:	
Mobile:	
EMail:	

Contractor	**Roto Rooter of Marin**
Responsible:	**Mike Caldwell**
Department:	**Televise**
Street:	**885 Olive Ave. #D**
City:	**Novato**
Telephone:	**415-898-2700**
Fax:	**415-898-6074**
Mobile:	
EMail:	

Notes:

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
from manhole next t...	San Anselmo	SUNNY HILLS DR	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
UP 50 FT			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
NEX TO PARK	135.1					

Distance:	135.1 ft.	Grade:	0
Condition:	Lateral Active		
Remarks:	PIPE IS CMP		

Distance:	135.1 ft.	Grade:	0
Condition:	Inspection Ends at Upstream MH		
Remarks:	AT 135.1 FT TOWARDS PARK		

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Left Plot

Pipe ID	City	Street	Shape		Map #1	Basin
from manhole next t...	San Anselmo	SUNNY HILLS DR	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
UP 50 FT			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
NEX TO PARK	135.1					

Media # 1	Cleaned	Situation	Reason: General Condition Control
Date 20121217	Clean Date	Weather: Light Rain	Remark
Start Time 08:53			
Operator: Mike_Caldwell	Customer: town of san anselmo	Truck: 22	Inspection Dir.: Upstream / Info
Operator Comment	P.O. Number	Present	Flow Control: Not Controlled / Camera: LARGE

NEX TO PARK

	Code:	Continuous:	Pos:	Val 1 / 2 :	% :	Gallons:
135.1 ft.	Lateral Active		3			
	PIPE IS CMP					
135.1 ft.	Inspection Ends at Upstream MH					
	AT 135.1 FT TOWARDS PARK					

UP 50 FT

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Novato Cailforina 94945
415-898-2700

Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
MANHOLE BYE PARK TO...	San Anselmo	SUNNY HILLS DR	Square			
US Manhole	Section Length	Year Laid	Material		Section Type	
NEXT TO PARK			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
UNDER RED HILL SHOP...	379.9					

Distance: 3.5 ft. **Grade:** 0
Condition: Lateral Active
Remarks: N/A

Distance: 39.7 ft. **Grade:** 0
Condition: Manhole
Remarks: ACROSS STREET

Distance: 43.0 ft. **Grade:** 1
Condition: Roots slight
Remarks: N/A

Distance: 82.0 ft. **Grade:** 4
Condition: Hole in pipe Void
Remarks: N/A

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
MANHOLE BYE PARK TO...	San Anselmo	SUNNY HILLS DR	Square			
US Manhole	Section Length	Year Laid	Material		Section Type	
NEXT TO PARK			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
UNDER RED HILL SHOP...	379.9					

Distance: 139.6 ft. **Grade:** 0
Condition: Lateral Active
Remarks: N/A

Distance: 216.2 ft. **Grade:** 2
Condition: Infiltration Dripping
Remarks: N/A

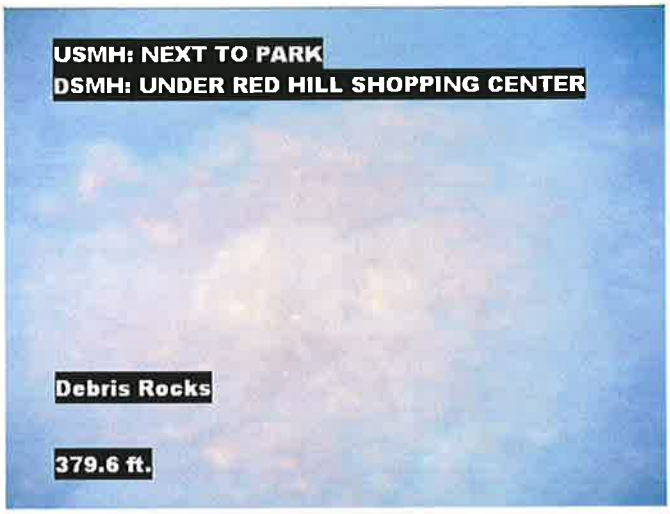
Distance: 281.7 ft. **Grade:** 0
Condition: Catch Basin
Remarks: IN PARKING LOT RED HILL

Distance: 357.0 ft. **Grade:** 3
Condition: Sag/Belly Camera under water
Remarks: N/A

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
MANHOLE BYE PARK TO...	San Anselmo	SUNNY HILLS DR	Square			
US Manhole	Section Length	Year Laid	Material		Section Type	
NEXT TO PARK			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
UNDER RED HILL SHOP...	379.9					



Distance: 379.6 ft. **Grade:** 2
Condition: Debris Rocks
Remarks: N/A

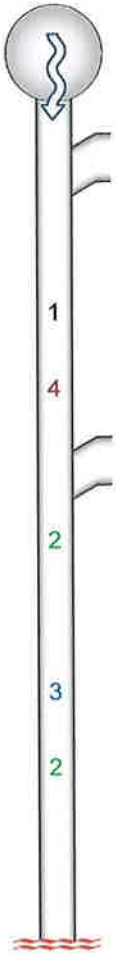
Distance: 379.9 ft. **Grade:** 0
Condition: Inspection Abandoned
Remarks: UNABLE TO PUSH BYE ROCK

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Left Plot

Pipe ID	City	Street	Shape		Map #1	Basin
MANHOLE BYE PARK TO...	San Anselmo	SUNNY HILLS DR	Square			
US Manhole	Section Length	Year Laid	Material		Section Type	
NEXT TO PARK			Insitu Concrete		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
UNDER RED HILL SHOP...	379.9					

Media # 1	Cleaned	Situation	Reason: General Condition Control
Date 20121217	Clean Date	Weather: Light Rain	Remark
Start Time 09:07			
Operator: Mike_Caldwell	Customer	Truck: 22	Inspection Dir.: Downstream / Info
Operator Comment	P.O. Number	Present	Flow Control: Not Controlled / Camera: LARGE



NEXT TO PARK

	Code:	Continuous:	Pos:	Val 1 / 2 :	% :	Gallons:
3.5 ft.	Lateral Active		11			
39.7 ft.	Manhole ACROSS STREET					
43.0 ft.	Roots slight		4 - 4			
82.0 ft.	Hole in pipe Void		2			
139.6 ft.	Lateral Active		12			
216.2 ft.	Infiltration Dripping		12 - 2			
281.7 ft.	Catch Basin IN PARKING LOT RED HILL					
357.0 ft.	Sag/Belly Camera under water					
379.6 ft.	Debris Rocks		3 - 7			
379.9 ft.	Inspection Abandoned UNABLE TO PUSH BYE ROCK					

Roto Rooter of Marin
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Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
FROM CMP ACROSS ROA...	San Anselmo	SUFFIELD AVE & VALL...	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
OPEN PIPE ON SUFFIE...			steel		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
OPEN PIPE ON VALLEY...	43.9					

Distance: 0.0 ft. **Grade:** 2
Condition: Debris Gravel
Remarks: N/A

Distance: 35.5 ft. **Grade:** 3
Condition: Sag/Belly Camera under water
Remarks: N/A

Distance: 43.9 ft. **Grade:** 0
Condition: Inspection Abandoned
Remarks: UNABLE TO PUSH ANY MORE

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Left Plot

Pipe ID	City	Street	Shape		Map #1	Basin
FROM CMP ACROSS ROA...	San Anselmo	SUFFIELD AVE & VALL...	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
OPEN PIPE ON SUFFIE...			steel		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
OPEN PIPE ON VALLEY...	43.9					

Media # 1	Cleaned	Situation	Reason: General Condition Control
Date 20121217	Clean Date	Weather: Cloudy	Remark
Start Time 11:01			
Operator: Mike_Caldwell	Customer	Truck: 22	Inspection Dir.: Downstream / Info
Operator Comment	P.O. Number	Present	Flow Control: Not Controlled / Camera: SMALL

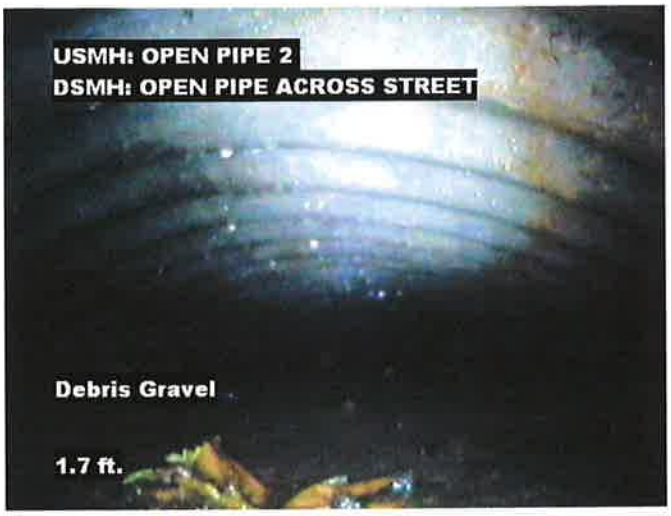
OPEN PIPE ON SUFFIELD

	Code:	Continuous:	Pos:	Val 1 / 2 :	% :	Gallons:
0.0 ft.	Debris Gravel		4 - 7			
35.5 ft.	Sag/Belly Camera under water					
43.9 ft.	Inspection Abandoned UNABLE TO PUSH ANY MORE					

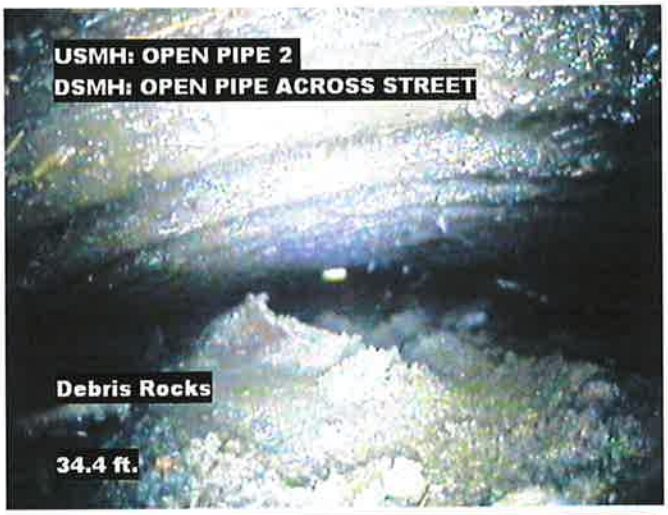
Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Pic Report 4/Page

Pipe ID	City	Street	Shape		Map #1	Basin
PIPE 2 FROM OPEN PI...	San Anselmo	SUFFIELD AVE & VALL...	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
OPEN PIPE 2			steel		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
OPEN PIPE ACROSS ST...	34.4					



Distance: 1.7 ft. **Grade:** 2
Condition: Debris Gravel
Remarks: N/A



Distance: 34.4 ft. **Grade:** 2
Condition: Debris Rocks
Remarks: N/A

Distance: 34.4 ft. **Grade:** 0
Condition: Inspection Abandoned
Remarks: UNABLE TO PUSH ANY MORE

Roto Rooter of Marin
885 Olive Ave. #D
Novato Cailforina 94945
415-898-2700

Left Plot

Pipe ID	City	Street	Shape		Map #1	Basin
PIPE 2 FROM OPEN PI...	San Anselmo	SUFFIELD AVE & VALL...	Circular			
US Manhole	Section Length	Year Laid	Material		Section Type	
OPEN PIPE 2			steel		Storm Water	
DS Manhole	Inspected Length	Year Renewed	Depth US	Depth DS	Joint Leng...	Diameter
OPEN PIPE ACROSS ST...	34.4					

Media #	1	Cleaned	Situation	Reason
Date	20121217	Clean Date		General Condition Control
Start Time	11:23		Weather: Cloudy	Remark

Operator	Customer	Truck	Inspection Dir.	Info
Mike_Caldwell		22	Downstream	
Operator Comment	P.O. Number	Present	Flow Control	Camera
			Not Controlled	SMALL

OPEN PIPE 2

	Code:	Continuous:	Pos:	Val 1 / 2 :	% :	Gallons:
1.7 ft.	Debris Gravel		4 - 8			
34.4 ft.	Debris Rocks		11 - 1			
34.4 ft.	Inspection Abandoned UNABLE TO PUSH ANY MORE					

1:	Occurances without damage: for example, laterals, joints etc. NO DEFECTS WERE DETECTED.
2:	Constructional deficiencies or occurances with insignificant influence to tightness, hydraulic or static pressure of pipe: f.e. wide joints, badly torched intakes, minor deformation of plastic pipes, minor erosions etc. REHABILITATION CAN BE SCHEDULED LONG-TERM.
3:	Constructional deficiencies diminishing static, hydraulic and tightness: f.e. open joints, untorched intakes, cracks, minor drainage obstructions such as calcide build ups, protruding laterals, minor damages to pipe wall, individual root penetrations, corroded pipe walls etc. REHABILITATION IS NECESSARY AND SHOULD BE COMPLETED IN A TIMELY MANOR.
4:	Constructional damages with nonsufficient static safety, hydraulic or tightness: f.e. axial/radial pipebursts, pipe deformations, visually noticeable infiltration/exfiltration, cavities in pipe-wall, severe protruding, laterals severe root penetrations, severe corrosion of pipe wall etc. Should be fixed or replaced soon. REHABILITATION PROCEDURE IS URGENT AND HAS TO BE COMPLETED AS SOON AS POSSIBLE NECESSITY FOR EMERCENCY OPERATIONS HAS TO BE EXAMINED.
5:	Pipe is already or will shortly be impermeable: f.e. collapsed pipe, deeply rooted pipe or other drainage obstructions. Pipe loses water or danger of backwater in basements etc. Need to replace immedaitly REHABILITATION IS URGENT AND SHORT-TERM. IN ORDER TO PREVENT FURTHER DAMAGE, NECESSARY TEMPORARY SPOT REPAIR HAS TO BE CONDUCTED ON EMERGENCY LEVEL. AS SOON AS POSSIBLE

Appendix 4a to Attachment 3

Initial Geotechnical Evaluation of Ross Valley Detention Basins (Except Phoenix Lake)

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ENGINEERING GROUP

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GEOTECHNICAL AND GEOLOGIC FEASIBILITY STUDY LOMA ALTA, LEFTY GOMEZ FIELD, MEMORIAL PARK AND RED HILL PARK DETENTION BASINS WATERSHED FLOOD DAMAGE REDUCTION & CREEK MANAGEMENT STUDY MARIN COUNTY, CALIFORNIA

April 6, 2010

Project 960.05

Prepared For:
Marin County Flood Control
c/o Stetson Engineers Inc.
2171 E. Francisco Blvd. Suite K
San Rafael, CA 94901

CERTIFICATION

This document is an instrument of service, prepared by or under the direction of the undersigned professionals, in accordance with the current ordinary standard of care. The service specifically excludes the investigation of radon, asbestos or other hazardous materials. The document is for the sole use of the client and consultants on this project. No other use is authorized. If the project changes, or more than two years have passed since issuance of this report, the findings and recommendations must be reviewed by the undersigned.

MILLER PACIFIC ENGINEERING GROUP
(a California corporation)

REVIEWED BY

Michael Jewett
Staff Geologist

Scott Stephens
Geotechnical Engineer No. 2398
(Expires 6/30/11)

GEOTECHNICAL AND GEOLOGIC FEASIBILITY STUDY
LOMA ALTA, LEFTY GOMEZ FIELD, MEMORIAL PARK
AND RED HILL PARK DETENTION BASINS
WATERSHED FLOOD DAMAGE REDUCTION &
CREEK MANAGEMENT STUDY
MARIN COUNTY, CALIFORNIA

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GEOTECHNICAL AND GEOLOGIC FEASIBILITY STUDY
LOMA ALTA, LEFTY GOMEZ FIELD, MEMORIAL PARK
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WATERSHED FLOOD DAMAGE REDUCTION &
CREEK MANAGEMENT STUDY
MARIN COUNTY, CALIFORNIA

I. INTRODUCTION

This report presents the results of our geotechnical and geologic feasibility evaluation for Loma Alta Detention Basin (DB), Lefty Gomez Field DB, Memorial Park DB and Red Hill Park DB as part of the Watershed Flood Damage Reduction and Creek Management Study, Marin County, California. The locations of the project sites are shown on Figure 1, Site Location Map. Our work was performed in accordance with our Agreement for Professional Services dated January 5, 2010 and Modification No. 1 dated February 26, 2010. The purpose of our current services is to review available data, evaluate geologic and geotechnical conditions, and provide our opinion regarding the feasibility of using the proposed sites as detention basins. The scope of our services includes the following:

- Review of geologic and geotechnical data available from the design team, local government sources (Town of Fairfax, Town of San Anselmo and Division of the State Architect (DSA)), published USGS and CGS data, and relevant Miller-Pacific reference data;
- Site reconnaissance at each of four sites to observe and evaluate existing site conditions and local geology;
- Aerial photography study for evaluation of geologic features suggestive of development hazards;
- Review of site plan and topographic mapping provided by the design team;
- Development of opinions regarding site-specific geologic hazards, potential mitigation measures, preliminary geotechnical recommendations and general development guideline;
- Preparation of this Geotechnical Feasibility Report.

This report is intended for the exclusive use of Marin County Flood Control and Water Conservation District, Stetson Engineers and their consultants on this project. No other use is authorized without the express written consent of Miller Pacific Engineering Group.
Supplemental services are expected to include a design level geotechnical investigation report based on subsurface exploration and laboratory testing at chosen sites, geotechnical consultation and plan review, and construction inspection and testing.

II. PROJECT DESCRIPTION

Four sites in central Marin County are being considered for development or redevelopment as Flood Control Detention Basins. A site location map is presented on Figure 1. Loma Alta DB is located in an undeveloped ravine upslope of White Hill School in Fairfax which is currently part of the Loma Alta Open Space Preserve under the management of the Marin County Open Space District. Lefty Gomez Field DB in Fairfax and Memorial Park DB and Red Hill Park DB in San Anselmo are currently developed as municipal parks.

Preliminary site plans indicate that the Loma Alta DB, along a tributary from the Loma Alta open space preserve, will require construction of an approximately 25 feet high and 200 feet wide earthen dam within an existing drainage ravine. The upstream and downstream slopes are planned at 4:1 (horizontal:vertical) inclinations. The project site is currently undeveloped. It should be noted that dams less than 25 feet in height and store less than 50 acre-feet of water would not be within Division of Safety of Dams (DSOD) jurisdiction.

Proposed construction of Lefty Gomez Field DB would be accomplished primarily by excavation to a maximum depth of roughly 22 feet below existing ground surface. A dike would also be constructed along the eastern side of the detention basin with a maximum height of about 8 feet. The detention basin side of the dike is currently planned with 2:1 (horizontal:vertical) slopes and the outboard side with 1:1 slopes. Concrete detention walls, 2 and 5 feet tall, are planned along the northern portion of the detention basin. A concrete dam (20 feet above channel bed) would be located in the creek channel in the northeast corner of the DB area.

Planned grading of Memorial Park DB is also primarily excavation to a maximum depth of rough 20 feet below existing ground surface. A low dike would be constructed along the southern side of the detention basin with a maximum height of 9 feet. The detention basin side of the dike is currently planned with 2:1 (horizontal:vertical) slopes and the outboard side with 1:1 slopes.

The proposed Red Hill DB would be created by construction of a compacted fill dike along the southern side to a maximum height of 12 feet. The detention basin side of the dike is currently planned with 2:1 (horizontal:vertical) slopes and the outboard side with 1:1 slopes.

Development of Lefty Gomez Field, Memorial Park, and Red Hill Park as detention basins will mainly require demolition of existing park improvements. All proposed detention basins include ancillary improvements such as spillways, gated inlet and/or outlet culverts, and slope protection.

The project team currently includes Marin County Flood Control and Water Conservation District, Stetson Engineers, Noble Consultants, Geomorph, and WRA Consultants.

III. SITE CONDITIONS

A. Regional Geology

The site is located within the Coast Range Geomorphic Province of California. The regional bedrock geology consists of complexly folded, faulted, sheared, and altered sedimentary, igneous, and metamorphic rock of the Jurassic-Cretaceous age (65-190 million years ago) Franciscan Complex.

The regional topography is characterized by northwest-southeast trending mountain ridges and intervening valleys formed from tectonic activity between the North American Plate and the Pacific Plate. Extensive faulting during the Pliocene Age (1.8-7 million years ago) formed the uneven depression that is now the San Francisco Bay. More recent tectonic activity is concentrated along the San Andreas Fault zone, a complex group of generally parallel faults.

Regional geologic mapping (USGS 2000) indicates that Loma Alta DB and Lefty Gomez Field DB are underlain by a significant amount of alluvial valley sediments, while the surrounding hills are underlain by sandstone, shale, and mélange of the Franciscan Complex. Memorial Park DB and Red Hill Park DB are also mapped as being underlain by alluvial deposits. The ridge separating Memorial Park DB and Red Hill Park DB is mapped as Franciscan sandstone, while the prominent knoll to the east of Red Hill Park DB is mapped as greenstone. A regional geologic map is presented on Figure 2.

B. Site Reconnaissance

We performed a site reconnaissance on February 19, 2010 at each of the four sites to observe and document existing conditions, as well as to evaluate the potential effects of site conditions on the proposed development.

Loma Alta DB is an unnamed tributary at the north end of Glen Drive in Fairfax, bounded by White Hill School to the south and by natural, undeveloped slopes to the east, west and north. Currently, the land is managed by the Marin County Open Space District. Slopes to the north and east were observed to be underlain by slightly to moderately weathered sandstone of the Franciscan Complex, with a thin veneer of residual soil at the surface. Slopes in these areas, particularly to the east, show terracing commonly associated with soil creep, but do not exhibit any signs of global instability. To the east of the creek, bedrock was observed to be highly weathered and somewhat less competent than on the west, and slopes east of the ravine are characterized by deeply incised eroded channels which are choked with debris. We observed numerous small slumps and debris flows, as well as common raveling and sloughing of creek banks and trail cut slopes. The bottom of the ravine consists of unsorted silts, sands, and

gravels typical of alluvial deposits as well as tree limbs and other debris.

We did observe a drainage channel on the slope east of the proposed dam which is relatively steep and, were the dam constructed in the proposed location, would discharge runoff across the downstream face of the dam, likely resulting in adverse erosion patterns which could affect the stability and lifespan of the dam. Significant geologic features observed during our site reconnaissance are shown on Figure 3.

Lefty Gomez Field DB is bounded by Sir Francis Drake Avenue to the south, Shadow Creek Court to the west, and Fairfax Creek to the north. The west side of the field abuts a residential development built along Sherman Court in the late 1960s and early 1970s. We observed a large outcrop of relatively fresh Franciscan graywacke at the south end of the field, but did not observe in-situ bedrock elsewhere on the site, including at the location of the proposed spillway at the northeast corner of the site. The field currently sits approximately 10 feet above the flowline of the creek, and our observations suggest most of the excavation required to lower the field elevation would be in alluvial deposits with bedrock in the southern portion. Geologic features observed are shown on Figure 4.

Memorial Park DB consists of a natural grass athletic field, a relatively new playground, tennis courts, and ancillary improvements. It is bounded on the south, west and north by commercial and residential development, and on the east by a steep, heavily vegetated slope. The slope is at an approximate inclination of 1.5:1 (horizontal:vertical), except at the base, where approximately 8 to 10 feet of soil is retained by large eucalyptus trees, forming a vertical face roughly 8 feet tall. About 100 feet above the vertical face, we observed a large headscarp, measuring roughly 20 feet tall and 150 feet across, marking the uppermost extend of an older landslide. We did not observe evidence of recent movement such as ground cracks, leaning trees, or excessive seepage, and the slide debris is covered with vertical eucalyptus trees on the order of 60 to 80 feet tall, suggesting the slide predates the trees. The composition of the slide debris suggests bedrock composed of Franciscan sandstone, which is consistent with the mapped geology. Aside from the steep slope east of the site, we did not observe any evidence of large-scale slope instability. Significant geologic features observed are shown on Figure 5.

Red Hill Park DB is located just east of Memorial Park and is currently occupied by an artificial-turf athletic field and associated improvements, which were completed in early 2009. The Park is bounded by Sunnyhills Drive on the west and Shaw Drive on the east. Red Hill shopping center lies to the south of the site at an elevation approximately 15 feet below the current field elevation. The shopping center and field are separated by a retaining wall approximately 13 feet high. Undeveloped slopes surrounding the park show evidence of minor soil creep, but we did not observe any evidence for large-scale slope instability. Site reconnaissance observations are

shown on Figure 6.

C. Review of Reference Documents

We reviewed documents held by various local agencies and authorities in an effort to find geologic or geotechnical information pertinent to the potential detention basin locations. On March 4, 2010 we visited both the Town of Fairfax and the Town of San Anselmo to view files on nearby structures and improvements. At the Town of San Anselmo we looked at information related to the Red Hill Park improvements, Sunny Hills Services, Ross Valley School District Office Building, Red Hill Shopping Center and various nearby residences. Unfortunately there was very little geologic or geotechnical information available to aid our evaluation. At the Town of Fairfax, we requested or reviewed files for the nearby White Hill Middle School and various adjacent residences. No relevant geologic or geotechnical information was contained in the files.

We contacted the Division of the State Architect on March 8, 2010 and viewed files for the Ross Valley School District Office Building, Red Hill School, Red Hill Park Improvements, and White Hill Middle School. We were unable to locate geotechnical or soils reports for these jobs. DSA reports that some jobs may not have required geotechnical reports, and that those jobs for which geotechnical reports were required have incomplete or missing files.

Historic Aerial Photographs – We reviewed historic aerial photographs of each site available from HJW Geospatial/Pacific Aerial Surveys of Oakland, California. We reviewed the photographs on March 3, 2010 to obtain information about site history and development. Historic photographs are summarized below with dates, identifications, and our review notes. Selected aerial photographs are presented on Figures 7 through 9.

Loma Alta Tributary DB:

Date	Photo ID	Comments
03-01-58	SFAREA-1-7	Site is undeveloped, and Smith Saddle water tanks have not yet been built. Grading appears to have begun for White Hill School to the south of the site.
07-02-70	AV957-02-20	Water tanks at Smith Saddle have been constructed, but no other development of the site has taken place. The main building at White Hill School is in place to the south of the site.
04-17-75	AV1187-02-20	No development at site since 1970. Residential development south of site along Glen Drive is occurring.
04-01-80	AV1840-02-21	No development at site since 1975. Residential development south of site along Glen Drive is occurring.
05-03-82	AV2140-02-21	No development at site since 1980.
03-15-90	AV3766-7-27	No development at site since 1982.
08-09-95	AV4890-15-51	No development at site since 1990. Residential development along Glen Drive to south of site is mostly complete.
03-06-05	KAV9010-14-2	No development at site since 1995. Development along Glen Drive has been completed.

Lefty Gomez Field DB:

Date	Photo ID	Comments
03-01-58	SFAREA-1-7	Sir Francis Drake Blvd. is in place, and grading for White Hill School appears to be underway. Glen Drive is unpaved and no residential development has taken place.
07-02-70	AV957-02-20	Residential development along Glen Drive and Sherman Court has begun and the main building at White Hill School is in place. The site has not yet been developed.
04-17-75	AV1187-02-20	Residential development along Glen Drive and Sherman Court is ongoing and a baseball field has been constructed at the site.
04-01-80	AV1840-02-21	Development of Sherman Court is complete, and development along Glen Drive continues to advance to the north and west. White Hill School has a new building.
05-03-82	AV2140-02-21	No major changes at the site since 1980.
03-15-90	AV3766-7-27	White Hill School has been expanded and development of Glen Drive has advanced slightly to the west.
08-09-95	AV4890-15-51	White Hill School has continued to expand. Shadow Creek Court and Maiden Lane have been constructed to the west of the site but no homes have yet been built.
03-06-05	KAV9010-14-2	Residential development to the north and west of the site is complete.

Memorial Park DB and Red Hill Park DB:

Date	Photo ID	Comments
12-14-53	AV124-01-01	Memorial Park's baseball field and tennis courts are in place and are bounded by existing residential development to the west and south. The north side of the park appears undeveloped open space, although the Log Cabin is already in place. Scattered single-family homes occupy the land where Red Hill Shopping Center will be built, and Red Hill Park is a natural drainage channel which has yet to be filled and developed.
07-09-63	AV550-03-15	No major changes since 1953.
07-02-70	AV957-03-22	Sonoma Avenue and Sunnyhills Drive have been built, as has Red Hill Shopping Center. North of the shopping center, the old natural drainage has been filled and leveled, and Sunnyhills Drive appears to follow its current alignment. Residential development which previously occupied the southern tip of the prominent knoll separating Memorial and Red Hill Parks has been demolished and redevelopment has not yet begun.
04-17-75	AV1187-03-21	Memorial Park has been improved to include 3 baseball diamonds. A new apartment complex occupies the space between the parks where previous development had been demolished. Red Hill Park now contains an oval track and a tennis court at the southeastern corner. The Sunnyhills Autistic Services center to the northwest of Red Hill Park appears to be nearing completion.
04-01-80	AV1840-03-26	The Sunnyhills Services center and Robin's Nest School are complete. The apartment complex south of Memorial Park has added a second set of tennis courts.
05-03-82	AV2140-04-23	The parking lot north of Memorial Park near the Log Cabin has been paved, and additional grading near the Robin's Nest School northeast of Red Hill Park appears to have taken place.
03-15-90	AV3766-09-26	No major changes since 1982.
03-06-05	KAV9010-16-4	The playground at the northwest corner of Memorial Park has been constructed.

D. Anticipated Subsurface Conditions

Based on our review of regional and local geologic maps as well as geotechnical reports for nearby sites, we anticipate Loma Alta DB is underlain by 10 to 20 feet of alluvial deposits over Franciscan Bedrock. We anticipate a thicker alluvial deposit on the order of 20-30 feet at Lefty Gomez Field DB. Memorial Park DB should be underlain by relatively shallow bedrock on the west side of the site, with bedrock increasing in depth to the west. At Red Hill Park DB, Red Hill Park, we have previously encountered up to 10 feet of fill atop alluvial deposits. Bedrock at Red Hill Park DB is anticipated to be between 20 and 30 feet deep. The depth to groundwater is not known at this time.

E. Seismicity

Active Faults in the Region- The project site is located within a seismically active area and will therefore experience the effects of future earthquakes. Earthquakes are the product of the build-up and sudden release of strain along a "fault" or zone of weakness in the earth's crust. Stored energy may be released as soon as it is generated or it may be accumulated and stored for long periods of time. Individual releases may be so small that only sensitive instruments detect them, or they may be violent enough to cause destruction over vast areas.

Faults are seldom single cracks in the earth's crust but typically are braids of breaks that comprise shatter zones which link to form networks of major and minor faults. Within the Bay Area, faults are concentrated along the San Andreas Fault zone. The movement between rock formations along either side of a fault may be horizontal, vertical, or a combination and is radiated outward in the form of energy waves. The amplitude and frequency of earthquake ground motions partially depends on the material through which it is moving. The earthquake force is transmitted through hard rock in short, rapid vibrations, while this energy movement becomes a long, high-amplitude motion when moving through soft ground materials, such as Bay Mud.

An "active" fault is one that shows displacement within the last 11,000 years and, therefore, is considered more likely to generate a future earthquake than a fault that shows no sign of recent rupture. The locations of the currently known active faults relative to the project sites are shown on Figure 10.

Historic Fault Activity- Numerous earthquakes have occurred in the region in historic times. The results of our computer database search indicate that 55 earthquakes (Richter Magnitude 5.0 or larger) have occurred within 150 kilometers (93 miles) of the site area between 1735 and 2010. The five most significant historic earthquakes to affect the project site are summarized in Table A.

TABLE A
SIGNIFICANT EARTHQUAKE ACTIVITY
Proposed Detention Basin Sites
Marin County, California

Epicenter (Latitude, Longitude)	Richter Magnitude	Fault	Year	Distance
37.80, -122.20	6.8	Hayward	1836	40 km
37.60, -122.40	7.0	San Andreas	1838	46 km
37.70, -122.10	6.8	Hayward	1868	53 km
38.20, -122.40	6.2	Rodgers Creek	1898	28 km
37.70, -122.50	8.2	San Andreas	1906	33 km

Reference: USGS (2009)

Probability of Future Earthquakes – The historical records do not directly indicate either the maximum credible earthquake or the probability of such a future event. To evaluate earthquake probability in this region, the USGS has assembled a group of researchers into the "Working Group on California Earthquake Probabilities" (2008) to estimate the probabilities of earthquakes on active faults. Potential sources were analyzed considering fault geometry, geologic slip rates, geodetic strain rates, historic activity, and micro-seismicity, to arrive at estimates of probabilities of earthquakes with a Moment Magnitude greater than 6.7 by 2038.

The probability studies focus on seven "fault systems" within the Bay Area. Fault systems are composed of different, interacting fault segments capable of producing earthquakes within the individual segment or in combination with other segments of the same fault system. The probabilities for the individual fault segments in the San Francisco Bay Area are presented on Figure 10.

In addition to the seven fault systems, the studies included probabilities of "background earthquakes." These earthquakes are not associated with the identified fault systems and may occur on lesser faults (i.e., West Napa) or previously unknown faults (i.e., the 1989 Loma Prieta and 2000 Mt. Veeder – Napa earthquakes). When the probabilities on all seven fault systems and the background earthquakes are combined mathematically, there is a 62 percent chance for a magnitude 6.7 or larger earthquake to occur in the Bay Area by the year 2032. Smaller earthquakes (between magnitudes 6.0 and 6.7), capable of considerable damage depending on proximity to urban areas, have about an 80 percent chance of occurring in the Bay Area by 2032 (USGS, 2008).

Additional studies by the USGS regarding the probability of large earthquakes in the Bay Area are ongoing. These current evaluations include data from additional active faults and updated geological data.

IV. GEOLOGIC HAZARDS

A. General

This section identifies potential geologic hazards at the property site, their significant adverse impacts, and recommended mitigation measures. The significant geologic hazards at the project site are seismic ground shaking and liquefaction.

B. Fault Surface Rupture

Under the Alquist-Priolo Special Studies Zone Act, the California Division of Mines and Geology (CDMG) produced 1:2000 scale maps showing all active faults. None of the proposed detention basin sites are located within an Alquist-Priolo Special Studies Zone and none are near any of the known active faults. The potential for fault surface rupture at the sites is remote.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*No mitigation measures required.*

C. Seismic Shaking

The sites will experience seismic ground shaking similar to other areas in the seismically active Bay Area. The intensity of ground shaking will depend on the characteristics of the causative fault, distance from the fault, the earthquake magnitude and duration, and site-specific geologic conditions. The locations of the project sites relative to known active faults are shown on Figure 10. Table B presents the expected ground accelerations at the sites shown for earthquakes on various nearby active faults. These acceleration values are for an earthquake originating on the closest portion of the fault to each site.

TABLE B
ESTIMATED PEAK GROUND ACCELERATIONS
Proposed Detention Basin Sites
Marin County, California

Location	Deterministic PGA	Probabilistic 10% in 50 yrs.	Probabilistic 2% in 50 yrs.
Loma Alta DB	0.31 g	0.47 g	0.74 g
Lefty Gomez Field DB	0.31 g	0.47 g	0.75 g
Memorial Park DB	0.30 g	0.48 g	0.74 g
Red Hill Park DB	0.30 g	0.48 g	0.73 g

Reference: Abrahamson and Silva (2008), Boore and Atkinson (2008), Campbell and Bozorgnia (2008), Chiou and Youngs (2008), Idriss (2008), USGS (2010)

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*Structures should be designed in accordance with the most recent version of the California Building Code. Seismic design guidelines and preliminary recommendations are presented in Section V of this report. Site-specific seismic design criteria will be presented in a design-level Geotechnical Investigation Report.*

D. Liquefaction Potential

Liquefaction refers to the sudden, temporary loss of soil strength during strong ground shaking. This phenomenon can occur where there are saturated, loose, granular (sandy) deposits subjected to seismic shaking. Liquefaction-related phenomena include settlement, flow failure, slope instability and lateral spreading. Because all four sites are located at least partially on alluvial deposits, the potential for liquefaction exists. Mapping by the USGS (2000) indicates all four sites lie in a zone of high liquefaction susceptibility, as shown on Figure 11. This will be confirmed based on subsurface exploration associated with our design level geotechnical investigation.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*Subsurface exploration is required to evaluate liquefaction potential. Site-specific liquefaction mitigation recommendations will be presented in a design-level Geotechnical Investigation Report. Potential mitigation may include ground improvement or retaining structures that limit lateral displacements.*

E. Seismic Induced Ground Settlement

Ground shaking can induce settlement of loose granular soils above the water table. Based on regional geologic mapping, all four sites are underlain by alluvium comprised of discontinuous strata of sand, silt, and clay. At Lefty Gomez Field DB, Memorial Park DB and Red Hill Park DB, which have been developed as municipal parks, the alluvial soils underlying park improvements has likely been compacted to prolong the lifespan of the improvements, and therefore densification of soils during a seismic event is low. At Loma Alta DB, which is undeveloped and unimproved, alluvium is expected to be less consolidated, and therefore more susceptible to seismic densification. However, we will confirm subsurface conditions during our design level geotechnical investigation.

Location	Mitigation measures required
Loma Alta DB	*Subsurface exploration required for evaluation of seismic densification hazard. Site-specific mitigation recommendations will be presented in a design-level Geotechnical Investigation Report. Mitigation measure may include removal of loose soils and replacement with compacted fill.*
Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*No mitigation measures required.*

F. Lurching and Ground Cracking

Lurching and associated ground cracking can occur during strong ground shaking. The ground cracking generally occurs along the tops of slopes where stiff soils are underlain by soft deposits or along steep channel banks. Loma Alta DB (Loma Alta Tributary) is bounded on three sides by steep terrain which is likely underlain with weathered bedrock. Lefty Gomez Field DB (Lefty Gomez Field) is currently bordered on the north by a creek channel approximately 10 feet deep and having near-vertical banks susceptible to lurching or cracking. Memorial Park DB and Red Hill Park DB are relatively flat sites and are not expected to be susceptible to lurching or cracking.

Location	Mitigation measures required
Loma Alta DB Memorial Park DB Red Hill Park DB	*No mitigation measures are required.*
Lefty Gomez Field DB	*Construction of the detention basin will eliminate the southern creek bank. Also, construction of a concrete retaining wall along the northern bank as indicated on preliminary plans will mitigate the potential for cracking and lurching in a seismic event. More detailed site-specific mitigation recommendations will be presented in a design-level Geotechnical Investigation Report.*

G. Erosion

Sandy soils on moderate slopes or clayey soils on steep slopes are susceptible to erosion when exposed to concentrated surface water flow. The potential for erosion is increased when

established vegetation is disturbed or removed. Loma Alta DB is vulnerable to erosion due to the expected colluvial and residual soil layers on the steep terrain at the site. Active erosion features were observed during our site reconnaissance. Sedimentation of the detention basin should be anticipated during major rainfall events. Careful attention should be given to the design and location of the proposed embankment in order to best mitigate the potential for adverse erosion and sedimentation patterns.

Preliminary plans indicate Lefty Gomez Field DB, Memorial Park DB, and Red Hill Park DB are to be constructed with perimeter dikes having slopes of 1:1 (horizontal:vertical). Slopes steeper than 2:1 will need to be designed and constructed with geogrid reinforcement. Erosion-control measures should be implemented to prevent adverse erosion patterns from affecting the planned cut slopes or embankments.

Location	Mitigation measures required
Loma Alta DB	*Existing erosion features should be repaired and stabilized as part of the detention basin construction. Careful attention should be given to the collection and control of surface drainage from the adjacent slopes to minimize erosion of embankment, slopes and reduce sedimentation within the basin. Erosion-control measures are discussed in further detail in Section V of this report. More detailed site-specific mitigation recommendations will be presented in a design-level Geotechnical Investigation Report.*
Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*Erosion-control measures including erosion control mats and planting should be implemented on all slopes to prevent loss of material. More detailed site-specific mitigation recommendations will be presented in a design-level Geotechnical Investigation Report.*

H. Seiche and Tsunami

Seiche and tsunamis are short duration earthquake-generated water waves in enclosed bodies of water and the open ocean, respectively. None of the sites are in close proximity to San Francisco Bay or the Pacific Ocean, and all are at elevations of at least 70 feet above sea level. Therefore, the likelihood of damage due to seiche or tsunami is remote.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*No mitigation measures required*.

I. Flooding

Typical adverse impacts from flooding are water damage to structures and furnishings. Based on Flood Insurance Rate Mps (FIRMs) published by the Federal Emergency Management Agency (FEMA), Memorial Park DB is located within the 500-year flood zone. None of the other

sites are located within a FEMA 100- or 500-year flood zone. Therefore, the potential for damage to improvements due to large-scale flooding is low. Construction of the detention basin(s) will further reduce the risk of flooding.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*Intent of detention basins is to temporarily hold flood waters. Design of detention basins should allow for short term hydrostatic pressures and drawdown conditions.*

J. Settlement

Consolidation settlement occurs from structures and other surface loads that cause deformation of soft, compressible clays. The project sites are expected to be underlain with thick deposits of dense or stiff alluvial sandy gravel, silt, and clay overlying bedrock. Soft compressible clay layers are not expected at the project sites. We will confirm subsurface conditions during our design level geotechnical investigation. At this time, we judge the potential for significant settlement to be low.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*No mitigation measures required.*

K. Expansive Soil

Expansive soil occurs when clay particles interact with water causing volume changes in the clay soil. The clay soil may swell when saturated and shrink when dried. This phenomenon generally decreases in magnitude with increasing confinement pressure at depth. These volume changes may damage lightly loaded foundations, flatwork, and pavements. During our site reconnaissance the ground was saturated due to recent rains and we did not observe shrinkage cracks induced by expansive soil shrink/swell. Based on our site inspections, soils onsite at all four locations are primarily varying quantities of gravels, sands, and low-plasticity silts and clays.

Location	Mitigation measures required
Loma Alta DB Lefty Gomez Field DB Memorial Park DB Red Hill Park DB	*No mitigation measures required.*

L. Slope Instability/Landsliding

Weak soils and bedrock on moderate to steep slopes can move downslope due to gravity. Slope instability is often initiated or accelerated from soil saturation and groundwater pressure. The primary adverse effect of slope instability is damage to structures and improvements.

Loma Alta DB is surrounded by steep topography and potentially unstable soils. Previous landslides and debris flows have occurred in the hills upslope of the proposed detention basin. Significant slope instability was not observed at the proposed embankment site or detention basin. Slope instability upslope of the proposed site could result in impoundment of soil and rock debris within the detention basin. The potential of slope instability at the proposed embankment location is low. However, the potential for instability in the surrounding hillsides is moderate to high.

Lefty Gomez Field DB is surrounded by relatively level terrain. Provided the planned cuts are 2:1 or flatter, we judge the risk of significant slope instability at Lefty Gomez Field DB is low. Subsurface exploration should be performed to confirm the existing soil types would be stable at the planned cut slopes.

Memorial Park DB is bounded on the east by a relatively steep slope which shows evidence of previous instability and landsliding. Although the observed landslide area appears inactive, the soil and slope conditions are susceptible to reactivation and instability during drawdown of impounded flood waters. Therefore the potential for localized slope instability at the site is moderate to high.

Red Hill Park DB is bounded by moderate slopes showing evidence of soil creep, but no sign of global instability. The planned grading involves construction of a fill embankment on general level terrain. Therefore, we judge the risk of significant slope instability at Red Hill Park DB to be low.

Location	Mitigation measures required
Loma Alta DB	*Existing erosion features near the proposed embankment should be stabilized and surface water collected and discharged into an appropriate drainage course. Periodic maintenance should be planned to remove soil and rock debris. Additional site-specific recommendations based on subsurface exploration should be included in a design-level Geotechnical Investigation Report. The planned embankment should be designed to achieve a minimum factor of safety of 1.5 for static conditions and minimal displacements (less than 1 foot) during strong seismic shaking.*
Lefty Gomez Field DB	*Subsurface exploration should be performed to evaluate the soil and groundwater conditions that may be exposed in the planned cut slopes.*
Memorial Park DB	*The stability of the existing landslide area will need to be evaluated in consideration of the planned grading and use of the detention basin. Based on the results of the analyses, landslide stabilization may be required. Subsurface exploration should be performed to evaluate the soil and groundwater conditions that may be exposed in the planned cut slopes.*
Red Hill Park DB	*The planned dike should be designed to achieve a minimum factor of safety of 1.5 for static conditions and have minimal displacements (less than 1 foot) during strong seismic shaking.*

M. Seepage

Groundwater seepage can saturate soils causing instability for inclined slopes. During periods of significant water storage in the detention basins, water seepage through or beneath the containment embankments or dikes could cause saturated soil conditions and ponded water at the surrounding properties. The potential for seepage conditions within the detention basins cut slopes is high. The potential for seepage through or under the planned embankments and dikes is moderate.

Location	Mitigation measures required
Loma Alta DB Red Hill Park DB	*The planned embankment should be constructed with low permeability fill or with an impermeable core A cut-off trench may be required in the foundation to control seepage under the embankment. Additional site-specific seepage control recommendations based on subsurface exploration should be included in a design-level Geotechnical Investigation Report.*
Lefty Gomez Field DB Memorial Park DB	*Subsurface exploration and monitoring should be performed to evaluate the soil and groundwater conditions that may be exposed in the planned cut slopes. Subsurface drainage improvements, such as horizontal drains or subdrains, may be required to lower groundwater levels near slopes. Weak soil areas, if present, need to be over-excavated and reconstructed with subsurface drainage and compacted fill buttresses. Low permeability fill and cut-off trenches should be utilized for the low perimeter dikes.*

V. CONCLUSIONS AND RECOMMENDATIONS

General

Based on our site inspections, research and evaluation, it is our professional opinion that development of all four proposed detention basin sites is feasible from a geotechnical and geologic standpoint. The significant issues that need to be considered in development are the potential for strong ground shaking, potential liquefaction at Lefty Gomez Field, Memorial Park and Red Hill Park Detention Basins, and potential slope instability at Loma Alta and Memorial Park Detention Basins.

General guidelines for project planning and preliminary recommendations are provided in the following sections. A geotechnical investigation with subsurface exploration and laboratory testing will be required to provide site specific evaluations, geotechnical recommendations and criteria for use in the design and construction of the project.

Development Guidelines and Preliminary Recommendations

Seismic Design – The seismic design of structures and dams should be in accordance with the most recent version of the California Building Code (CBC, 2007). Based on our reconnaissance, a CBC soil type of S_D (stiff soil profile) will likely apply in the channel area of Loma Alta DB and a soil type of S_B (rock profile) will likely apply to surrounding slopes. A CBC soil type of S_D (stiff soil profile) will likely apply to Lefty Gomez Field DB, DB-3 and Memorial Park DB. We recommend the CBC coefficients and site values shown in Table C for use in equations 30-4 through 30-8 to calculate the design base shear of new construction. Subsurface exploration of the project sites must be conducted to confirm the CBC coefficients.

TABLE C
2007 CBC FACTORS
Marin County Detention Basin LOMA ALTA DB Slopes
Marin County, California

Factor Name	Coefficient	CBC Table	Site Specific Value
Site Class[1]	$S_{A,B,C,D,E, or F}$	1613.5.2	S_B
Spectral Acc. (short)	S_s	1613.5.1	1.50 g
Spectral Acc. (1-sec)	S_1	1613.5.1	0.66 g
Site Coefficient	F_a	1613.5.3 (1)	1.0
Site Coefficient	F_v	1613.5.3 (2)	1.0

(1) Site Class B Description: Rock profile with shear wave velocities between 2,500 ft./sec. and 5,000 ft./sec.

TABLE D
2007 IBC FACTORS
Marin County Detention Basins LOMA ALTA DB Channel and LEFTY GOMEZ FIELD DB, MEMORIAL PARK DB and RED HILL PARK DB
Marin County, California

Factor Name	Coefficient	CBC Table	Site Specific Value
Site Class[1]	$S_{A,B,C,D,E, or F}$	1613.5.2	S_D
Spectral Acc. (short)	S_s	1613.5.1	1.50 g
Spectral Acc. (1-sec)	S_1	1613.5.1	1.00 g
Site Coefficient	F_a	1613.5.3 (1)	1.0
Site Coefficient	F_v	1613.5.3 (2)	1.5

(1) Site Class D Description: Stiff soil profile with shear wave velocities between 600 and 1,200 fps, Standard Penetration Test N values between 15 and 50, and undrained shear strength between 1,000 and 2,000 psf.

Site Grading – Site grading at the proposed detention basin is expected to consist of a combination of excavation and fill placement.

1. Preparation – Clear all grass, brush, roots, over-sized debris and organic material from within the new project work area. Loose soil or highly permeable soil needs to be stripped within the foundation area of planned embankments or dikes. Near residential areas, cut-off trenches will likely be required below perimeter dikes to reduce the potential for groundwater seepage beneath the dikes. Any live utilities within the planned excavation areas will need to be located, capped and re-routed prior to grading.

2. Excavations – Excavations up to a depth of roughly 20 feet may be performed to create the detention basins. Excavations will generally be into stiff alluvial soils and should be possible with conventional grading equipment (i.e. scrapers and dozers). Localized area of hard bedrock may be encountered within portions of the Lefty Gomez DB.

3. Fill Criteria – Most on-site material will likely be suitable for re-use as compacted fill. For fill material, we recommend using non-expansive soil and rock free of organic matter, with a Liquid Limit of less than 40, a Plasticity Index of less than 20, a minimum R-value of 20, and conforms to the gradation limits in Table D. Select clayey impermeable fill material will be needed for the embankment core and perimeter dikes. The permeability criteria for the select fill should be determined based on design level analyses. Typical values would be less than 10^{-6} cm/sec.

TABLE E
FILL GRADATION LIMITS
Marin County Detention Basins
Marin County, California

Particle Size	Percent Finer by Dry Weight
4 inch	100
No. 4 sieve	20 - 100
No. 200 sieve	0 - 50

4. Compacted Fill – Structural fill and scarified subgrades should be conditioned to near their optimum moisture content. Properly moisture conditioned and cured on-site materials should subsequently be placed in loose horizontal lifts of 8 inches thick or less and uniformly compacted to at least 90 percent relative compaction for general fill area. The proposed embankments should be compacted to at least 95% relative compaction to provide a firm unyielding, impermeable surface. Relative compaction, maximum dry density, and optimum moisture content of fill materials should be determined in accordance with ASTM Test Method D 1557, “Moisture-Density Relations of soils and Soil-Aggregate Mixtures Using a 10-lb. Rammer and 18-in. Drop”.

5. Slopes – Preliminary site plans indicate that perimeter dikes at Lefty Gomez Field DB, Memorial Park DB and Red Hill Park DB are planned with 1:1 (horizontal:vertical) slopes. If possible all cut and fill slopes should not be steeper than 2:1. If steeper slopes are required, they will need to be specifically designed and will likely require geotextile reinforcement and erosion control mats. Site-specific recommendations regarding perimeter dikes and slope stability will be presented in a design-level Geotechnical Investigation Report.

For temporary slopes, the Federal Occupational Safety and Health Administration (OSHA) has promulgated rules for Excavations, 29 CFR Part 1926, October 31, 1989. OSHA dictates allowable slope configurations and minimum shoring requirements based on categorized soil types. In conformance with OSHA's categorization, on site soils are expected to be “Type C.” The Contractor may elect to use a variety of shoring and temporary slope configurations, but his operations must conform to Federal and State OSHA regulations. Additionally, it should be made clear that the safety of excavations, slopes, construction operations, and personnel are the sole responsibility of the Contractor.

Performance of cut slopes will be influenced by the length of time the cut is unsupported, groundwater seepage, surface runoff over the cut face, bedding planes of rock, soil materials

and other factors. Permanent and temporary cut slopes should be inspected by a Geotechnical Engineer during construction.

6. Retaining Structures – Retaining structures could be utilized in the site grading to improve stability of landslide areas, enlarge the storage capacity of the detention basin, or reduce the inclination of steep slopes. Based on the anticipated site conditions, soil nailed, reinforced shotcrete retaining structures would be best suited for the cut areas and mechanically stabilized earth (MSE) walls, such as Keystone or Versa-lok, would be best suited in the fill areas.

VI. SUPPLEMENTAL SERVICES

Following preliminary approval of the project, a geotechnical investigation including subsurface exploration and laboratory testing will be needed to provide geotechnical evaluation, analyses, recommendations and criteria for the design and construction of the project.

During design we should provide geotechnical consultation to the design team regarding geologic and geotechnical condition that could impact the project. We should review plans and specifications as they are developed to confirm that the intent of our geotechnical recommendations has been incorporated and provide supplemental recommendations, if needed.

During construction, we must observe and test the geotechnical portions (foundations, subsurface drainage and site grading) of the project to confirm that subsurface conditions are as expected and the contractor's work is performed in accordance with the contract documents.

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United States Geological Survey (USGS), "National Seismic Hazards Map Program," Version 5.0.9, October 06, 2008.

SITE LOCATION

SCALE

0 2000 4000 8000 FEET

0 1000 2000 METERS

NORTH

REFERENCE: DeLorme 3D TopoQuads, 1999

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SITE LOCATION MAP

Marin County Flood Control
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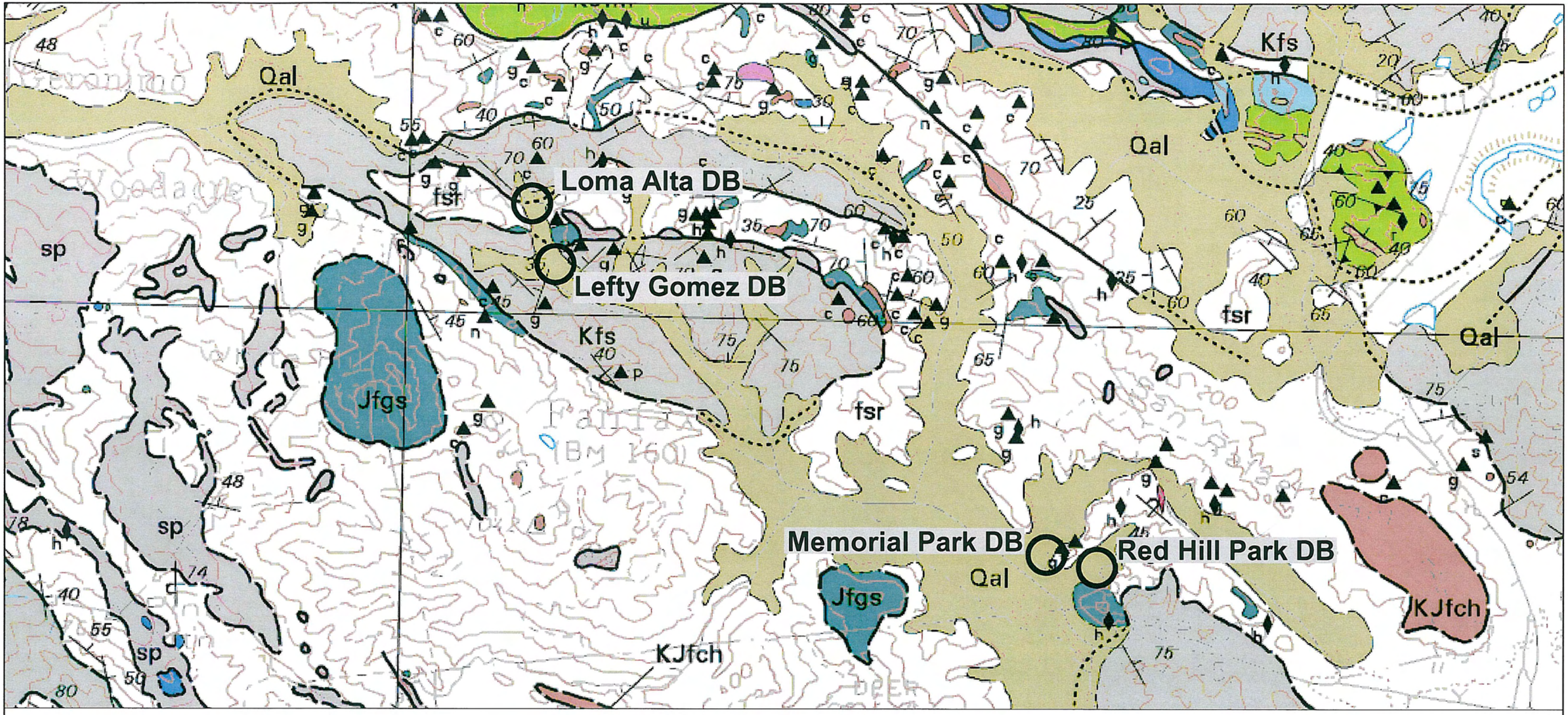
Project No. 960.05 Date: 3/2/10

Designed
Drawn JSC
Checked

1
FIGURE



LEGEND

- **Qal - Alluvium (Quaternary)**
  Stream and channel deposits, typically poorly-sorted discontinuous beds of silts, sands and gravels

Franciscan Complex

- **Kfs - Sandstone and Shale (Cretaceous)**
  Sandstone commonly medium to thick-bedded, fine- to coarse-grained arkosic wacke (graywacke) with dark gray to black shale interbeds
- **Jfgs - Greenstone (Jurassic)**
  Commonly well-bedded pillow lavas with minor intrusive diabase. Smaller masses often widely fractured; larger masses typically highly weathered and intensely fractured
- **Fsr - Melange**
  Composed chiefly of sandstone and shale with lesser amounts of volcanic and metmorphic rock. Typically highly sheared, highly weathered, and intensely fractured.
- **sp - Serpentinite**
  Slightly to highly altered ultramafic rock, typically highly sheared, outcrops often lenticular or irregular

APPROXIMATE SCALE
0 1250 2500 5000 FEET

NORTH

REFERENCE: Blake Jr., M.C., Graymer, R.W., and Jones, D.L., "Geologic Map and Map Database of Parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma COunties, California: A Digital Database", United States Geological Survey Miscellaneous Field Study MF-2337 Version 1.0, 2000

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FILE: 960.05GM.dwg

GEOLOGIC MAP

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Project No. 960.05 Date: 03/02/10

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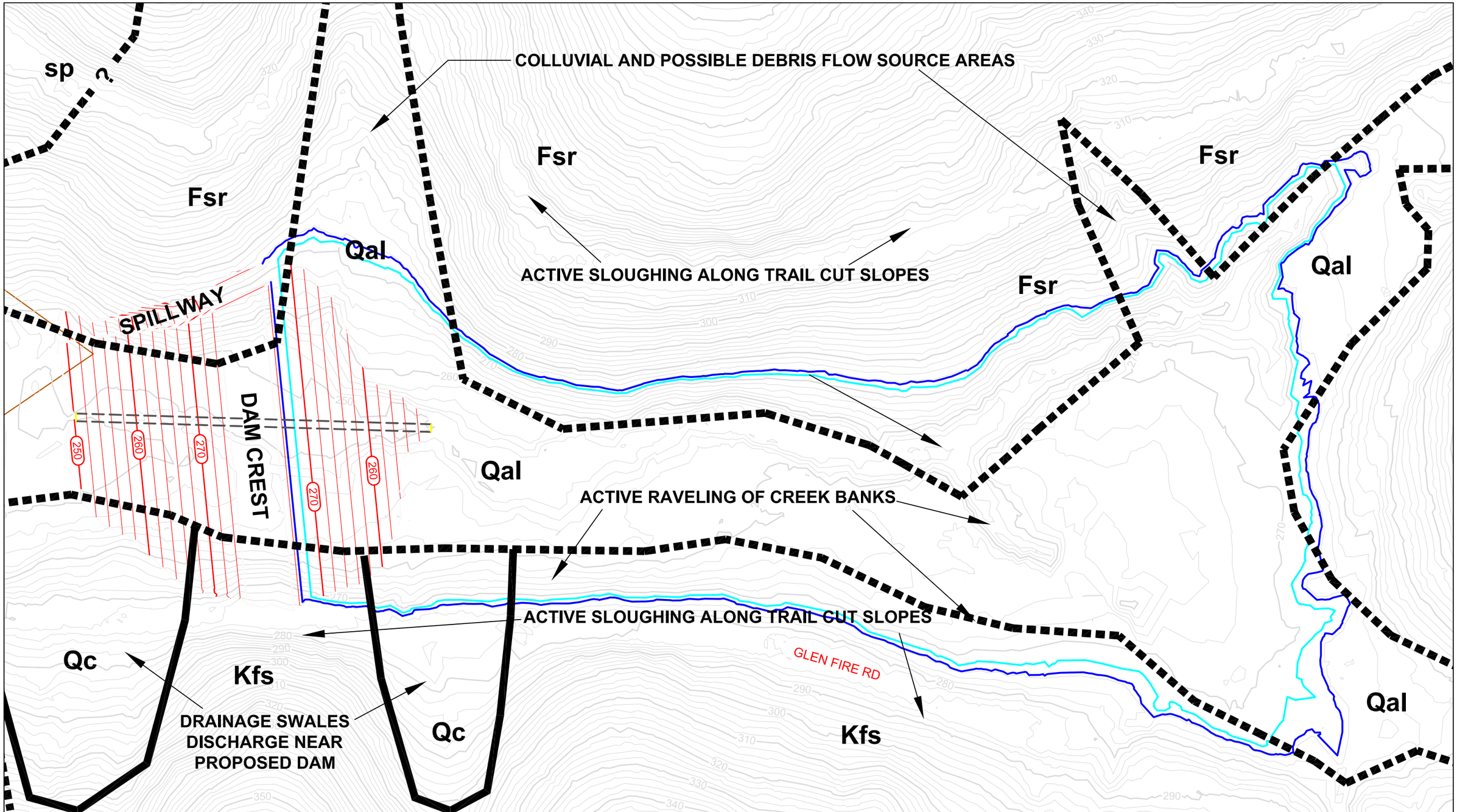
Checked

2
FIGURE



LEGEND:

- EXISTING 2 FT CONTOURS
- PROPOSED 2 FT CONTOURS
- NORMAL WSE (ELEV=217')
- MAXIMUM WSE (ELEV=218.5')

GEOLOGIC UNITS

- Fsr = FRANCISCAN MELANGE
- sp = SERPENTINITE
- Qal = ALLUVIAL DEPOSITS

SCALE (FEET)

0 50 100 200 FEET

NORTH

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LOMA ALTA DB SITE PLAN

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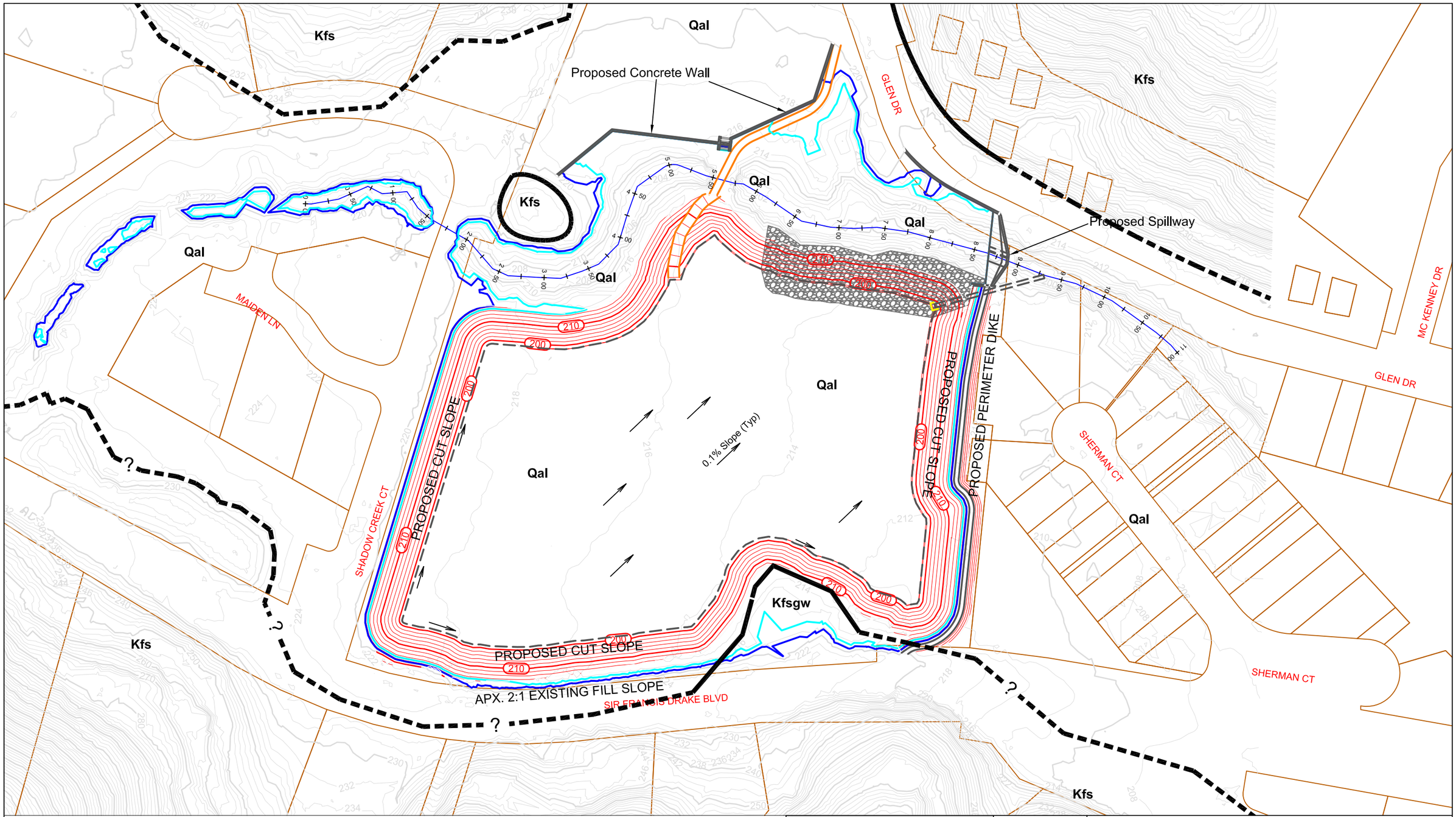
3
FIGURE



LEGEND:

- EXISTING 2 FT CONTOURS
- PROPOSED 2 FT CONTOURS
- NORMAL WSE (ELEV=217')
- MAXIMUM WSE (ELEV=218.5')

GEOLOGIC UNITS

- Kfs = FRANCISCAN SANDSTONE AND SHALE
- Kfsgw = FRANCISCAN GRAYWACKE SANDSTONE
- Qal = ALLUVIAL DEPOSITS

SCALE

0 50 100 200 FEET

NORTH

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FILE: 960,05SPb.dwg

LEFTY GOMEZ DB SITE PLAN

Marin County Flood Control
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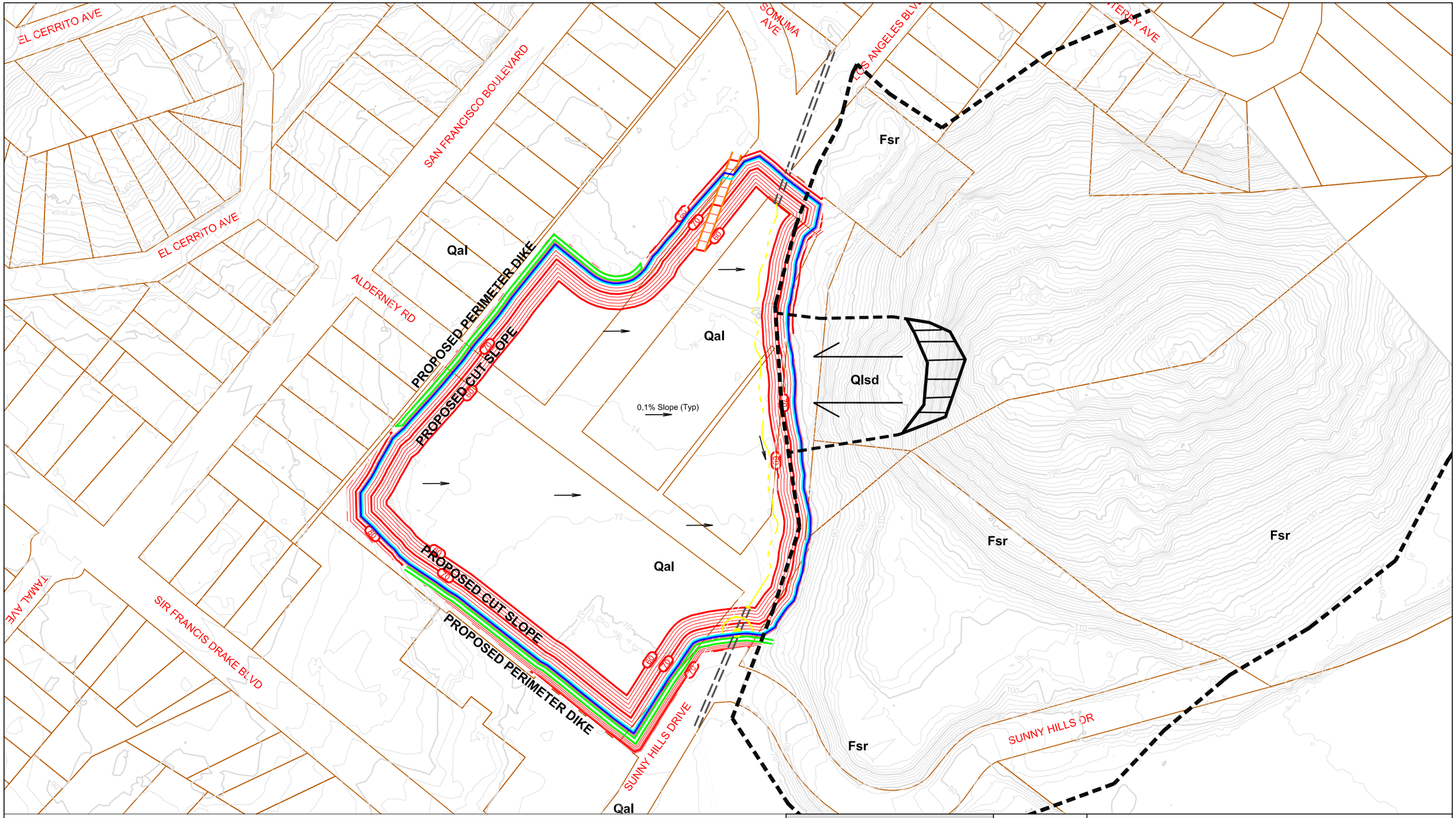
Project No. 960.05 Date: 03/19/10

Drawn MFJ
Checked

4
FIGURE



LEGEND:

- EXISTING 2 FT CONTOURS
- PROPOSED 2 FT CONTOURS
- NORMAL WSE (ELEV=217')
- MAXIMUM WSE (ELEV=218.5')

GEOLOGIC UNITS

- Qlsd = LANDSLIDE DEBRIS (DORMANT)
- Qal = ALLUVIAL DEPOSITS
- Fsr = FRANCISCAN MELANGE

SCALE

0 60 120 240 FEET

NORTH

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MEMORIAL PARK DB SITE PLAN

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Checked

5
FIGURE

Qal

Fsr

Qaf

HILLS DRIVE

SUNNY HILLS DR

PROPOSED DIKE

Existing Culvert

RED HILL SHOPPING CENTER

LEGEND:

EXISTING 2 FT CONTOURS

PROPOSED 2 FT CONTOURS

NORMAL WSE (ELEV=217')

MAXIMUM WSE (ELEV=218.5')

GEOLOGIC UNITS

Qal = ALLUVIAL DEPOSITS

Fsr = FRANCISCAN MELANGE

SCALE (FEET)

0 40 80 160 FEET

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FILE: 960,05SPDB6.dwg

RED HILL PARK DB SITE PLAN

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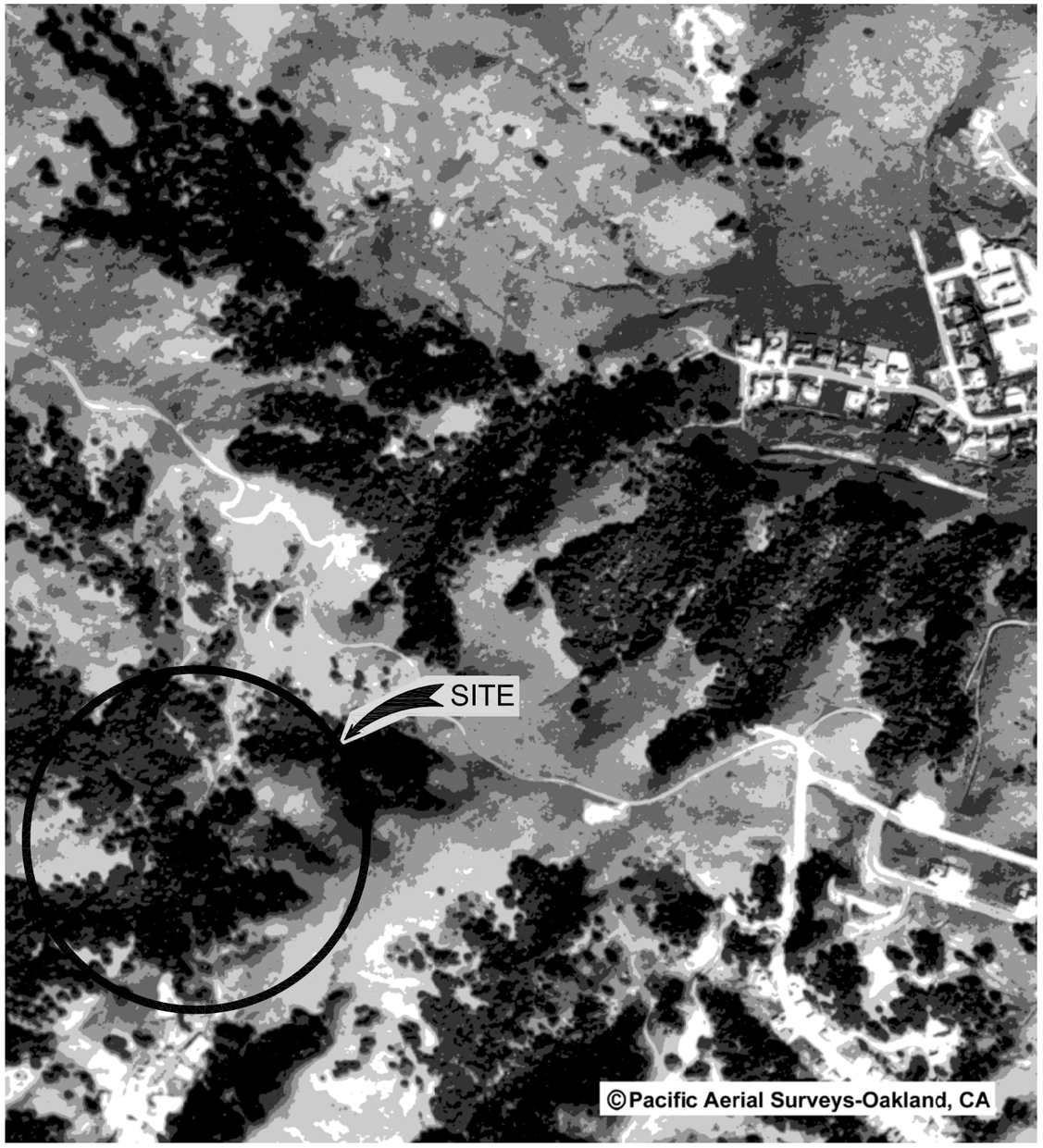
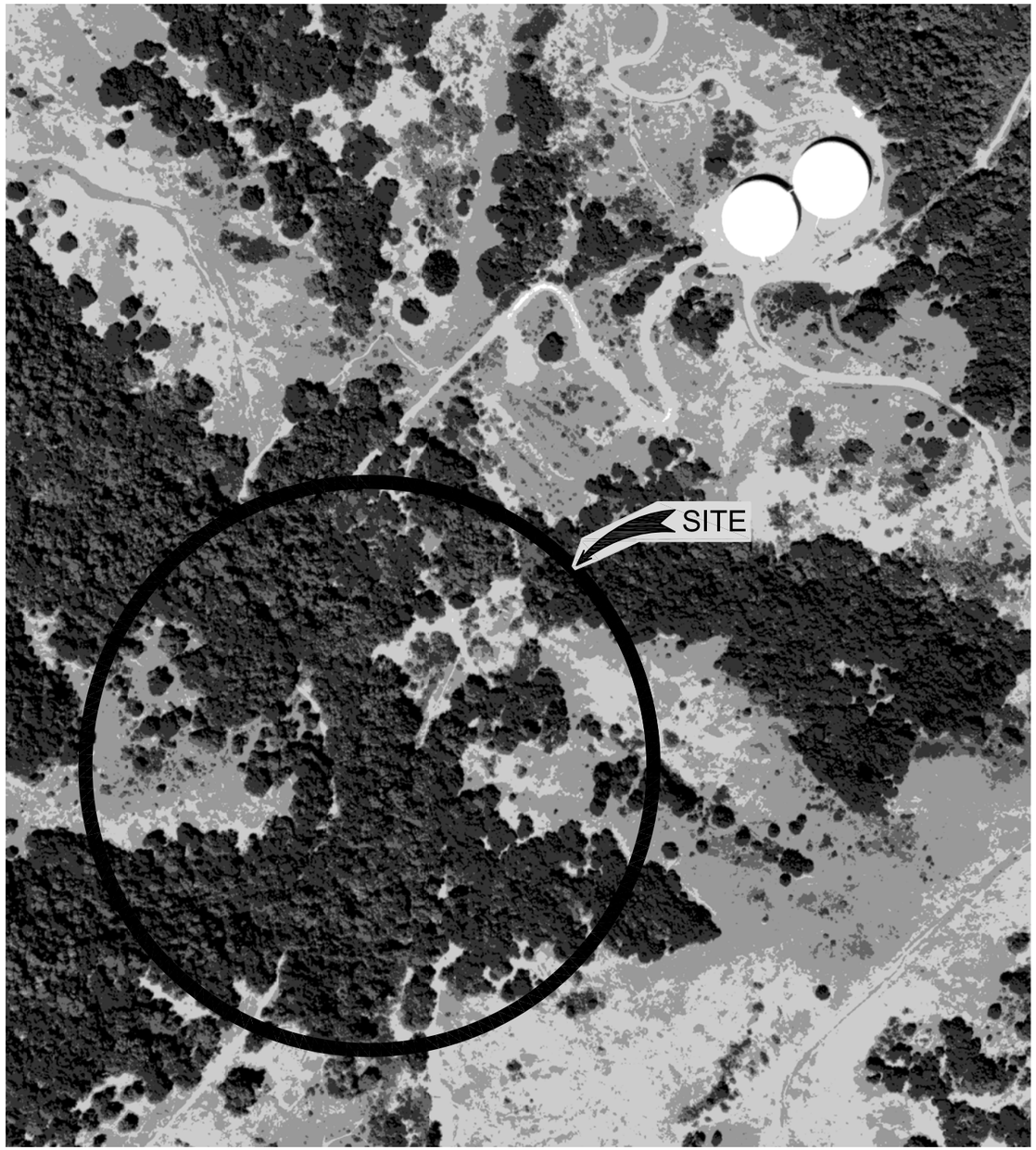
Project No. 960.05 Date: 03/19/10

Drawn MFJ
Checked

6
FIGURE



AERIAL PHOTOGRAPH TAKEN MARCH 8, 1958
NOTE FIRE ROADS AND ABSENCE OF WATER TANKS AT SMITH SADDLE (CENTER LEFT)



AERIAL PHOTOGRAPH TAKEN AUGUST 9, 1995
NOTE WATER TANKS AT SMITH SADDLE (UPPER RIGHT)

NORTH

PHOTOS COURTESY OF PACIFIC AERIAL SURVEYS, OAKLAND, CALIFORNIA

PHOTOGRAPHS NOT SHOWN TO SCALE

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LOMA ALTA HISTORIC AERIAL PHOTOGRAPHS

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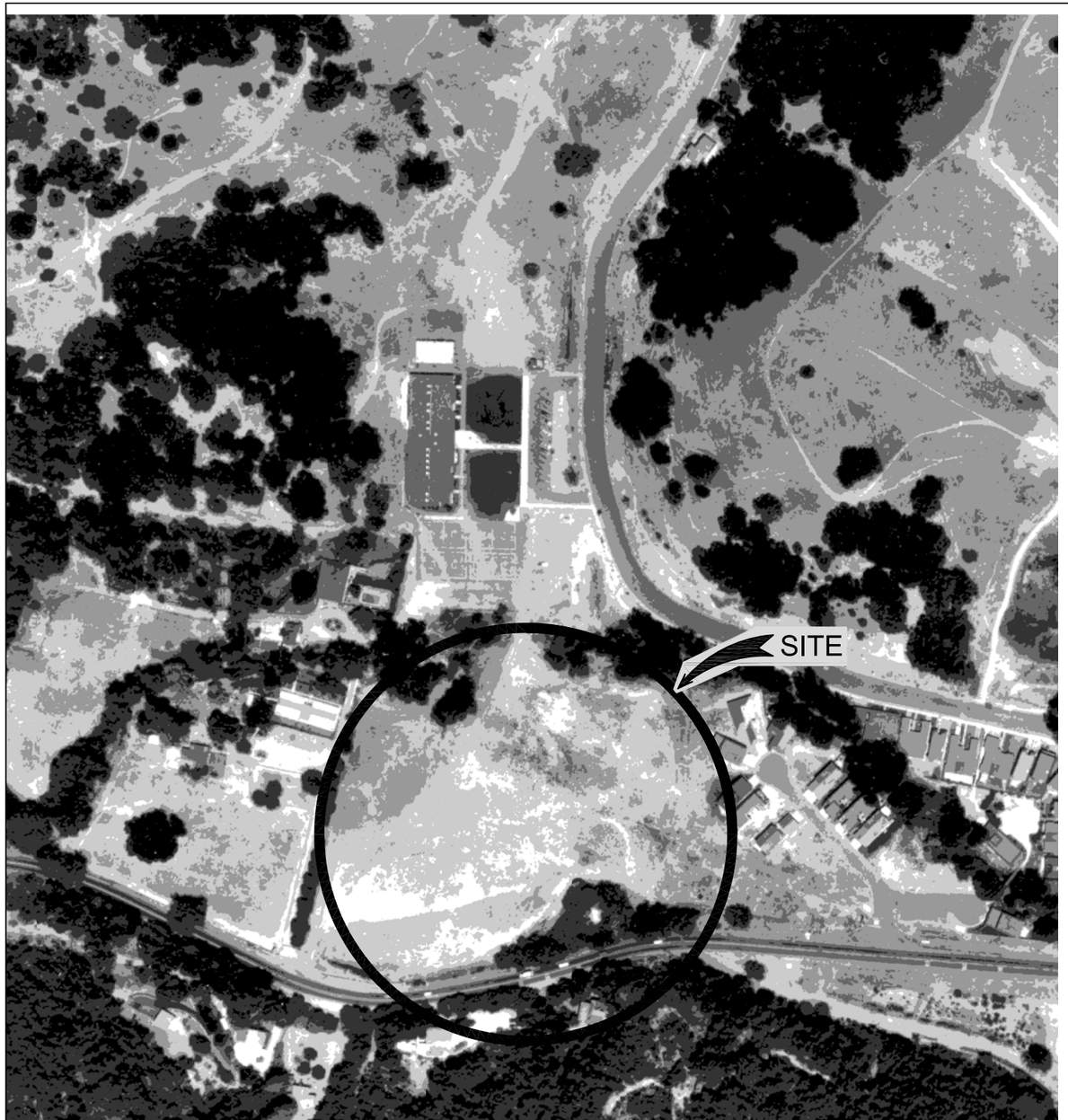
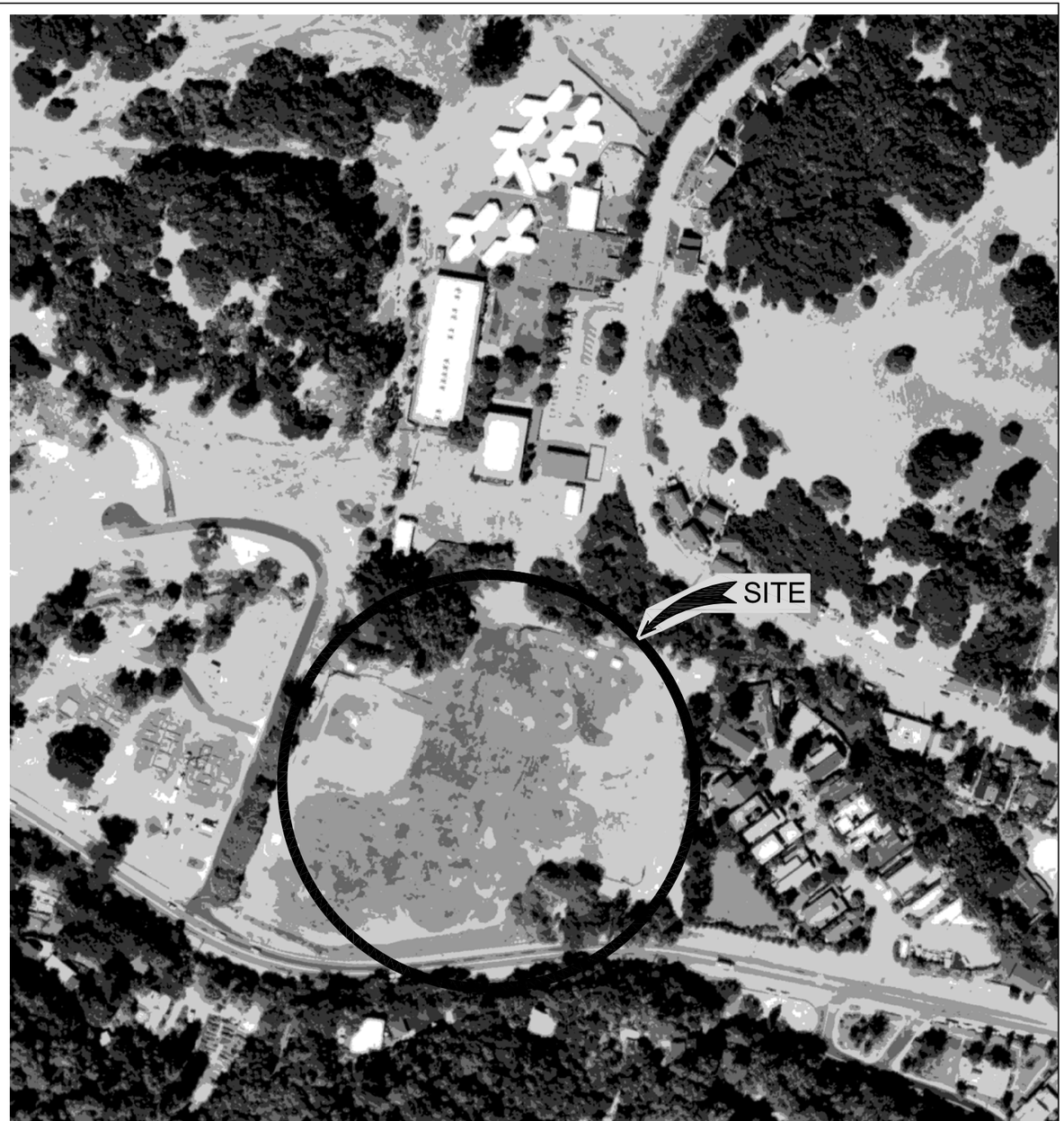
Drawn MFJ
Checked

7
FIGURE



AERIAL PHOTOGRAPH TAKEN JULY 2, 1970



AERIAL PHOTOGRAPH TAKEN AUGUST 9, 1995

NORTH

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PHOTOGRAPHS NOT SHOWN TO SCALE

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FILE: 960,05DB2AERIALS,dwg

LEFTY GOMEZ HISTORIC AERIAL PHOTOGRAPHS

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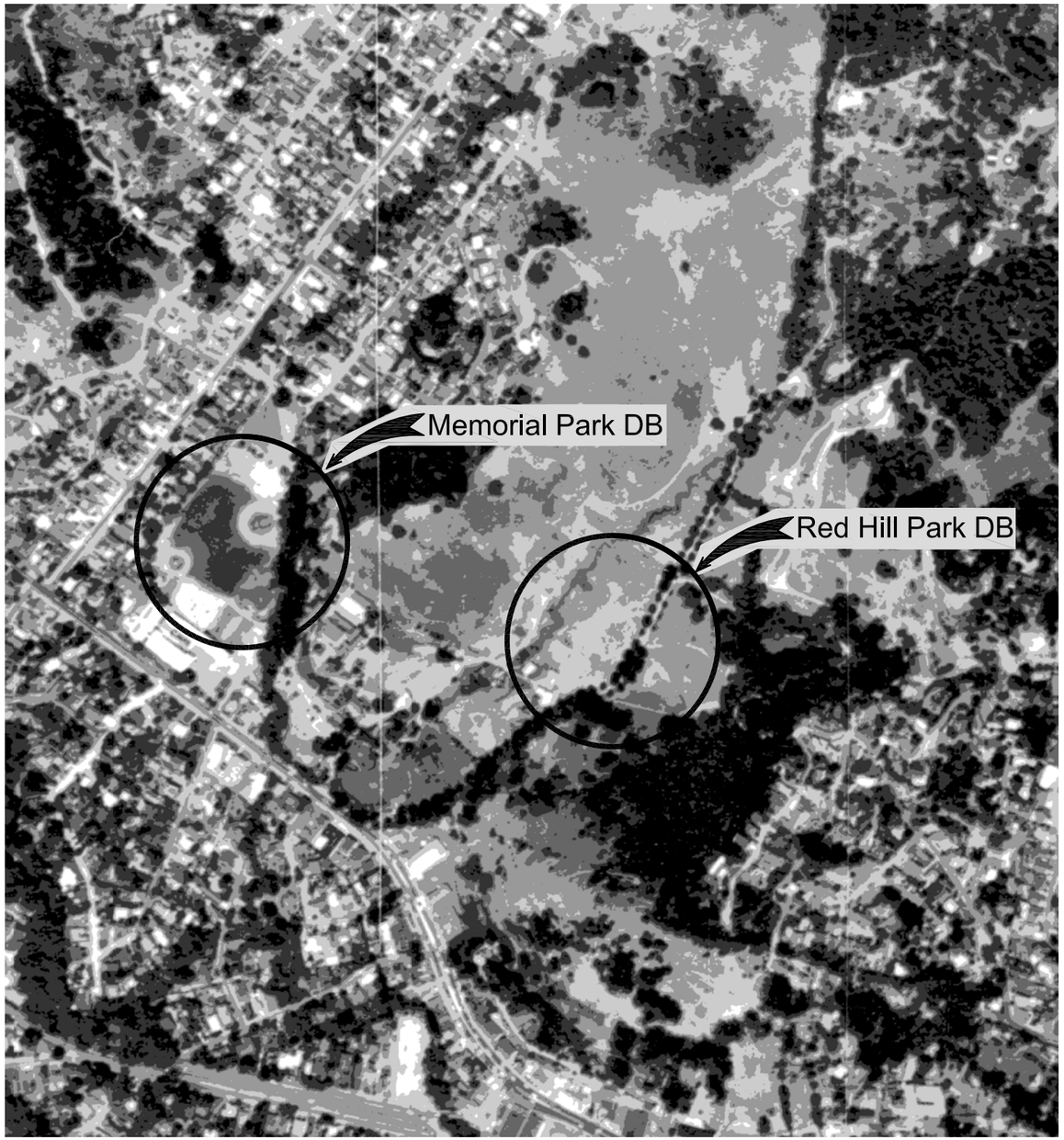
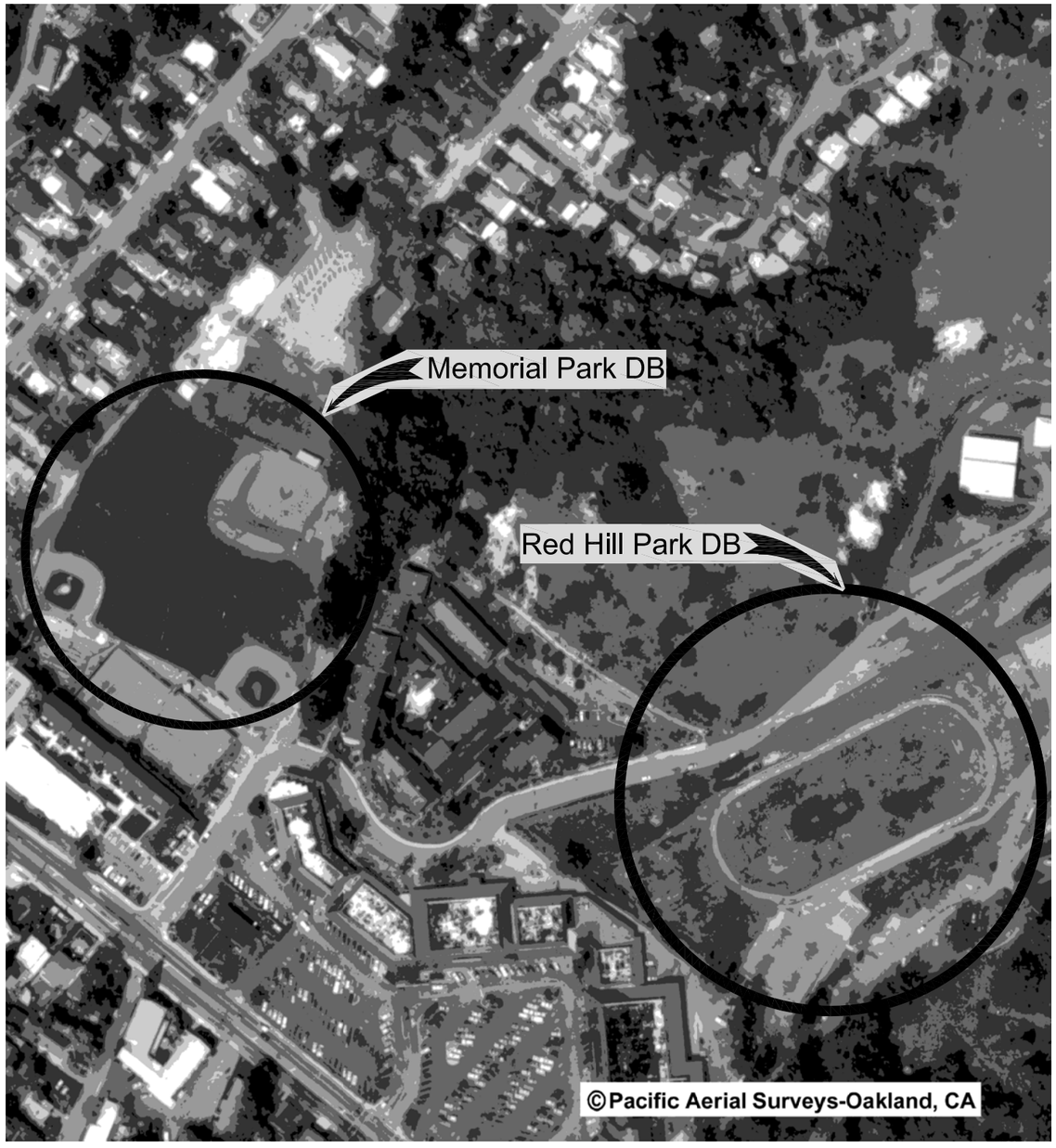
Project No. 960.05 Date: 03/03/10

Drawn MFJ
Checked

8
FIGURE



AERIAL PHOTOGRAPHY TAKEN JULY 9, 1963
NOTE NATURAL DRAINAGE CHANNEL AT DB-6 SITE.



AERIAL PHOTOGRAPHY TAKEN MARCH 15, 1990
NOTE EXTENT OF DEVELOPMENT AND OF FILL PLACED AT DB-6 RELATIVE TO 1963 PHOTO.

NORTH

PHOTOS COURTESY OF PACIFIC AERIAL SURVEYS, OAKLAND, CALIFORNIA

PHOTOGRAPHS NOT SHOWN TO SCALE

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MEMORIAL PARK AND RED HILL PARK
HISTORIC AERIAL PHOTOGRAPHS

Marin County Flood Control
Flood Damage Reduction
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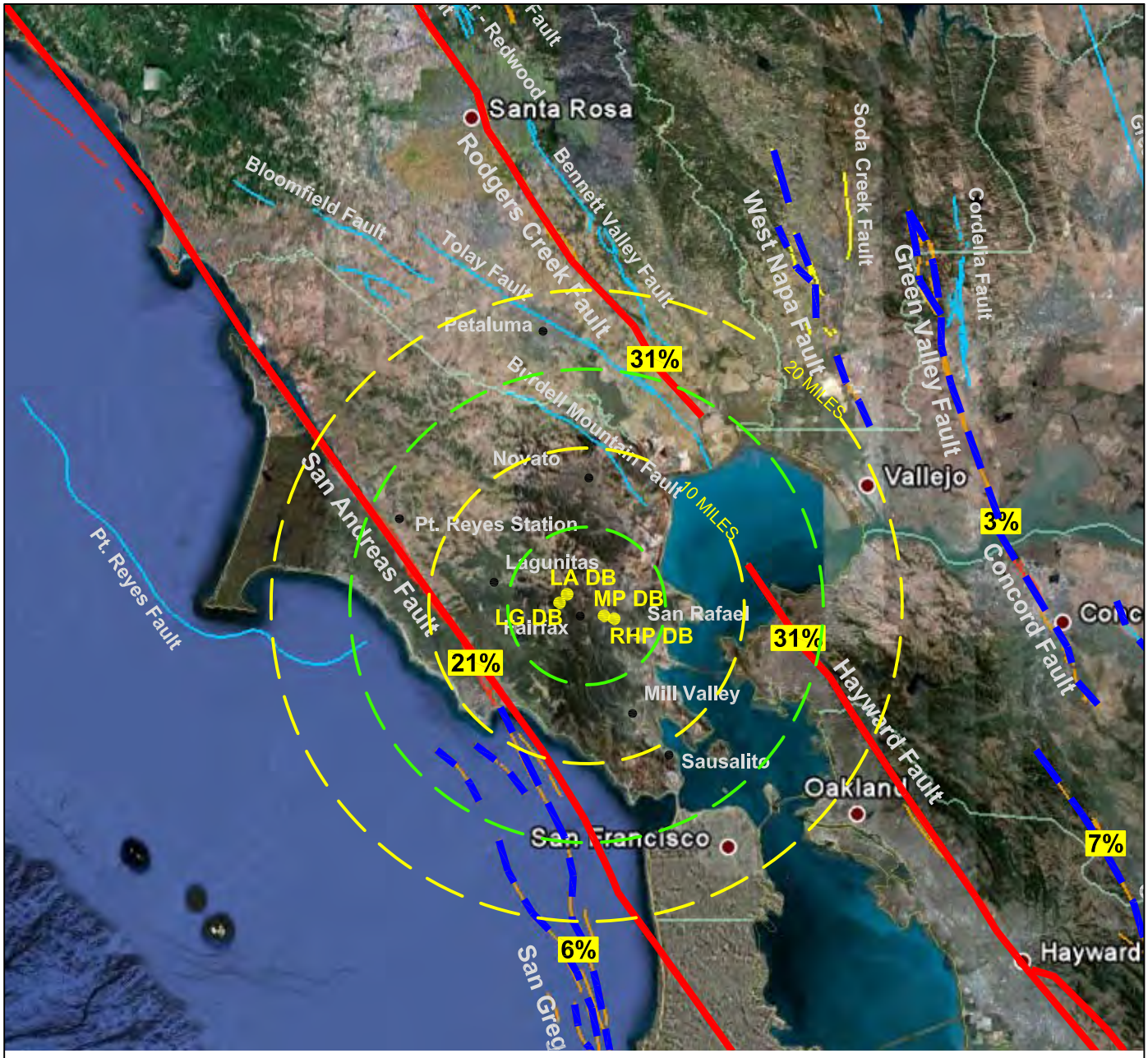
Project No. 960.05 Date: 03/03/10

Drawn MFJ
Checked

9
FIGURE



LEGEND

SITE: LATITUDE, 38.0000°
LONGITUDE, -122.0000°

FAULT	TYPE	CBC DESCRIPTION
	"A"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES AND HIGH RATE OF SEISMIC ACTIVITY
	"B"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES OR HIGH RATE OF SEISMIC ACTIVITY

21% PROBABILITY OF M≥6.7 BETWEEN 2008-2038 FOR FAULTS SHOWN. OVERALL PROBABILITY OF 63% IN BAY AREA OF ONE OR MORE M≥6.7 EARTHQUAKES FROM 2008-2038.

LA DB = Loma Alta Detention Basin
MP DB = Memorial Park Detention Basin
LG DB = Lefty Gomez Detention Basin
RHP = Red Hill Park Detention Basin

REFERENCES:

1) ACTIVE FAULT MAP MODIFIED FROM SUMMARY OF EARTHQUAKE PROBABILITIES IN THE S.F. BAY REGION, 2008-2038, THE 2007 WORKING GROUP ON CALIFORNIA EARTHQUAKE PROBABILITIES, 2008.

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FILE: 960.05FM.dwg

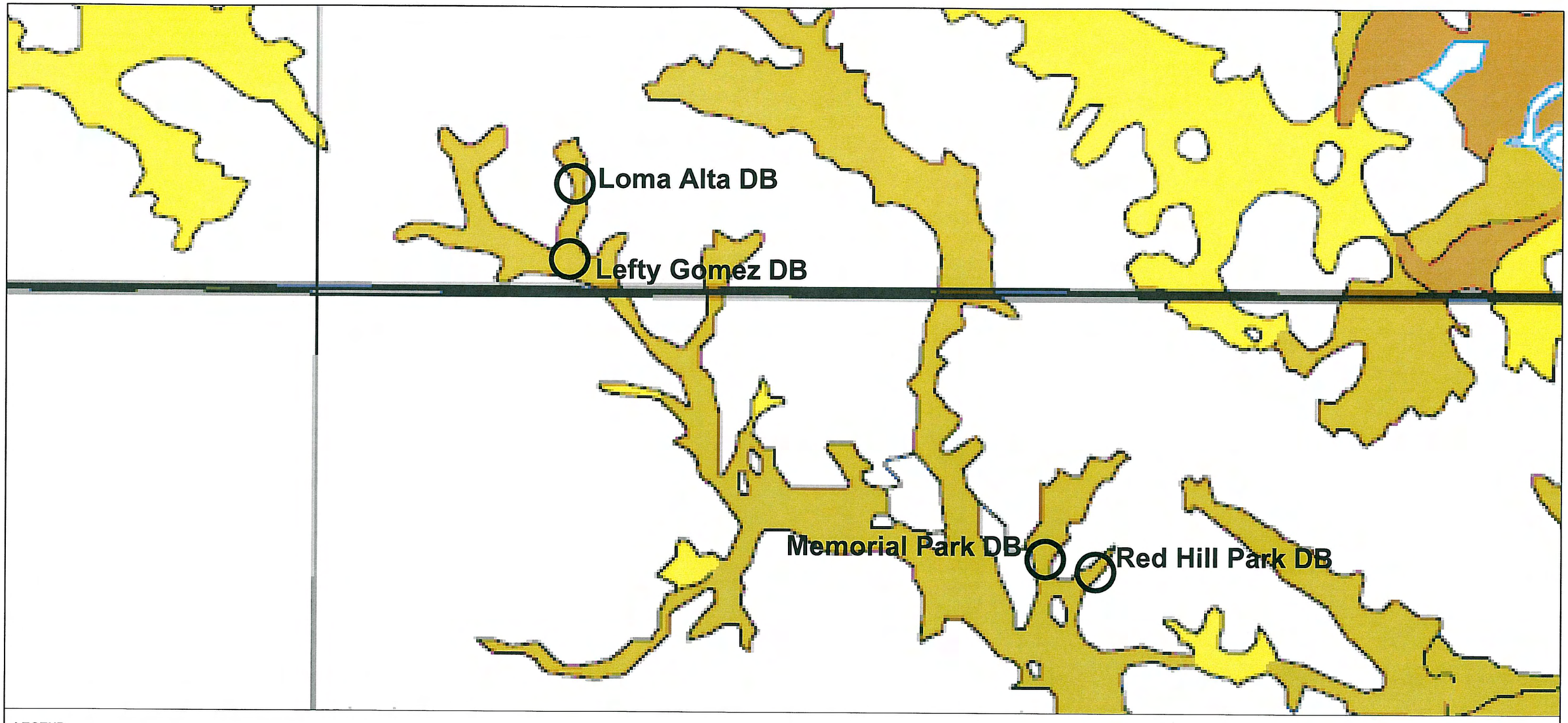
ACTIVE FAULT MAP

Marin County Flood Control
Flood Damage Reduction
& Creek Management Study

Project No. 960.05 Date: 03-23-10

Drawn MFJ
Checked

10
FIGURE



LEGEND

- Very High Susceptibility
- High Susceptibility
- Moderate Susceptibility
- Low Susceptibility
- Very Low Susceptibility

APPROXIMATE SCALE

0 1250 2500 5000 FEET

NORTH

REFERENCE: Knudsen, et. al., "Perliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region", United States Geological Survey Open-File Report 00-444, 2000

Miller Pacific ENGINEERING GROUP	1333 N. McDowell Blvd. Suite C Petaluma, CA 94947 T 707 / 765-6140 F 707 / 765-6222 www.millerpac.com	LIQUEFACTION SUSCEPTIBILITY MAP		
FILE: 960.05GM.dwg		Marin County Flood Control Flood Damage Reduction & Creek Management Study Project No. 960.05 Date: 03/02/10	Drawn MFJ Checked	11 FIGURE

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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IIGER06045.0M

Appendix 4b to Attachment 3

Supplemental Geotechnical Evaluation of Memorial Park Detention Basin

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January 29, 2013
File: 215.16altr.doc

Town of San Anselmo
Department of Public Works
525 San Anselmo Avenue
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Attn: Mr. Sean Condry

Re: Preliminary Geotechnical Investigation
Memorial Park Flood Detention Basin
San Anselmo, California

Introduction

This letter summarizes our preliminary Supplemental Geotechnical Investigation for the proposed Memorial Park Flood Detention Basin in San Anselmo, California. The project site location is shown on Figure 1. The purpose of our services is to evaluate existing geologic and geotechnical conditions and prepare preliminary geotechnical recommendations for use in project planning and design.

The project is part of a larger Marin County Flood Control District project aimed at reducing flooding risks in the Ross Valley area. We previously prepared a Geotechnical and Geologic Feasibility Study for Stetson Engineers, dated April 6, 2010, which assessed five detention basin sites, including Memorial Park. More recently, we performed a subsurface exploration and supervised the construction of five groundwater monitoring wells at the Memorial Park site.

Our current scope of services includes laboratory testing of select samples from our exploration, preparation of well and drilling logs, evaluation of local groundwater conditions based on data collected from the monitoring wells, evaluation of potential geologic and geotechnical hazards, development of conceptual mitigation measures for identified hazards, development of "rough" cost estimates for proposed mitigation measures, and preparation of this letter.

Project Description

The proposed project consists of removing existing improvements and lowering grades across the 7.5-acre site by up to approximately 15-feet in order to create a floodwater detention basin. Ancillary work would include construction of new inlet and outlet works, removal of an existing box culvert along the west side of the park and "daylighting" of the stream channel within, construction of a new underdrain system, and reconstruction of park facilities within the new detention basin. A conceptual site plan showing most of the major project components is shown on Figure 2.

Primary geotechnical considerations for the project are expected to include appropriate underdrain system design, appropriate design for acceptable performance of permanent cut slopes, mitigation for slope instability along the east side of the park due to removal of toe support from a mapped dormant landslide, seepage into and out of adjacent properties, and possible settlements associated with lowering the local groundwater table and/or raising elevations along Sunny Hills Drive.

Regional Geology

The site is located within the Coast Ranges Geomorphic Province of California. The regional bedrock geology is dominated by complexly folded, faulted, sheared, and altered sedimentary, igneous, and metamorphic rock of the Jurassic-Cretaceous age (65-190 million years ago) Franciscan Complex.

Northwest-southeast trending mountain ridges formed by previous tectonic activity characterize the regional topography. Extensive faulting during the Pliocene Age (1.8-7 million years ago) formed the uneven depression that is now the San Francisco Bay. More recent tectonic activity is concentrated along the San Andreas Fault zone, a complex group of generally parallel faults.

Regional geologic mapping[1] indicates that the project site is underlain by alluvial deposits. Alluvial deposits are typically comprised of moderately- to well-sorted silts, clays, sands, and gravels deposited in stream, terrace, or floodplain environments. The prominent ridgeline which rises from the eastern site boundary is mapped as being underlain by a variety of Franciscan bedrock types, including Melange, greenstone, sandstone, chert, and several small- to large-sized landslides are shown on the map. The more subdued hills west of the site are mapped as being underlain chiefly by Franciscan sandstone, though several small debris flow scars and larger landslides are shown with debris fields extending east to San Francisco Avenue, just west of the site. An interpreted concealed fault is also mapped, trending roughly northwest-southeast, and located approximately coincident with the northwest site boundary. A regional geologic map is presented on Figure 3.

Subsurface Exploration and Laboratory Testing

Prior to commencing with our subsurface exploration, we pre-marked the site for underground utility location as required by USA (Underground Service Alert). Additionally, we obtained an encroachment permit from the Town of San Anselmo and a Well Construction Permit from the Marin County Department of Environmental Health Services (Marin EHS).

We performed subsurface exploration at the site with five soil borings drilled on October 8-9 and November 22-23, 2012. Borings were excavated at the locations shown on Figure 2 (labeled MW-1 through MW-4) using a truck-mounted Deeprock DR10K drill rig equipped with 8- and 10-inch hollow-stem augers. Borings were drilled to depths ranging from about 31 to 45-feet below the existing ground surface. Materials encountered were logged by our Field Geologist and select samples retained for laboratory testing. Soil and rock classification charts are presented on Figures A-1 and A-2, respectively, while the boring logs are shown on Figures A-3 through A-14.

Laboratory tests were performed in general accordance with applicable ASTM standards and included determination of in-situ dry density, moisture content, unconfined compressive strength, Atterberg limits/plasticity index, and sieve (gradation) analysis. Laboratory test results

[1] Smith, T.C, Rice, S.J., and Strand, R.G. (1976), "Geology of the Upper Ross Valley and the Western part of the San Rafael Area, Marin County, California" *in* Geology for Planning in Central and Southeastern Marin County, California, California Department of Conservation, Division of Mines and Geology Open-File Report 76-2, Plate 1B, Map Scale 1:12,000.

are presented on the boring logs, excepting plasticity index results (Figure A-15) and sieve analysis results (Figures A-16 through A-18). The subsurface exploration and laboratory testing program is discussed in further detail in Appendix A.

Subsurface Conditions

The results of our subsurface exploration generally confirm the regionally-mapped geology. Each boring encountered predominantly medium stiff to very stiff clayey soils with lesser interbedded granular deposits, generally composed of medium dense to dense sands and gravels. In general, the thickness and frequency of the granular deposits increases with depth and to the south.

Within the upper 11-feet, where the vast majority of site excavations required for construction will occur, soils encountered in all borings were composed almost entirely of silty, sandy and/or "clean" clays. Below a depth of 11-feet, subsurface conditions generally consist of interbedded clay and sand layers. Given the local topographic and geologic conditions, it is likely that the sand and gravel deposits are representative of historic stream channels trending roughly in the north-south direction.

Borings MW-1 and MW-2B each encountered medium dense to dense sand with clay and clayey sand at depths greater than 10-feet, while Boring MW-4 encountered medium dense sandy gravel between about 11 and 13-feet. Generally, more significant granular deposits were encountered at greater depths in all borings except MW-3. A generalized geologic cross-section is shown on Figure 4.

Groundwater was encountered during exploration in each boring. Groundwater was encountered between 9 and 17-feet below the ground surface. The exploration was undertaken over the course of two 2-day periods separated by about a month, during which time several significant rainstorms impacted central Marin County. Water levels encountered during drilling may not represent stabilized groundwater levels due to the variability in soil composition and percolation rates. Therefore, groundwater measurements during exploration should be generally considered non-correlative for the purposes of modeling the local or regional groundwater table.

Monitoring Well Construction

Upon completion of drilling, each boring was converted to a groundwater monitoring well. Wells were generally constructed to the full depth of the boring (ranging from about 31 to 45-feet below the ground surface) and were constructed using flush-threaded 2- or 4-inch Schedule 40 PVC pipe. Wells were fitted with a 2-foot interval of blank casing at the bottom to provide a sediment trap and a 3-foot blank interval at the top to facilitate placement of the annular seal. The remainder of the well casings consisted of slotted PVC casing with 0.020-inch factory machined slots. Wells were capped using locking, watertight, expandable pressure caps.

Filter pack materials for all wells consisted of kiln-dried 2x12 quartz sand. In accordance with the provisions of our Well Construction Permit, annular seals were inspected during placement by Marin EHS personnel and consisted of 1-foot of hydrated bentonite chips and at least 2-feet of neat Portland cement grout. Surface protection consisted of steel manhole covers either set flush with grade (in paved areas, including MW-1 and MW-3) or approximately 6- to 12-inches below grade (in grassy areas within the park, including MW-2A, MW-2B, and MW-4). Those

wells set below grade were also fitted with artificial turf "plugs" to reduce the potential tripping and/or impact hazard to park users. "As-built" monitoring well construction details are shown on Figures A-19 through A-23.

Groundwater Monitoring

We have reviewed groundwater level data plots provided by the Town of San Anselmo. Plots show groundwater levels in each monitoring well between November 27 and December 10, 2012, based on data collected from dataloggers installed at each wellhead. Additionally, manual water level measurements at then-completed wells were performed by the Town between October 17, 2012 and January 22, 2013.

Water level plots indicate relatively stagnant water levels through late October and early November. Groundwater levels recorded prior to the onset of winter rains (generally prior to November 28th) varied between about six feet below the ground surface at MW-2B and 10-feet below the ground surface at the existing irrigation well on the east side of the park. Immediately prior to the first significant early-season rainstorms, groundwater in all wells was about five to eight feet below the ground surface.

A series of significant early-season rainstorms impacted central Marin between November 28th and December 2nd. By December 2nd, water levels in all wells had risen to within about three to four feet of the ground surface. A second series of significant rainstorms occurred between December 21st and 24th; with a cumulative total of about 1.5-inches precipitation recorded from the 21st to the 23rd. Over this period of time, a similar response was observed in the wells, with water levels rising to within about 3-feet of the ground surface. On December 23rd and 24th, about 2.75-inches of precipitation was recorded, but water levels rose only a few inches in response to the additional rainfall.

Additionally, a series of constant-rate pump-drawdown tests were conducted between December 6 and December 10, 2012. A small pump was placed in Existing Well 2 (located near the existing irrigation storage tank at the south end of the site as shown on Figure 2), and water levels were recorded in the other monitoring wells around the site. Water level plots for the observation wells indicate fluctuating water levels in MW-1, MW-2B, and MW-4, while little to no variation in groundwater levels was recorded at MW-2A and MW-3 during pump testing.

Similar pump tests were performed on December 17th-18th and 30th-31st, and again on January 3rd-4th, 8th-12th, 14th-16th, and 18th-20th. Similar to initial pump tests, hydrographs indicate changing water levels in MW-1, MW-2B, and MW-4, while little to no response was observed at MW-2A. Pump test results indicate yields of about 4 gallons per minute (GPM) may be expected in pumping wells at the site. Based on this data, the dewatering trenches will likely generate a significant volume of water for irrigation or other use at the site.
A preliminary estimated "summertime" groundwater contour map, based on groundwater data discussed above, is shown on Figure 5. Based on conditions observed during well drilling and water level monitoring and pump test data, it appears the upper 10 to 12-feet at the project site has a lower hydraulic conductivity compared to the deeper soils. The increased hydraulic conductivity of deeper soil horizons is strongly controlled by the interbedded sand and gravel layers. Because of these layers, groundwater drawdown at one location can influence (lower) groundwater wells for a distance of several hundred feet. Also, based on the predicted groundwater contours and local geology, a majority of the groundwater flow towards and into

the planned detention basin would be from the north and west sides. Some groundwater infiltration is expelled from the south and east, but to a lesser extent.

Additionally, MW-2A does not appear to have penetrated significant water-bearing strata as noted during installation of other wells, and therefore may not have penetrated the same confined aquifer as other wells. Hence, data from MW-2A has been disregarded for the purpose of preparing our groundwater contour map shown on Figure 5. The groundwater data plot is shown on Figure A-24.

Geologic Hazards Evaluation

We have evaluated commonly-considered geologic hazards in light of the proposed construction. Based on the results of our Feasibility Study and Preliminary Geotechnical Investigation, the primary hazards to be considered include strong seismic ground shaking, slope instability, settlement, flooding, and erosion. Other hazards, such as fault surface rupture, liquefaction, seiche/tsunami and lurching/ground cracking are judged less than significant at the site based on the results of our previous Feasibility-level reconnaissance and mapping and more recent subsurface exploration. Our evaluations and conceptual mitigation measures for the "primary" geologic hazards are summarized in detail below.

SEISMIC GROUND SHAKING

The site will likely experience seismic ground shaking similar to other areas in the seismically active San Francisco Bay Area. Earthquakes along several active faults in the region, as shown on Figure 6, could cause moderate to strong ground shaking at the site. Estimates of peak ground accelerations are based on either deterministic or probabilistic methods.

Deterministic methods use empirical relations developed from data collected during previous earthquakes to provide estimates of median peak ground accelerations. A summary of the active faults that could most significantly affect the site, their maximum credible magnitude, closest distance to the project area, and probable peak accelerations is provided in Table A.

TABLE A
ESTIMATED SEISMIC GROUND MOTIONS
Memorial Park Flood Detention Basin
San Anselmo, California

Deterministic Hazard Analysis Fault	Moment Magnitude for Characteristic Earthquake[1]	Closest Estimated Distance (kilometers)[2]	Median Peak Ground Acceleration (g)[3,4]
San Andreas	7.8	12.6	0.33
Rodgers Creek	7.0	16.3	0.24
Hayward	6.9	16.0	0.23
San Gregorio	7.2	24.1	0.20
Point Reyes	6.5	23.7	0.15

(1) USGS (2003, 2008)
(2) Blake, T.F. (2001)
(3) Abrahamson and Silva (2008), Boore and Atkinson (2008), Campbell and Borzognia (2008), Chiou and Youngs (2008), Idriss (2008)
(4) Vs^{30} = 270 m/s (900 ft/s) used for stiff soil profile (Site Class D) per 2010 CBC.

The potential for strong seismic shaking at the project site is high. The San Andreas Fault is the closest and most likely source for a future earthquake. The most significant adverse impact associated with strong seismic shaking is potential damage to structures and improvements.

Evaluation: *Less than significant with mitigation.*
Mitigation: *New retaining structures should be designed to withstand a seismic surcharge load. Seismic design criteria will be provided in a future design-level investigation report. Preliminary recommendations for new retaining structures are presented in the Conclusions and Recommendations section of this report.*

SLOPE INSTABILITY
Weak soils and bedrock on moderate to steep slopes can move downslope due to gravity. Slope instability is often initiated or accelerated from soil saturation and groundwater pressure, though may also be aggravated by grading activity, such as removal of toe support by excavation or addition of new loads, such as fill placement. The primary adverse effect of slope instability is damage to structures and improvements.

The Memorial Park site is bounded to the east by a relatively steep natural slope which shows evidence of previous instability and landsliding. During a site reconnaissance for our previous Feasibility Study, we mapped a moderate to large-sized landslide, approximately 120-feet wide and extending approximately 100-feet upslope of the park's eastern boundary as shown on Figure 2. Although the observed landslide area appears inactive (dormant), the soil and slope conditions may be susceptible to reactivation and instability as a result of excavation during construction and during drawdown of impounded flood waters.

Additionally, preliminary plans indicate permanent cut slopes along the west and northwest sides of the site will be constructed in relatively close proximity to existing single-family

residences along Alderney Drive and San Francisco Boulevard. Based on the results of our subsurface exploration, soils underlying these cut slopes are expected to be relatively stable under static conditions. However, given the proximity of the existing residential structures to the proposed top-of-slope, there may be some potential for lurching during a seismic event and shallow sloughing due to seepage emerging on the slope. Some shallow sloughing or raveling may also be expected due to seepage emerging at the face of new cut slopes. Therefore, the potential for localized slope instability at the site is moderate to high.

Evaluation: *Less than significant with mitigation.*
Mitigation: *A new retaining structure with tiebacks will be required to provide toe support for the mapped landslide during excavations for the new flood detention basin. Additional subsurface exploration, laboratory testing, and engineering evaluation will be required as part of a future design-level investigation to determine the depth at which historic slide movement has occurred and prepare geotechnical design criteria for a new retaining structure. More detailed slope-stability analyses will also be required to evaluate and design permanent cut slopes along the west and northwest sides of the site. Installation of new subdrains as conceptually shown on Figure 2 should improve performance and reduce the risk of instability. Geologic inspection of cut slopes during construction will be required to ensure conditions are as expected and to provide supplemental recommendations, if needed. Additional discussion and "rough" cost estimates for new retaining structures and associated slope-stability mitigation measures are presented in the Conclusions and Recommendations section of this report.*

SETTLEMENT

Application of new surface loads, such as fills and/or structures, to soft clayey soils may result in soil consolidation and deformation, and ultimately, subsidence of the ground surface. Settlement may also occur as a result of hydro-compression and consolidation of underlying clayey soils due to long-term lowering of the groundwater table. Settlement of the ground surface can result in cracking of "brittle" surfaces, including concrete foundations and flatwork and interior and exterior building finishes as a result of differential ground surface displacement.

Based on our review of preliminary project plans, up to about 10-feet of new fill is planned to raise grades along Sunnyhills Drive at the southeast corner of the site. Additionally, construction of the proposed detention basin will result in a permanent lowering of the local groundwater table. Combined with the potential for minor lateral deformation as a result of permanent cut slopes constructed along the western and northwestern site boundaries, preliminary calculations indicate that some minor settlements in these areas should be expected. Therefore, we judge the risk of significant settlement at the site resulting from the proposed construction is moderate to high.

Evaluation: *Less than significant with mitigation.*
Mitigation: *Additional laboratory testing and engineering analysis will be required as part of a future design-level Investigation to develop more precise soil parameters and settlement magnitude and rate estimates for areas adjacent to the southern and eastern project boundaries. Depending on the magnitude of expected settlements, mitigation measures may consist of new retaining structures, soil remediation, or other ground improvement techniques. However, based on preliminary settlement analyses, total settlements over a large area are expected*

to be less than 2-inches, and differential settlements across individual structures would likely be less than ½-inch. New fills, planned to raise grades along Sunnyhills Drive, should be constructed in accordance with the Site Grading recommendations presented in the Conclusions and Recommendations section of this report.

FLOODING

Typical adverse impacts from flooding are water damage to structures and furnishings. Based on Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA), Memorial Park is located within the 500-year flood zone. Additionally, the primary purpose of the project is to repurpose the site as a flood detention basin in order to reduce the risk of flooding in other portions of the Ross Valley drainage. Therefore, the likelihood of inundation by flood waters at the site is high.

Evaluation: *Less than significant with mitigation.*

Mitigation: *The purpose of the proposed detention basin is to temporarily impound flood waters. Inundation by flood waters should be anticipated and short term hydrostatic pressures and drawdown conditions should be considered during design of the detention basin's drainage system, embankments, and cut slopes. The likelihood of inundation should also be considered during design of new park improvements constructed within the new detention basin, including new field turf and associated improvements, the new concessions and restroom structures, and new underground and/or above-grade utilities.*

EROSION

Sandy soils on moderate slopes or clayey soils on steep slopes are susceptible to erosion when exposed to concentrated surface water flow. The potential for erosion is increased when established vegetation is disturbed or removed.

Preliminary plans indicate that embankment slopes in certain locations along the perimeter of the proposed detention basin will be inclined at 1:1 (horizontal:vertical) on the outboard side (where applicable) and 2:1 on the inboard side. Based on our subsurface exploration, these slopes generally will be constructed in medium stiff to stiff clayey soils with lesser sands. There is a high probability that localized zones of loose to medium-dense sands and gravels will also be encountered, though generally near the toe of the proposed embankments. Therefore, we judge the risk of erosion at the site is high.

Evaluation: *Less than significant with mitigation.*

Mitigation: *Permanent embankment slopes should be constructed in accordance with the Site Grading recommendations presented in the Conclusions and Recommendations section of this report. Slopes should not be steeper than 2:1. Any steeper slopes will need to be internally reinforced and will require long-term erosion control mats. All slopes will require erosion-control mats and re-planting to reduce the potential for erosion. The project Civil Engineer should design the site drainage to collect water into surface storm drain systems and discharge water at appropriate locations. Erosion-control measures should conform to the most recent version of the Erosion and Sediment Control Field Manual (California Regional Water Quality Control Board, 2002) and the project's Stormwater*

Pollution Prevention Plan (SWPPP). After construction, vegetation should be re-established and erosion-control measures implemented in disturbed areas.

Conclusions and Recommendations

Based on the results of our Preliminary Supplemental Geotechnical Investigation, we conclude that the proposed project is feasible from a geologic and geotechnical perspective. The primary considerations during project design and planning are appropriate design of permanent cut slopes, providing effective subdrainage for the new, lowered fields and associated facilities, appropriate design of new retaining structures, and adequate dewatering of excavations during construction. More detailed discussion and preliminary recommendations for these and other geotechnical aspects of the proposed work are presented in the following sections.

CONSTRUCTION SITE DEWATERING AND GRADING

Based on the results of our subsurface exploration, excavations for construction of the proposed flood control detention basin will generally be in medium stiff to very stiff clayey alluvial soils and can likely be accomplished with "conventional" grading equipment, such as excavators or scrapers. Historic stream channels, trending roughly north-south and composed mainly of sand and gravel, will likely be exposed in cut slopes along the northern and western site boundaries and may act as conduits for a significant amount of groundwater. Therefore, due to the likelihood of relatively shallow groundwater and sporadic, unpredictable zones of loose and/or soft soils prone to instability, careful consideration of excavation methods and sequencing will be required to maintain safe, dry working conditions and construct permanent and temporary cut slopes that will provide the necessary level of performance.

1. Site Dewatering

   Prior to commencing with site excavations, dewatering will be required to draw down the local groundwater table and maintain dry working conditions. Dewatering could be achieved through a variety of methods, including dewatering wells and installation of temporary or permanent subdrainage. Since dewatering wells would need to be located throughout the project site and would interfere with excavation and grading operations, we judge that subdrains would be a more efficient way of dewatering excavations for both short- and long-term conditions.

   A new subdrain should be constructed upgradient of the site, behind the northernmost planned cut slope and at a depth of about 10-feet, and should discharge by gravity to the creek channel to the east. Similar subdrains should be constructed behind the cut slopes planned around the western and southwestern portions of the site and temporarily discharged via pumping. Subdrain discharge should be conveyed by temporary piping to an appropriate location, such as an established storm drain system. These subdrains will remain as permanent drainage facilities, and are shown conceptually on Figure 2.

2. Excavations

   As noted above, excavations will be primarily in medium stiff to very stiff clayey soils and thus can likely be reasonably accomplished with "traditional" excavation equipment, including excavators, backhoes, dozers, and scrapers. Because the vast majority of excavation spoils will be off-hauled from the site and disposed of,

scrapers, though efficient at excavation, are likely impractical due to the need to transfer spoils to trucks for off-haul. Therefore, the majority of site excavations are likely to be accomplished by moderate- to large-size excavators.

We recommend beginning excavation at the north end of the project site and proceeding downgradient to the south. By using relatively large excavators capable of reaching the maximum proposed excavation depths, the need for rubber-tire equipment, including dump trucks, within the lower portions of site excavations (where soft conditions and groundwater may exist) is reduced. Excavation spoils are likely to be suitable for re-use as select fill after drying, and excess spoils should be legally disposed of by the Contractor.

The California Division of Occupational Safety and Health, better known as Cal/OSHA, has promulgated rules for excavations. Cal/OSHA dictates allowable slope configurations and minimum shoring requirements based on categorized soil types. In conformance with Cal/OSHA's categorization, the cohesive clayey alluvial soils anticipated at the site would classify as "Type B" soil. Localized zones of more granular materials, such as sands and gravels, may be prone to raveling and sloughing in excavations and would therefore classify as "Type C" soils. Type C soils are not expected to be widespread in the upper 15-feet, but could be more prevalent in excavations deeper than 15-feet from existing grade. These deeper excavations may be needed for installation of the new field subdrainage system and relocation of existing underground utilites.

The Contractor should implement a shoring system during construction to prevent potential instability of the sides of the excavations. Many shoring systems are available, and the selected system should be capable of providing immediate support to the sides of excavations as to minimize the time in which vertical cuts are left unsupported. Trench excavations having a depth of five feet or more which will be entered by workers must be sloped, braced, or shored in accordance with current Cal/OSHA regulations.

3. Cut and Fill Slopes

Preliminary plans indicate that permanent cut slopes will be inclined at 2:1. Based on our subsurface exploration, these slopes are likely to perform well given the relatively competent underlying soils. However, additional slope-stability and settlement analyses will be required as part of a design-level investigation to verify expected seismic performance will be sufficient. Slopes steeper than 2:1, such as are planned for the outboard side of the levee embankment at Sunnyhills Drive, will need to be reinforced and specifically designed.

Additional recommendations and criteria for site grading, including site preparation, fill gradation and compaction criteria, and temporary cut slope recommendations will be presented in a design-level investigation report.

SITE DRAINAGE

A new underdrain system will be required to permanently lower the local groundwater table and keep the new detention basin dry enough for development of the planned new fields and associated improvements. We recommend that subdrains be installed at depths of about 10-feet behind the proposed cut slopes on the north, west, and southwest sides of the site as discussed above. Additionally, a slightly shallower (approximately 5-feet deep) subdrain should be provided behind the east-west trending cut slope planned between the north end of the athletic field and the south end of the play area. A typical trench subdrain detail is shown on Figure 6.

Additionally, shallow subdrains, roughly 1.5-feet deep, should be provided at regular intervals beneath the new athletic fields to provide under-field drainage. Based on or previous experience, ADS AdvanEDGE drainage panels or similar panel-type trench drains function well and are simpler and more cost-effective to install than typical perforated pipe subdrains. Trenched panel drains should be connected to 3-foot deep perforated pipe collector drains and discharges at an appropriate location such as Sorish Creek along the east side of the site.

For the field areas, a 6-inch layer of sand or suitable permeable growing medium should be placed on the clayey subgrade soils to allow drainage and lateral movement of water to the subdrains. A conceptual field drainage plan is shown on Figure 2.

PROBABLE FOUNDATION TYPES

New structures, such as the restroom structure and concessions building planned at the southwest corner of the new park, can likely be founded on shallow foundation systems bearing on firm alluvial soils. For concrete retaining walls, deep foundations will be required to provide sufficient lateral support. We anticipate that drilled, cast-in-place concrete piers are likely the most cost-effective foundation type for new concrete walls.

RETAINING STRUCTURES

Preliminary plans indicate new retaining walls up to about 10-feet high are planned at the southeast corner of the site to create a level area for new tennis courts, at the southwest corner of the site to support the rear yard areas of adjacent existing residences, and along the eastern margin of the site to provide toe support for a mapped landslide and create a level building area for new irrigation and graywater systems. Additionally, new perimeter retaining walls will be constructed along the western and southern site boundaries.

We judge that reinforced concrete walls are likely the most effective for new perimeter retaining walls and for the retaining wall at the southwest corner of the site. Other retaining walls, such as for the tennis courts and irrigation/graywater building pad could be either reinforced concrete or soil-nail-and-shotcrete type walls.

All walls over three feet high require drainage to prevent excessive buildup of hydrostatic pressure. A schematic wall backdrain detail is shown on Figure 7.

FIELD TURF CONSIDERATIONS

Many new athletic fields are constructed of artificial turf over a specially-designed subdrainage system as will be designed for Memorial Park. The artificial turf for these fields consists of synthetic fiber “grass blades” and some sort of synthetic rubberized infill, often derived of

recycled tires. These types of field systems usually provide excellent performance, year-round usability, and minimal maintenance.

However, since the new park area is designed to periodically impound floodwaters, we judge that artificial turf may prove impractical. The synthetic infill is likely to be depleted over time as it is eroded and transported by rising and receding flood waters, and the influx of outside soil and other detritus brought on by rising floodwaters is likely to impede drainage of the synthetic turf. We judge that a natural turf surface underlain by several inches of sandy topsoil will provide the best combination of drainage and low maintenance.

ESTIMATED CONSTRUCTION COSTS

We have prepared "rough" cost estimates for the geotechnical portions of the proposed construction, including site grading, excavation and off-haul/disposal, foundations, retaining and flood walls, site drainage, and new turf surfacing. Our cost estimates are based on brief discussions with local Contractors and our experience with similar projects in the greater San Francisco Bay Area.

For the purposes of estimation, we have assumed excavation spoils will be off-hauled and disposed at a site within approximately 10-miles of Memorial Park, and that no additional grading work, such as "shaping", trimming, or compaction, will be required at the disposal site. Increased driving distance or additional grading work required at the eventual disposal site will increase costs accordingly. Since we understand our estimates may be used in an effort to secure project funding, we have erred on the side of conservatism where appropriate.

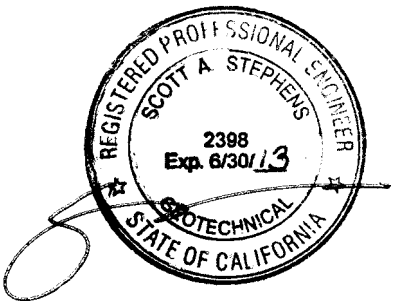
Supplemental Services

We anticipate some consultation with the project design team will be required during the project planning and development phase. Additional subsurface exploration, groundwater monitoring, laboratory testing, and engineering evaluation will also be required as part of a future design-level investigation in order to develop specific recommendations and design criteria for use in final design and construction of the project.

We should review project plans as they near completion to ensure that the intent of our recommendations has been sufficiently incorporated, and should be present during construction to verify that actual conditions encountered are consistent with our recommendations and design criteria.

We trust that this letter includes the information you require at this time. Please do not hesitate to contact us should there be any questions or concerns.

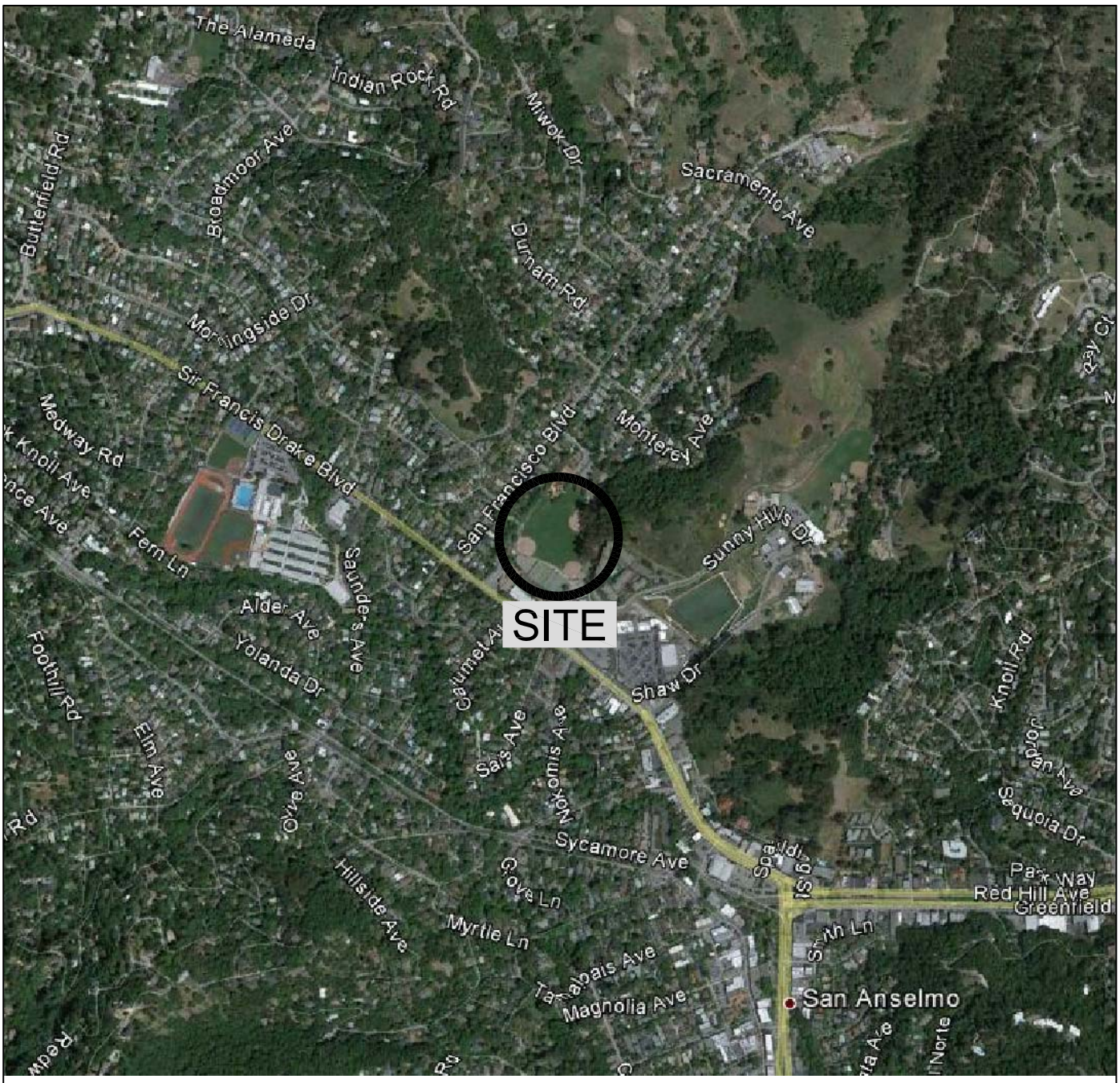
Yours very truly,
MILLER PACIFIC ENGINEERING GROUP REVIEWED BY



Mike Jewett
Project Geologist No. 9020
(Expires 1/31/15)

Scott Stephens
Geotechnical Engineer No. 2398
(Expires 6/30/13)

Attachments: Figures 1 through 9,
Appendix A



SITE: LATITUDE, 37.9828°
LONGITUDE, -122.5667°

SITE LOCATION

NORTH

REFERENCE: Google Earth, 2012

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FILE: 215.16 SLM.dwg

SITE LOCATION MAP

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, Califorina

Project No. 215.16 Date: 12/27/12

Drawn JTO
Checked

1
FIGURE

LEGEND AND KEY TO MAP SYMBOLS

Qaf — FILL
Soil and rock debris placed by man

Qls — LANDSLIDE DEPOSITS
Relatively poorly-sorted soil and rock debris transported rapidly downslope by mass-wasting processes

Qal — ALLUVIUM
Moderately- to well-sorted silts, sands, clays, and gravels deposited in channel or floodplain environments

Qc — COLLUVIUM
Soil and rock debris tranported downslope by natural weathering processes and gravity

Fm — FRANCISCAN MELANGE
Zones of resistant rock types, including sandstone, greenstone, chert, serpentinite, and other high-grade metamorphic rocks embedded in a sheared shale matrix

GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE

MONITORING WELL BY MILLER PACIFIC, 2012

EXISTING WELL BY OTHERS, 1970's

PERFORATED SUBDRAIN, APX. 10-FEET DEEP

PERFORATED SUBDRAIN, APX. 5-FEET DEEP

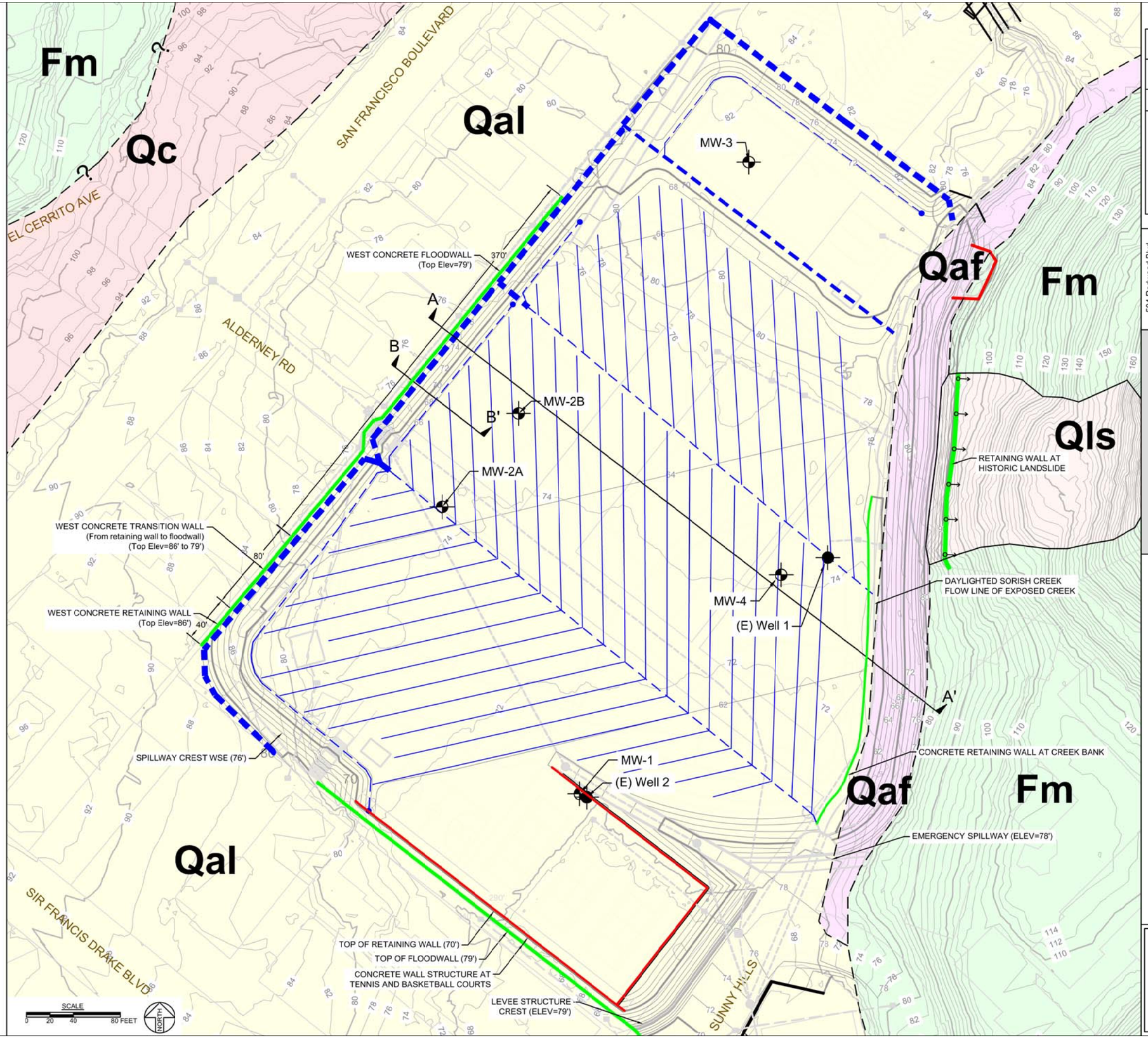
PERFORATED COLLECTOR DRAIN, APX. 3-FEET DEEP

"ADS" OR EQUIVALENT FIELD DRAIN PANELS, APX. 1.5-FEET DEEP + 6 INCH SAND COVER

NEW DRILLED PIER SUPPORTED REINFORCED CONCRETE FLOOD WALL OR RETAINING WALL

NEW DRILLED PIER SUPPORTED REINFORCED CONCRETE OR SHOTCRETE-AND-SOIL-NAIL WALL

DRILLED PIER SUPPORTED WALL WITH TIEBACKS



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FILE: 215.15SP.dwg

CONCEPTUAL SITE DRAINAGE PLAN

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Designed SAS
Drawn MFJ
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Project No. 215.16
Date: 12/28/12

2
FIGURE

REGIONAL GEOLOGIC MAP

(NOT TO SCALE)

NORTH

LEGEND

Qaf Fill, typically soil, rock, garbage, and/of other debris deposited by man on natural surfaces

Qa Alluvium, unconsolidated deposits of clay, silt, sand and gravels underlying stream valleys, consisting of materials transported and deposited by streams.

Qc Colluvium, unconsolidated and unsorted soil material and weathered rock fragments accumulated on or at the base of slopes by natural gravitational or slope wash processes.

Fm Franciscan Melange, typically sandstone and shale with lesser amounts of volcanic and metamorphic rocks.

ch Chert and allied siliceous rocks. Mainly isolated prominent outcrops of reddish-brown, greenish, or light-gray, thinnly bedded radiolarian chert.

gs Greenstone, more or less altered or metamorphosed basaltic igneous rocks.

REFERENCE: Smith, T.C., Rice, S.J., and Strand, R.G (1976), "Geology of the Upper Ross Valley and the Western Part of the San Rafael Area, Marin County, California" *in* Geology for Planning in Central and Southeastern Marin County, California, California Department of Conservation, Division of Mines and Geology Open-File Report 76-2, Plate 1B, Map Scale 1:12,000.

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FILE: 215.16GM.dwg

GEOLOGY MAP

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/27/12

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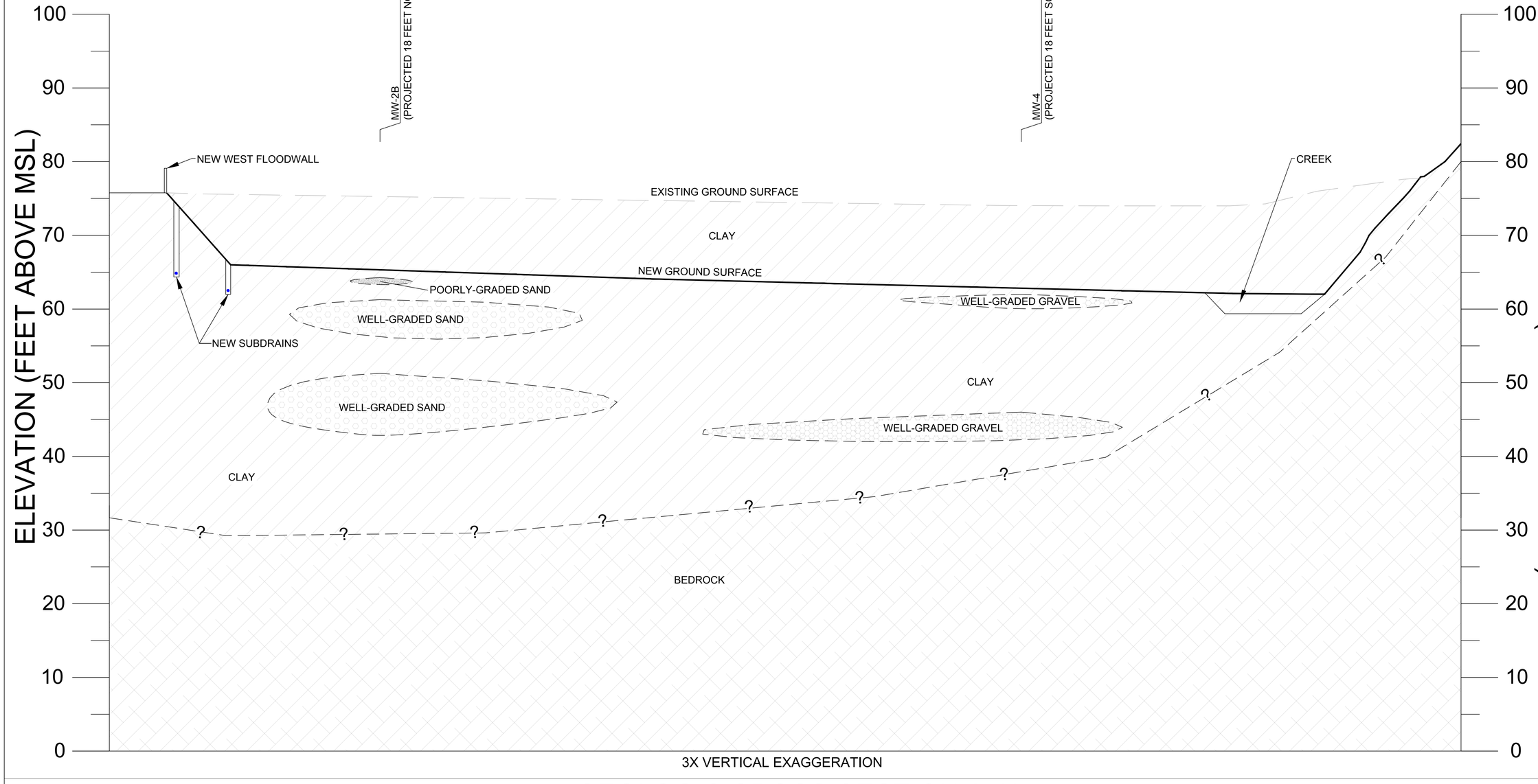
3
FIGURE



HORIZONTAL SCALE
0 10 20 40FEET

GEOLOGIC CROSS-SECTION A-A'

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CONCEPTUAL CROSS SECTION A - A'

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Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.15
Date: 12/28/12

4
FIGURE

LEGEND AND KEY TO MAP SYMBOLS

Qaf FILL
Soil and rock debris placed by man

Qls LANDSLIDE DEPOSITS
Relatively poorly-sorted soil and rock debris transported rapidly downslope by mass-wasting processes

Qal ALLUVIUM
Moderately- to well-sorted silts, sands, clays, and gravels deposited in channel or floodplain environments

Qc COLLUVIUM
Soil and rock debris tranported downslope by natural weathering processes and gravity

Fm FRANCISCAN MELANGE
Zones of resistant rock types, including sandstone, greenstone, chert, serpentinite, and other high-grade metamorphic rocks embedded in a sheared shale matrix

GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE

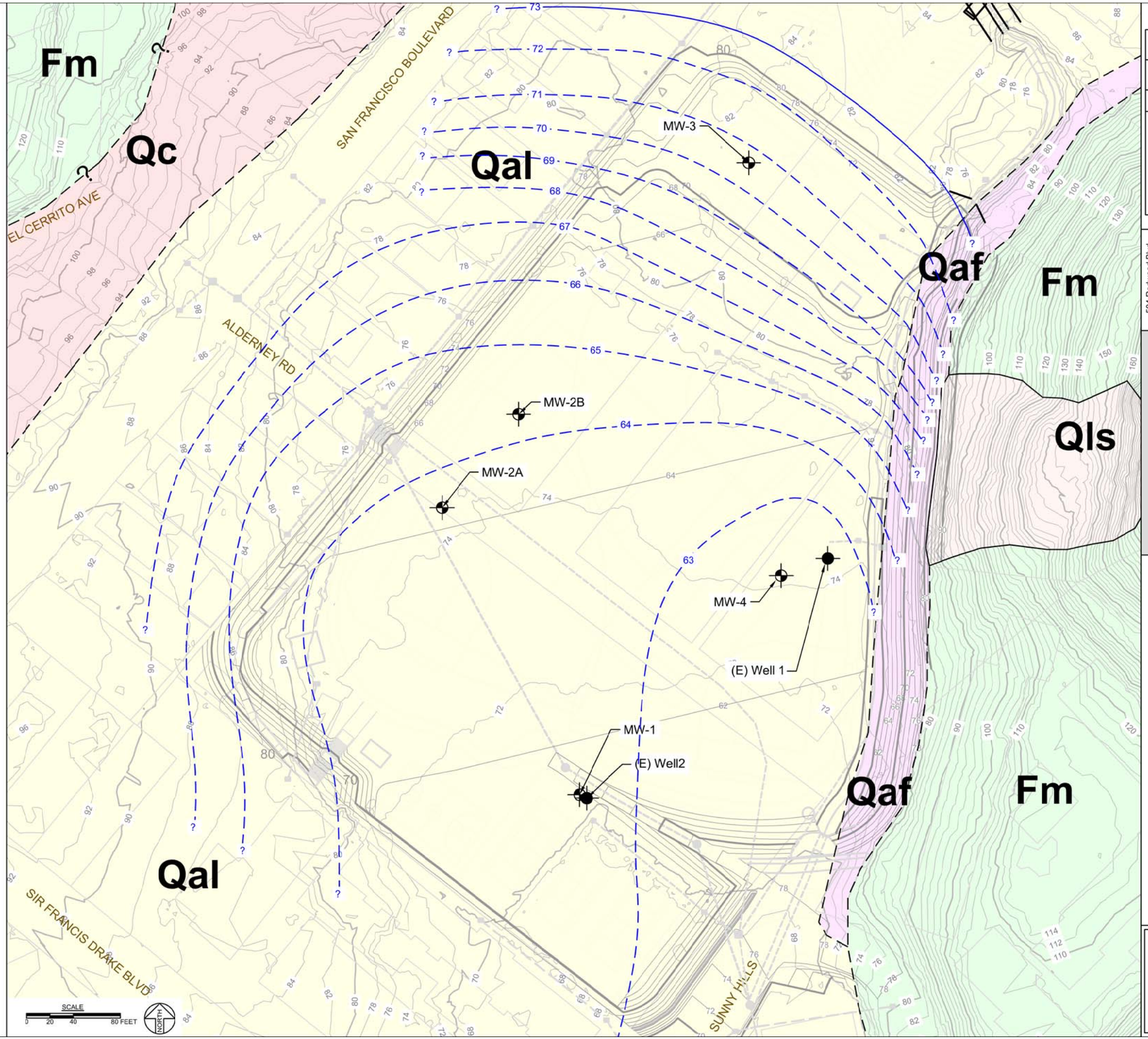
MONITORING WELL BY MILLER PACIFIC, 2012

EXISTING WELL BY OTHERS, 1970's

ESTIMATED GROUNDWATER ELEVATION DURING LATE SUMMER-FALL MONTHS

NOTES:

1. GROUNDWATER ELEVATIONS SHOWN ARE APPROXIMATE AND REFLECT ESTIMATED GROUNDWATER LEVELS DURING LATE SUMMER AND EARLY FALL MONTHS.
2. ESTIMATED GROUNDWATER ELEVATIONS BASED ON DATA COLLECTED FROM MONITORING WELLS BY TOWN OF SAN ANSELMO ON NOVEMBER 27, 2012.
3. ELEVATIONS SHOWN REFLECT 3-FOOT REDUCTION IN ELEVATIONS MEASURED ON NOVEMBER 27, 2012, BASED ON AVERAGE 3-FOOT RISE IN WATER LEVELS BETWEEN INITIAL EXPLORATION (MW-2A AND MW-4) IN MID-OCTOBER AND SUPPLEMENTAL EXPLORATION (MW-1, MW-2B, AND MW-3) IN LATE NOVEMBER.



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FILE: 215.15GWSP.dwg

PRELIMINARY ESTIMATED GROUNDWATER CONTOURS

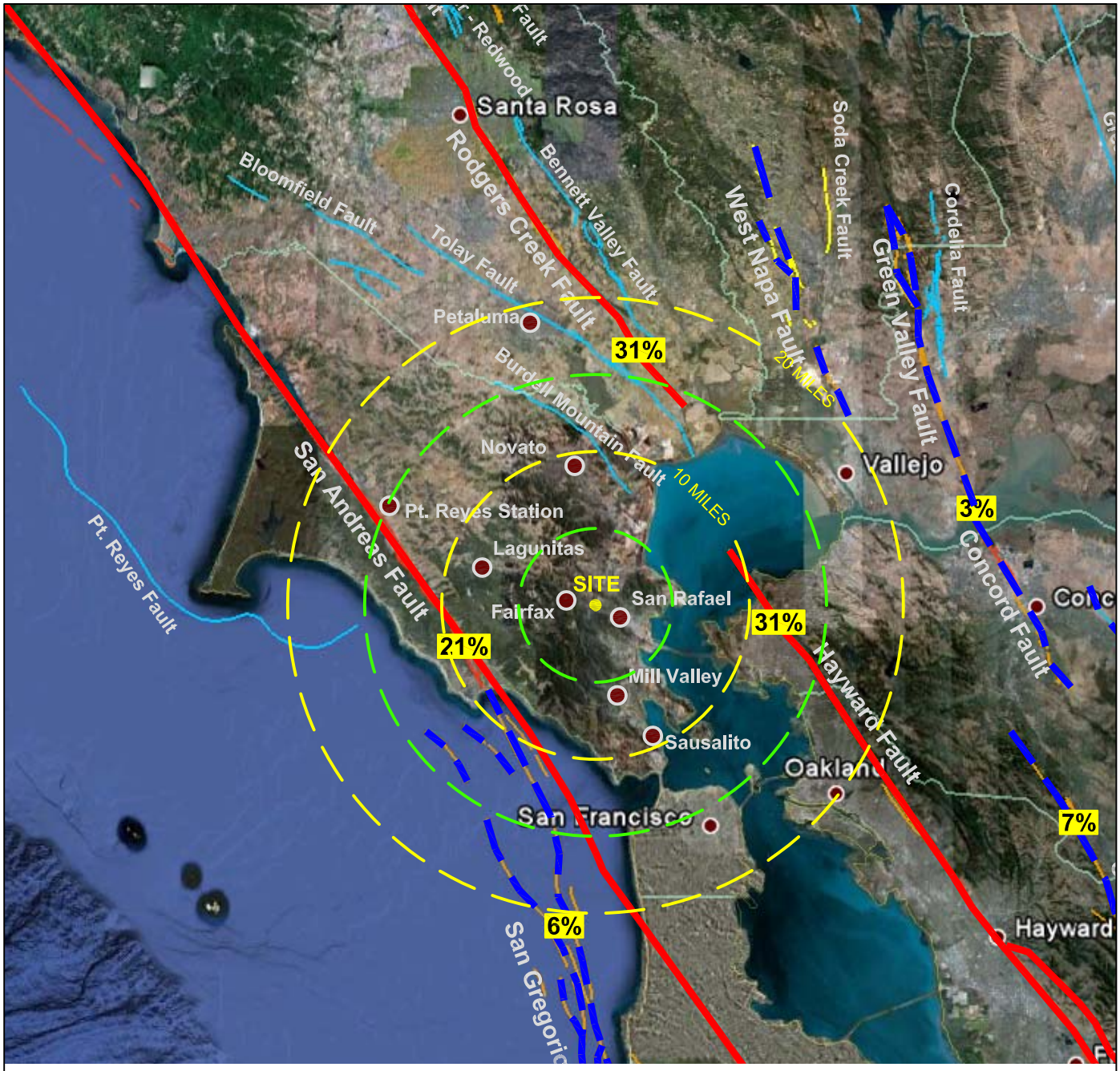
Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16

Designed SAS
Drawn MFJ
Checked

Date: 1/7/13

5
FIGURE



LEGEND

SITE: LATITUDE, 37.9828°
LONGITUDE, -122.5667°

NORTH

FAULT	TYPE	CBC DESCRIPTION
	"A"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES AND HIGH RATE OF SEISMIC ACTIVITY
	"B"	CAPABLE OF LARGE MAGNITUDE EARTHQUAKES OR HIGH RATE OF SEISMIC ACTIVITY

21% PROBABILITY OF M≥6.7 BETWEEN 2008-2038 FOR FAULTS SHOWN. OVERALL PROBABILITY OF 63% IN BAY AREA OF ONE OR MORE M≥6.7 EARTHQUAKES FROM 2008-2038.

REFERENCES:

1) ACTIVE FAULT MAP MODIFIED FROM SUMMARY OF EARTHQUAKE PROBABILITIES IN THE S.F. BAY REGION, 2008-2038, THE 2007 WORKING GROUP ON CALIFORNIA EARTHQUAKE PROBABILITIES, 2008.

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FILE: 215.16 FM.dwg

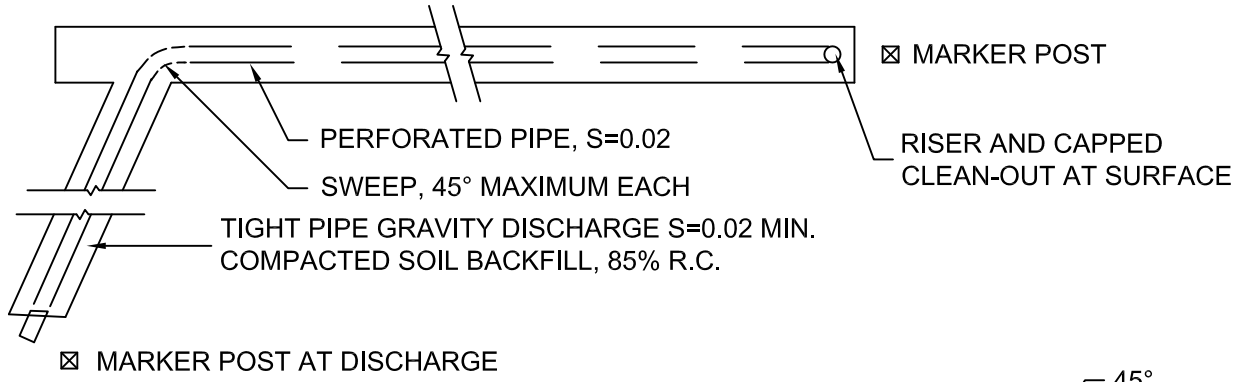
ACTIVE FAULT MAP

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

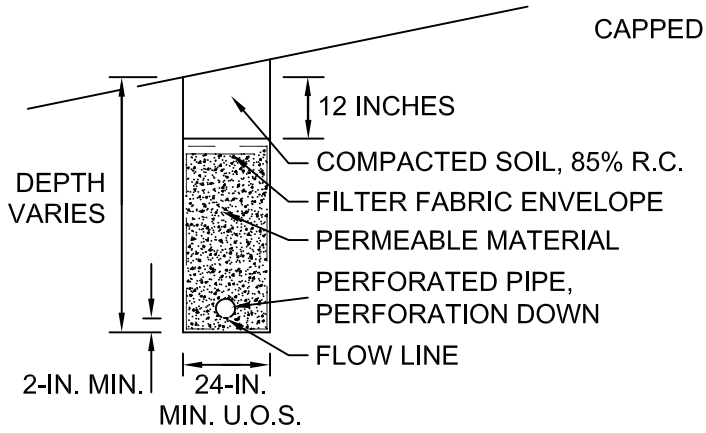
Project No. 215.16 Date: 1/2/13

Drawn EDT
Checked

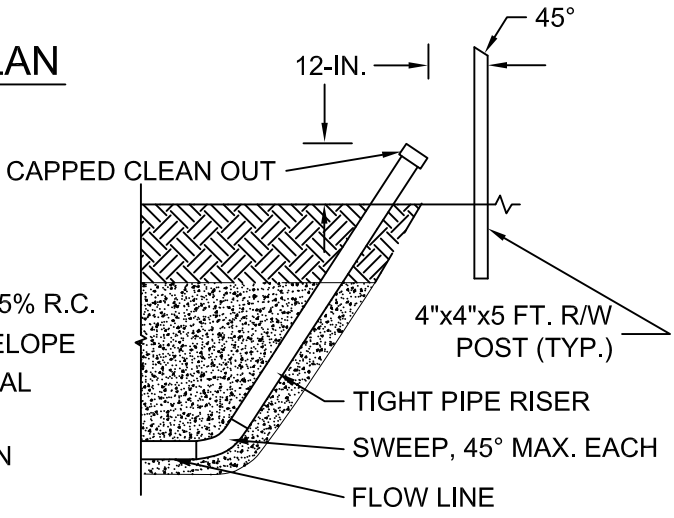
6
FIGURE



PLAN



SECTION



PARTIAL PROFILE

NOTES:

(1) PIPE TO BE 6-IN. DIAMETER, SCHEDULE 40 PVC
(2) FILTER FABRIC TO BE MIRAFI 140N OR EQUIVALENT
(3) PERMEABLE MATERIAL TO BE CALTRANS CLASS 1A OR 1B
(4) R.C. = RELATIVE COMPACTION

TYPICAL DETAILS FOR SUBDRAINS, RISERS, AND DISCHARGE

NO SCALE

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FILE: 215.16SD.dwg

TYPICAL DETAILS FOR
SUBDRAINS, RISERS, AND DISCHARGE

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 1-7-13

Designed SAS
Drawn MFJ
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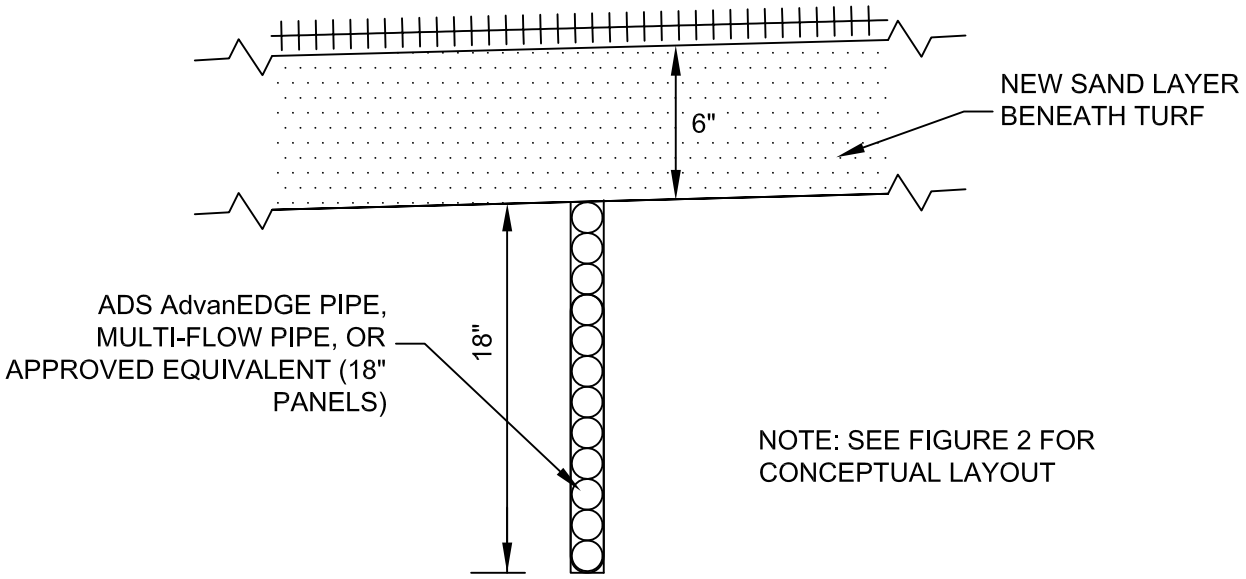
7
FIGURE



FIELD PANEL DRAIN DETAIL

(NOT TO SCALE)

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F 707 / 765-6222
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FILE: 1038.07 Notes & Details.dwg

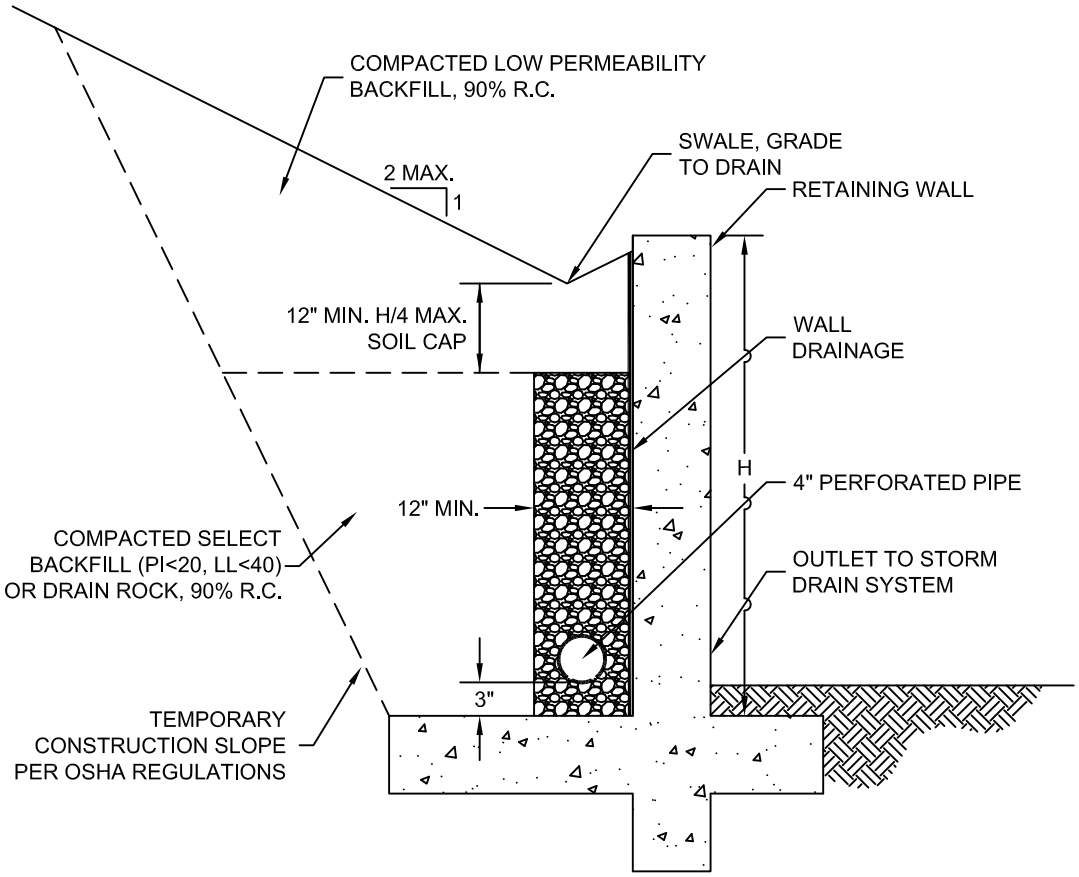
TRENCHED PANEL DRAIN DETAIL

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 1/8/13

Drawn MFJ
Checked

8
FIGURE



NOTES:

1. Wall drainage should consist of clean, free draining 3/4 inch crushed rock (Class 1B Permeable Material) wrapped in filter fabric (Mirafi 140N or equivalent) or Class 2 Permeable Material. Alternatively, pre-fabricated drainage panels (Miradrain G100N or equivalent), installed per the manufacturers recommendations, may be used in lieu of drain rock and fabric.

2. All retaining walls adjacent to interior living spaces shall be water/vapor proofed as specified by the project architect or structural engineer.

3. Perforated pipe shall be SCH 40 or SDR 35 for depths less than 20 feet. Use SCH 80 or SDR 23.5 perforated pipe for depths greater than 20 feet. Place pipe perforations down and slope at 1% to a gravity outlet.

4. Clean outs should be installed at the upslope end and at significant direction changes of the perforated pipe. Additionally, all angled connectors shall be long bend sweep connections.

5. During compaction, the contractor should use appropriate methods (such as temporary bracing and/or light compaction equipment) to avoid over-stressing the walls. Walls shall be completely backfilled prior to construction in front of or above the retaining wall.

6. Refer to the geotechnical report for lateral soil pressures.

7. All work and materials shall conform with Section 68, of the latest edition of the Caltrans Standard Specifications.

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FILE: 215.16 RW Backdrain.dwg

RETAINING WALL BACKDRAIN CRITERIA

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/27/12

Designed
Drawn JTO
Checked

9
FIGURE

APPENDIX A
SUBSURFACE EXPLORATION AND LABORATORY TESTING

A. Soil and Rock Classification Systems

We have classified soil materials for engineering purposes in general conformance with ASTM Standard D 2488, "Field Identification and Description of Soils (Visual-Manual Procedure)" and the Unified Soil Classification System. These systems enable geotechnical engineers to correlate soil stratigraphy and compare physical soil properties. The soil classification system and symbols used for the soil borings and in discussions throughout this report are briefly explained on Figures A-1, Soil Classification Chart, and A-2, Rock Classification Chart.

B. Field Exploration and Sampling

We explored subsurface conditions at the site on October 8-9 and November 22-23, 2013 with five soil borings excavated at the locations shown on Figure 2. The purpose of the soil borings was to determine the subsurface soil and rock profile, examine the materials encountered, obtain representative samples for laboratory testing, and construct wells for groundwater monitoring. The exploration was performed under the technical supervision of our Field Geologist who examined and logged the soil materials encountered and obtained samples.

Soil borings were drilled to depths between about 36 and 45 feet below the ground surface using a truck-mounted Deeprock DR-10K drill rig equipped with 8- and 10-inch diameter hollow-stem augers. Relatively “undisturbed” samples were collected from the soil borings using a 2.5-inch inside diameter, split-barrel “Modified California” sampler equipped with 2.5-inch by 6-inch brass liners and a 2.0-inch inside diameter “Standard Penetration Test” (SPT) sampler. The samplers were driven using a 140-pound hammer falling approximately 30-inches. Boring Logs are shown on Figures A-3 through A-14.

C. Laboratory Testing

We conducted laboratory tests on selected “undisturbed” samples to verify field identifications and to evaluate engineering properties. The following laboratory tests were conducted in general accordance with the ASTM standard test method cited:

- Laboratory Determination of Water (Moisture Content) of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D 2216,
- Density of Soil in Place by the Drive-Cylinder Method, ASTM D 2937;
- Unconfined Compressive Strength of Cohesive Soil, ASTM D 2166;
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D 4318;
- Amount of Material in Soils Finer than No. 200 (75-µm) Sieve, ASTM D 1140; and
- Particle-Size Analysis (Gradation) of Soils, ASTM D 422.

Moisture, density, compressive strength, and -200 test results are shown on the boring logs. Plasticity index results are shown on Figure A-15, and gradation analysis results are shown on Figures A-16 through A-18. The exploratory boring logs, descriptions of soils encountered and the laboratory test data reflect conditions only at the location of the excavation at the time they were excavated or retrieved. Conditions may differ at other locations and may change with the passage of time due to a variety of causes including natural weathering, climate, and changes in surface and subsurface drainage.

MAJOR DIVISIONS		SYMBOL	DESCRIPTION
COARSE GRAINED SOILS over 50% sand and gravel	CLEAN GRAVEL	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
	GRAVEL with fines	GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	CLEAN SAND	SW	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly-graded sands or gravelly sands, little or no fines
	SAND with fines	SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS over 50% silt and clay	SILT AND CLAY liquid limit <50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silt-clays of low plasticity
	SILT AND CLAY liquid limit >50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS		PT	Peat, muck, and other highly organic soils
ROCK			Undifferentiated as to type or composition

KEY TO BORING AND TEST PIT SYMBOLS

CLASSIFICATION TESTS

PI	PLASTICITY INDEX
LL	LIQUID LIMIT
SA	SIEVE ANALYSIS
HYD	HYDROMETER ANALYSIS
P200	PERCENT PASSING NO. 200 SIEVE
P4	PERCENT PASSING NO. 4 SIEVE

SAMPLER TYPE

- MODIFIED CALIFORNIA
- STANDARD PENETRATION TEST
- THIN-WALLED / FIXED PISTON
- HAND SAMPLER
- ROCK CORE
- X DISTURBED OR BULK SAMPLE

STRENGTH TESTS

TV	FIELD TORVANE (UNDRAINED SHEAR)
UC	LABORATORY UNCONFINED COMPRESSION
TXCU	CONSOLIDATED UNDRAINED TRIAXIAL
TXUU	UNCONSOLIDATED UNDRAINED TRIAXIAL
	UC, CU, UU = 1/2 Deviator Stress

SAMPLER DRIVING RESISTANCE

Modified California and Standard Penetration Test samplers are driven 18 inches with a 140-pound hammer falling 30 inches per blow. Blows for the initial 6-inch drive seat the sampler. Blows for the final 12-inch drive are recorded onto the logs. Sampler refusal is defined as 50 blows during a 6-inch drive. Examples of blow records are as follows:

- 25 sampler driven 12 inches with 25 blows after initial 6-inch drive
- 85/7" sampler driven 7 inches with 85 blows after initial 6-inch drive
- 50/3" sampler driven 3 inches with 50 blows during initial 6-inch drive or beginning of final 12-inch drive

NOTE: Test boring and test pit logs are an interpretation of conditions encountered at the excavation location during the time of exploration. Subsurface rock, soil or water conditions may vary in different locations within the project site and with the passage of time. Boundaries between differing soil or rock descriptions are approximate and may indicate a gradual transition.

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SOIL CLASSIFICATION CHART

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 10/31/12

Drawn MFJ
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A-1
FIGURE

FRACTURING AND BEDDING

Fracture Classification	Spacing	Bedding Classification
Crushed	less than 3/4 inch	Laminated
Intensely fractured	3/4 to 2-1/2 inches	Very thinly bedded
Closely fractured	2-1/2 to 8 inches	Thinly bedded
Moderately fractured	8 to 24 inches	Medium bedded
Widely fractured	2 to 6 feet	Thickly bedded
Very widely fractured	greater than 6 feet	Very thickly bedded

HARDNESS

Low	Carved or gouged with a knife
Moderate	Easily scratched with a knife, friable
Hard	Difficult to scratch, knife scratch leaves dust trace
Very hard	Rock scratches metal

STRENGTH

Friable	Crumbles by rubbing with fingers
Weak	Crumbles under light hammer blows
Moderate	Indentations <1/8 inch with moderate blow with pick end of rock hammer
Strong	Withstands few heavy hammer blows, yields large fragments
Very strong	Withstands many heavy hammer blows, yields dust, small fragments

WEATHERING

Complete	Minerals decomposed to soil, but fabric and structure preserved
High	Rock decomposition, thorough discoloration, all fractures are extensively coated with clay, oxides or carbonates
Moderate	Fracture surfaces coated with weathering minerals, moderate or localized discoloration
Slight	A few stained fractures, slight discoloration, no mineral decomposition, no affect on cementation
Fresh	Rock unaffected by weathering, no change with depth, rings under hammer impact

NOTE: Test boring and test pit logs are an interpretation of conditions encountered at the location and time of exploration. Subsurface rock, soil and water conditions may differ in other locations and with the passage of time.

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ROCK CLASSIFICATION CHART

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Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 10/31/12

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A-2
FIGURE

BORING MW-1

EQUIPMENT: Truck-mounted Deeprock DR-10K Drill Rig with 8-inch Hollow-Stem Augers
DATE: 11/09/2012
ELEVATION: 70.8-feet (NAVD88)*
*REFERENCE: Survey by Stetson Engineers, 2012

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
						0 / 0			4-INCHES ASPHALT CONCRETE 4-INCHES AGGREGATE BASEROCK
									CLAY WITH SAND (CL) Light brown, moist, medium stiff, low plasticity, ~15-20% very fine to fine sand [FILL]
		UC 2200	19	27.7	97	1 / 5			CLAY (CL) Dark gray, moist, medium stiff to stiff, low to medium plasticity [ALLUVIUM] Grades medium stiff at 4.0 feet. Grades with ~10% very fine to coarse sand and ~10% fine to medium angular to subrounded gravel at 5.5 feet.
						2			Groundwater encountered at 9.0 feet during exploration.
			10	19.4	109	3 / 10			SANDY CLAY (CL) Dark gray, saturated, medium stiff, low to medium plasticity, ~40-50% very fine to coarse sand, trace fine gravel [ALLUVIUM]
	P200 30.7%		17	21.1	109	4 / 15 5			CLAYEY SAND (SC) Dark gray, mottled brown and orange, saturated, medium dense, ~30% low to medium plasticity clay, trace fine gravel [ALLUVIUM]
						6 / 20			SANDY CLAY (CL)

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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BORING LOG

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 10/30/12

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A-3
FIGURE

BORING MW-1 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			20	16.6	113	20 / 7			SANDY CLAY (CL) Dark gray, saturated, stiff, low to medium plasticity, ~30-40% very fine to coarse sand [ALLUVIUM]
			54	24.1	106	25 / 8			Grades very stiff, with ~20-25% very fine to coarse sand at 25.5 feet.
									SANDY GRAVEL (GW) Medium gray, saturated, loose to medium dense, ~50% each fine to coarse sand and fine to coarse gravel [ALLUVIUM]
			94/11"	21.2	114	30 / 9 – 10			CLAY WITH SAND (CL) Medium gray, saturated, very stiff, low to medium plasticity, ~15-20% very fine to coarse sand, ~5-10% fine to coarse gravel [ALLUVIUM]
			78	14.2		35 / 11			SAND WITH CLAY AND GRAVEL (SW) Medium gray, mottled orange and red, saturated, dense to very dense, very fine to coarse grained, subangular to well-rounded, ~20% low plasticity clay, ~20% fine to coarse rounded gravel [ALLUVIUM]
						12 / 40			CLAY (CL) Dark blue-gray, saturated, medium stiff to stiff, low to medium plasticity, ~10-15% very fine to medium sand, trace fine gravel [ALLUVIUM]

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
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San Anselmo, California
Project No. 215.16 Date: 10/31/12

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A-4
FIGURE

BORING MW-1 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			31	20.5	110	40			CLAY (CL) Dark blue-gray, saturated, very stiff, low to medium plasticity, ~10-15% very fine to medium sand, trace fine gravel [ALLUVIUM]
						13			
						45			SHALE Dark gray, low to moderate hardness, moderately strong, intensely fractured to crushed [BEDROCK]
			78/10"			14			Boring terminated at 45 feet 10 inches. First groundwater encountered at 9 feet 0 inches. Boring completed as 2-inch monitoring well in accordance with Figure A-19, "MW-1 As-Built Construction Detail".
						15			
						50			
						16			
						55			
						17			
						18			
						60			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
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Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 11/27/12

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A-5
FIGURE

BORING MW-2A

EQUIPMENT: Truck-mounted Deeprock DR-10K Drill Rig with 8-inch Hollow-Stem Augers
DATE: 10/22/2012
ELEVATION: 73.7-feet (NAVD88)*
*REFERENCE: Survey by Stetson Engineers, 2012

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
						0 / 0			CLAY (CL) Dark gray, moist, medium stiff to stiff, medium plasticity [ALLUVIUM]
			19	25.4	94	1 / 5			
	P200 53.0%	UC 1400	16	16.0	118	2 / 10			SANDY CLAY (CL) Medium brown, moist, stiff, low to medium plasticity, ~40-45% very fine to fine sand [ALLUVIUM]
						3 /			Grades very stiff at 14.0-feet.
		UC 2100	44	14.8	115	4 / 15			Groundwater encountered at 17.0 feet during exploration.
						5 /			CLAYEY SAND WITH GRAVEL (SC)
						6 / 20			CLAY (CL) Medium blue-gray with orange mottling, moist, very stiff, low plasticity [ALLUVIUM]

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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San Anselmo, California
Project No. 215.16 Date: 10/30/12

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A-6
FIGURE

BORING MW-2A (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			38	20.9	107	20 – 7			CLAY (CL) Medium blue-gray with orange mottling, moist, very stiff, low plasticity [ALLUVIUM]
			38	26.9	101	25 – 8			Grades stiff at 28.0 feet.
			22	26.7	101	30 – 9 – 10			
						35 – 11 – 12 40			Boring terminated at 36 feet 0 inches. First groundwater encountered at 17 feet 0 inches. Boring completed as 2-inch monitoring well in accordance with Figure A-20, "MW-2A As-Built Construction Detail".

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING LOG

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San Anselmo, California
Project No. 215.16 Date: 10/31/12

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A-7
FIGURE

BORING MW-2B

EQUIPMENT: Truck-mounted Deeprock DR-10K Drill Rig with 10-inch Hollow-Stem Augers
DATE: 11/08/2012
ELEVATION: 74.3-feet (NAVD88)*
*REFERENCE: Survey by Stetson Engineers, 2012

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
	PI=30 LL=52		41	18.3	107	0 / 0			SILTY CLAY (CH) Dark gray, moist, stiff to very stiff, medium to high plasticity, ~50% each silt and clay [ALLUVIUM] Grades with ~5% fine to coarse sand at 3.0 feet.
		UC 1400	13	21.2	107	3 / 10			CLAY (CL) Light to medium brown, moist to wet, medium stiff, low plasticity, trace very fine sand [ALLUVIUM] Groundwater encountered at 11.5 feet during exploration.
									CLAYEY SAND (SC)
						4			CLAY (CL) Medium to dark brown, wet to saturated, medium stiff to stiff, low plasticity, trace very fine to fine sand [ALLUVIUM]
	P200 18.2%		50	15.1	115	5 / 15			SAND WITH CLAY (SW) Medium brown, saturated, dense, very fine to coarse-grained, ~20% low plasticity clay, ~5-10% fine to medium rounded gravel [ALLUVIUM]
						6 / 20			CLAY WITH SAND (CL) Light brown, saturated, stiff, low plasticity, ~15-20% very fine sand [ALLUVIUM]

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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Memorial Park Detention Basin
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Project No. 215.16 Date: 10/30/12

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A-8
FIGURE

BORING MW-2B (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			23	22.0	107	20 / 7			CLAY WITH SAND (CL) Light brown, saturated, stiff, low plasticity, ~15-20% very fine sand [ALLUVIUM]
	P200 22.0%		62/6"	15.4	110	25 / 8			SAND WITH CLAY (SW) Medium brown, mottled orange, saturated, dense, very fine to coarse-grained, ~20% low plasticity clay [ALLUVIUM]
			78/11"	17.5	100	30 / 9			
						10			CLAY (CL) Dark brown, saturated, very stiff, low to medium ,plasticity, trace very fine sand [ALLUVIUM]
		UC 1100	78/11"	17.5	100	35 / 11			Boring terminated at 36 feet 0 inches. First groundwater encountered at 11 feet 6 inches. Boring completed as 4-inch monitoring well in accordance with Figure A-21, "MW-2B As-Built Construction Detail".
						12			
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
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BORING LOG

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San Anselmo, California

Project No. 215.16 Date: 10/31/12

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A-9
FIGURE

BORING MW-3

EQUIPMENT: Truck-mounted Deeprock DR-10K Drill Rig with 8-inch Hollow-Stem Augers
DATE: 11/08/2012
ELEVATION: 80.7-feet (NAVD88)*
*REFERENCE: Survey by Stetson Engineers, 2012

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
						0 / 0			4-INCHES ASPHALT CONCRETE 4-INCHES AGGREGATE BASEROCK
									SILTY SAND WITH GRAVEL (SM) Light brown, dry to moist, dense, very fine to coarse-grained, ~30% low plasticity silt, ~15-20% fine to medium angular gravel [FILL]
						1 / 5			SILTY SAND (SM) Medium brown, moist, medium dense to dense, very fine to coarse-grained, ~30% low plasticity silt [ALLUVIUM]
		UC 5000	50	21.7	102	2			CLAYEY SILT (ML) Dark gray, moist, very stiff, low plasticity, ~50% each clay and silt, trace very fine sand [ALLUVIUM]
	PI=20 LL=40	UC 2300	25	19.4	110	3 / 10			CLAY (CL) Medium blue-gray, mottled brown and orange, moist, medium stiff, medium plasticity, trace very fine to medium sand [ALLUVIUM]
						4			GRAVELLY CLAY (CL) Medium blue-gray, mottled brown and orange, moist, medium stiff, ~40% fine to medium rounded gravel, trace very fine to coarse sand [ALLUVIUM]
			13	21.0	109	▽ 15			CLAY (CL) Light to medium brown, moist, medium stiff, medium plasticity [ALLUVIUM] Groundwater encountered at 14.5 feet during exploration.
						5			CLAY WITH SAND (CL) Light to medium brown, saturated, medium stiff, medium plasticity, ~20% fine to coarse sand, <5% fine to medium rounded gravel [ALLUVIUM]
						6 / 20			CLAY (CL)

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
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BORING LOG

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San Anselmo, California
Project No. 215.16 Date: 10/30/12

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A-10
FIGURE

BORING MW-3 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			18	22.7	108	20 – 7			CLAY (CL) Medium blue-gray, mottled brown and orange, saturated, stiff, low plasticity, <5% fine to coarse sand [ALLUVIUM]
	P200 13.4%		28	14.1	122	25 – 8			SAND WITH CLAY (SW) Medium brown, saturated, medium dense, very fine to coarse-grained, ~15% low plasticity clay, trace fine to medium rounded gravel [ALLUVIUM]
						– 9			CLAY (CL) Light brown, saturated, soft to medium stiff, low plasticity [ALLUVIUM]
	P200 26.7%		54	16.7	120	30 – 10			CLAYEY SAND (SC) Light brown, moist to wet, dense, very fine to coarse-grained, ~25% low plasticity clay, trace fine gravel [ALLUVIUM]
									CLAY (CL) Medium blue-gray, wet, medium stiff to stiff, low plasticity, trace very fine to fine sand [ALLUVIUM]
	P200 22.1%		58	15.0	124	35 – 11			GRAVELLY SAND WITH CLAY (SW) Medium blue-gray, saturated, dense, very fine to coarse-grained, ~30% fine to medium rounded gravel, ~20% clay [ALLUVIUM]
						– 12			CLAY (CL) Medium blue-gray, moist, very stiff, low plasticity [ALLUVIUM]
						40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING LOG

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 10/31/12

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A-11
FIGURE

BORING MW-3 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
		UC 2300	45	19.5	111	40			CLAY (CL) Medium blue-gray, moist, very stiff, low plasticity [ALLUVIUM]
						13			Boring terminated at 41 feet 6 inches. First groundwater encountered at 14 feet 6 inches. Boring completed as 2-inch monitoring well in accordance with Figure A-22, "MW-3 As-Built Construction Detail".
						45			
						14			
						15			
						50			
						16			
						55			
						17			
						18			
						60			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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BORING LOG

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 11/27/12

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A-12
FIGURE

BORING MW-4

EQUIPMENT: Truck-mounted Deeprock DR-10K Drill Rig with 8-inch Hollow-Stem Augers
DATE: 10/23/2012
ELEVATION: 74.0-feet (NAVD88)*
*REFERENCE: Survey by Stetson Engineers, 2012

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
						0 / 0			SILTY CLAY (CL) Medium gray, moist, medium stiff, medium plasticity, organics [TOPSOIL/ALLUVIUM]
						1			SANDY CLAY WITH GRAVEL (CL) Medium brown with orange and yellow mottling, moist, stiff, low plasticity, ~30% very fine to coarse sand, ~15% fine to medium rounded gravel [ALLUVIUM]
			18	20.3	91	5 / 2			CLAY (CL) Dark gray, moist, medium stiff, medium plasticity, <5% each very fine to coarse sand and fine rounded gravel [ALLUVIUM] Grades soft, wet at 7.0-feet.
			14			3 / 10			Groundwater encountered at 11.5-feet during exploration. Note cobble in sampler shoe at 10-feet, blow counts inaccurate, no sample recovery
						4			SANDY GRAVEL (GW) Medium brown, wet to saturated, medium dense, ~30-40% very fine to coarse sand, ~60-70% fine to medium subangular to subrounded gravel [ALLUVIUM]
			19	26.2	96	15 / 5			CLAY (CL) Medium blue-gray, saturated, stiff, low to medium plasticity, trace very fine to coarse sand [ALLUVIUM] Grades with ~10% each very fine to coarse sand and fine to medium rounded gravel at 17.0-feet.
						6 / 20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
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A-13
FIGURE

BORING MW-4 (CONTINUED)

OTHER TEST DATA	OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters / feet	SAMPLE	SYMBOL (3)	
			16	22.2	105	20 / 7			CLAY (CL) Medium blue-gray, saturated, stiff, low to medium plasticity, ~10% each very fine to coarse sand and fine to medium rounded gravel [ALLUVIUM]
			38	22.2	92	25 / 8			SAND (SP) Loose, saturated [ALLUVIUM]
									CLAY (CL) Medium blue-gray, saturated, stiff, low to medium plasticity, ~10% each very fine to coarse sand and fine to medium rounded gravel [ALLUVIUM]
	P200 22.1%		22	12.2	121	30 / 9			SANDY GRAVEL WITH CLAY (GW) Medium gray with orange and yellow mottling, medium dense, saturated, subangular to subrounded, ~30% very fine to coarse sand, ~15% low to medium plasticity clay [ALLUVIUM]
						35 / 10			Boring terminated at 31 feet 6 inches. First groundwater encountered at 11 feet 6 inches. Boring completed as 2-inch monitoring well in accordance with Figure A-23, "MW-4 As-Built Construction Detail".
						40 / 11			
						12			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

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FILE: 215.16BL.dwg

BORING LOG

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 10/31/12

Drawn MFJ
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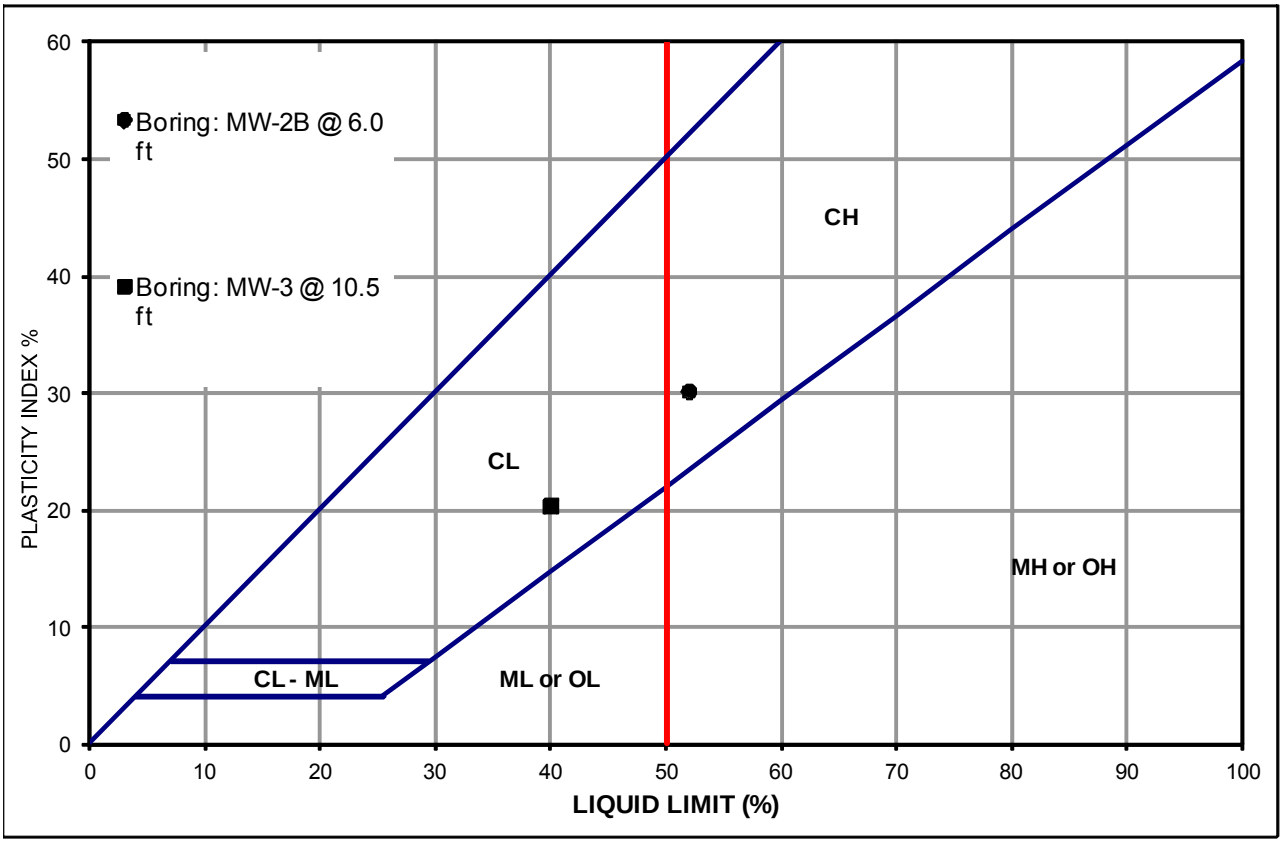
A-14
FIGURE

MILLER PACIFIC ENGINEERING GROUP

ATTERBERG LIMITS TEST (ASTM D 4318)



Sample	Classification	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Boring: MW-2B @ 6.0 ft	CLAY DARK BROWN	52	22	30
Boring: MW-3 @ 10.5 ft	CLAY DARK BROWN	40	20	20

PI = 0-1: Non-Plastic
PI = 1-5: Slightly Plastic
PI = 5-10: Low Plasticity
PI = 10-20: Medium Plasticity
PI = 20-40: High Plasticity
PI > 40: Very High Plasticity

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FILE: 215.16.dwg

PLASTICITY INDEX

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/24/12

Drawn JTO
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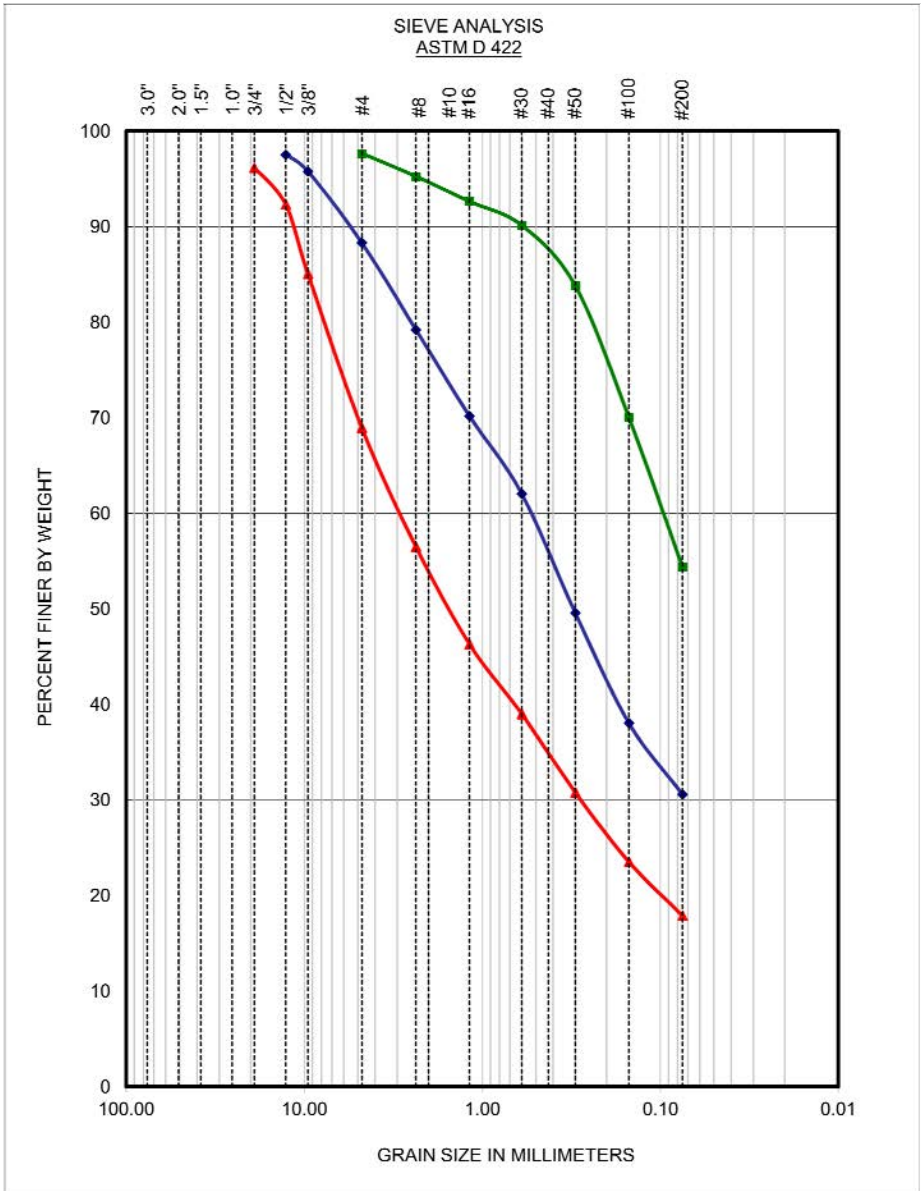
A-15
FIGURE



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
	MW-1 @ 16.0'	CLAYEY SAND
	MW-2 @10.5'	CLAY WITH SAND
	MW-2B @ 16.0'	SAND WITH CLAY

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FILE: 215.16 SA.dwg

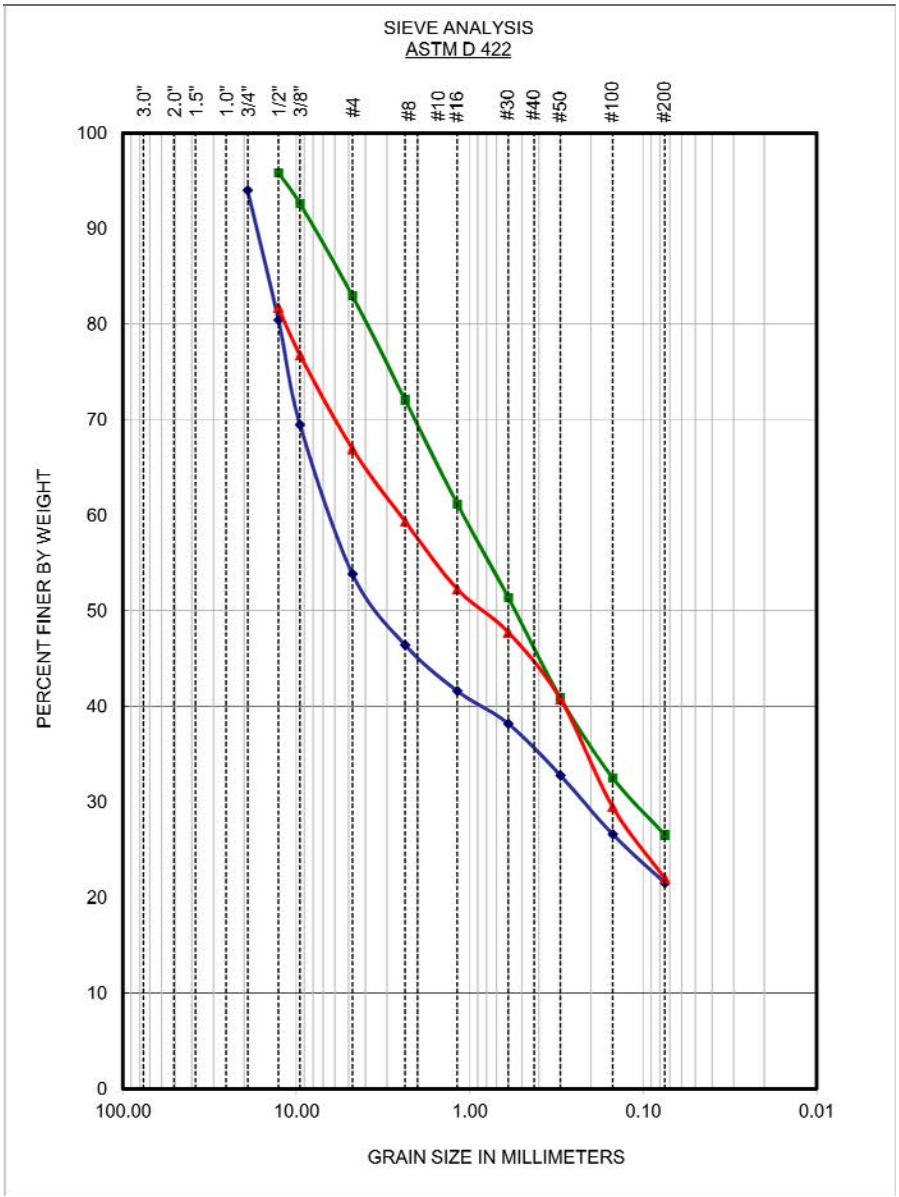
SIEVE ANALYSIS

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/24/12

Drawn JTO
Checked

A-16
FIGURE



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
	MW-2B @ 25.0'	SAND WITH CLAY
	MW-3 @ 31.0'	CLAYEY SAND
	MW-3 @ 36.5'	CLAYEY SAND WITH GRAVEL

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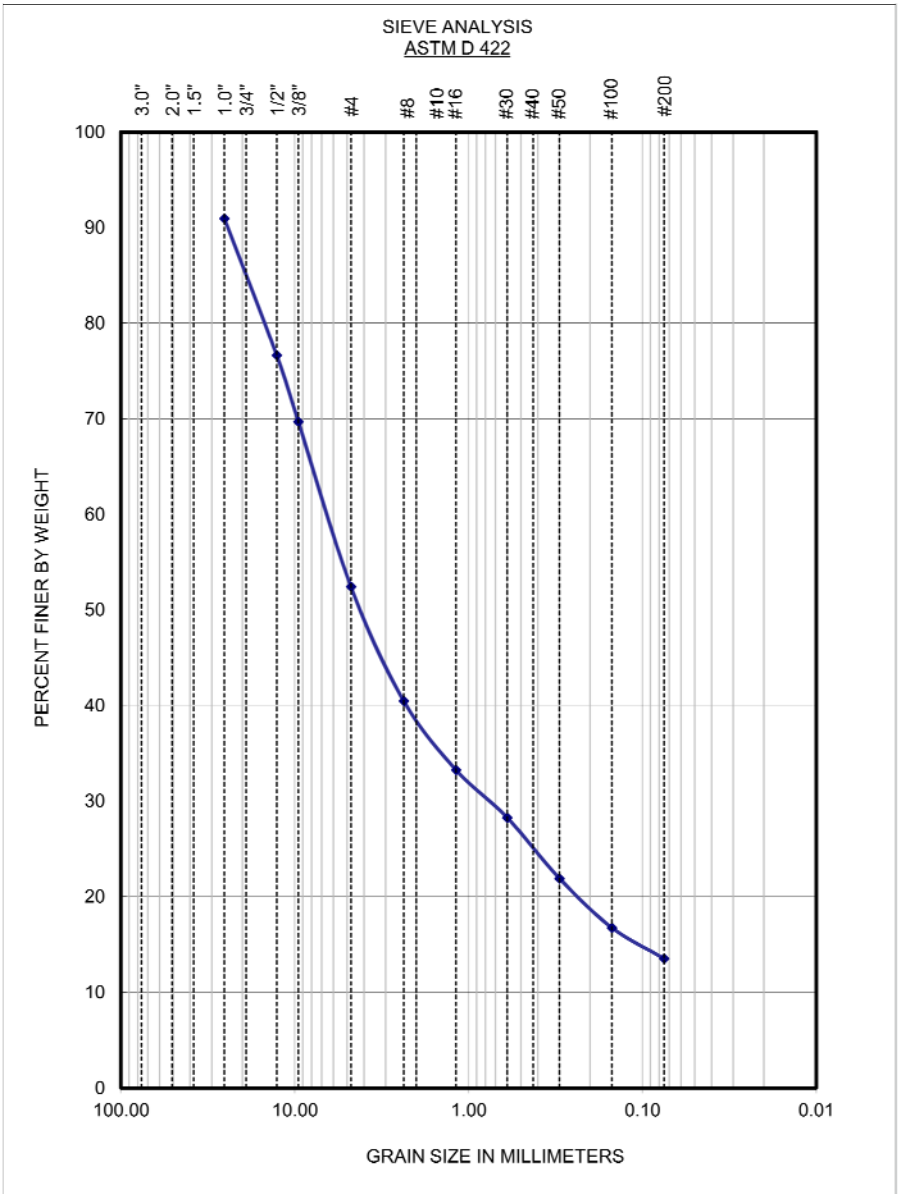
SIEVE ANALYSIS

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 12/24/12

Drawn JTO
Checked

A-17
FIGURE



SYMBOL	SAMPLE SOURCE	CLASSIFICATION
◆	MW-4 @30.5'	SANDY GRAVEL WITH CLAY

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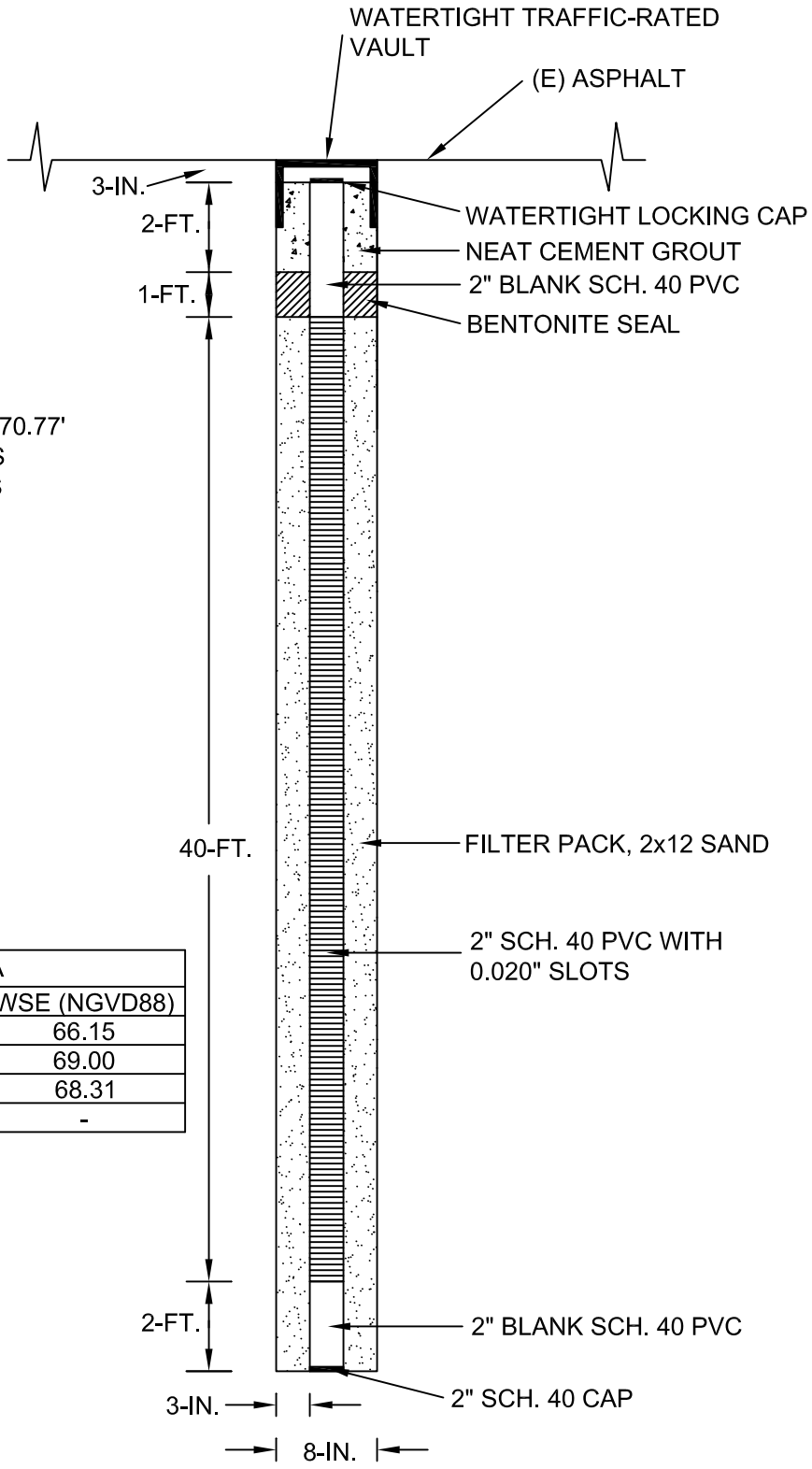
SIEVE ANALYSIS

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California
Project No. 215.16 Date: 12/24/12

Drawn JTO
Checked

A-18
FIGURE



NOTES:

WELL SURFACE EL. (NGVD88) = 70.77'
TOTAL BORING DEPTH = 45' BGS
TOTAL CASING DEPTH = 45' BGS
TOTAL SEAL THICKNESS = 3'
SCREEN DEPTH = 3' - 43' BGS
GROUT MIX:
5 GAL MAX H2O : 94# CEMENT

WATER LEVEL DATA		
DATE	DEPTH (BGS)	WSE (NGVD88)
11/27/2012	4.62	66.15
12/2/2012	1.77	69.00
12/5/2012	2.46	68.31
TBD	-	-

AS-BUILT 2-INCH GROUNDWATER MONITORING WELL - "MW-1"

(NO SCALE)

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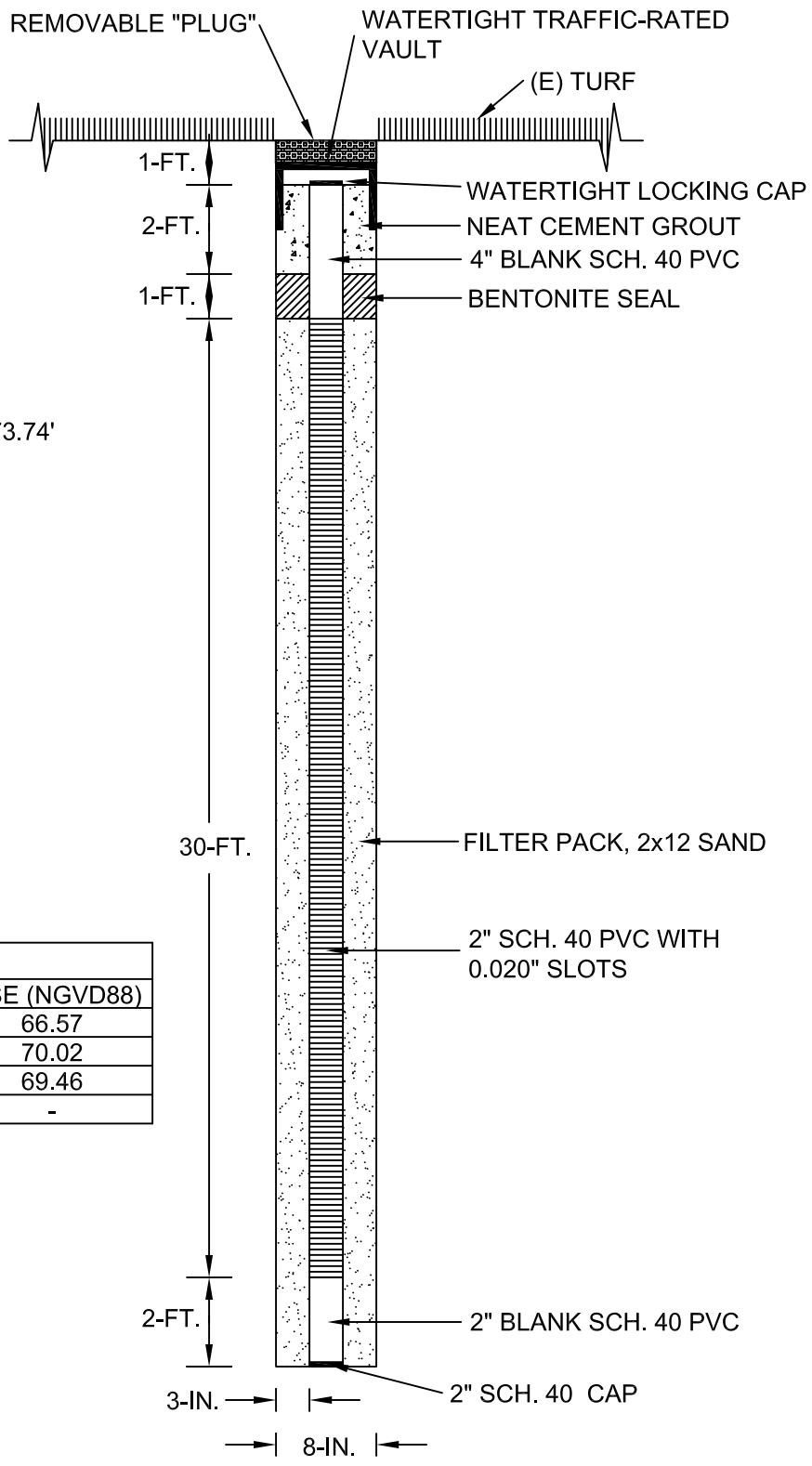
MW-1 AS-BUILT CONSTRUCTION DETAIL

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/28/12

Drawn MFJ
Checked

A-19
FIGURE



NOTES:

WELL SURFACE EL. (NGVD88) = 73.74'
TOTAL BORING DEPTH = 36' BGS
TOTAL CASING DEPTH = 36' BGS
TOTAL SEAL THICKNESS = 3'
SCREEN DEPTH = 4' - 34' BGS
GROUT MIX:
5 GAL MAX H2O : 94# CEMENT

WATER LEVEL DATA		
DATE	DEPTH (BGS)	WSE (NGVD88)
11/27/2012	7.17	66.57
12/2/2012	3.72	70.02
12/5/2012	4.28	69.46
TBD	-	-

AS-BUILT 2-INCH GROUNDWATER MONITORING WELL - "MW-2A"

(NO SCALE)

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MW-2A AS-BUILT CONSTRUCTION DETAIL

Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/28/12

Drawn MFJ
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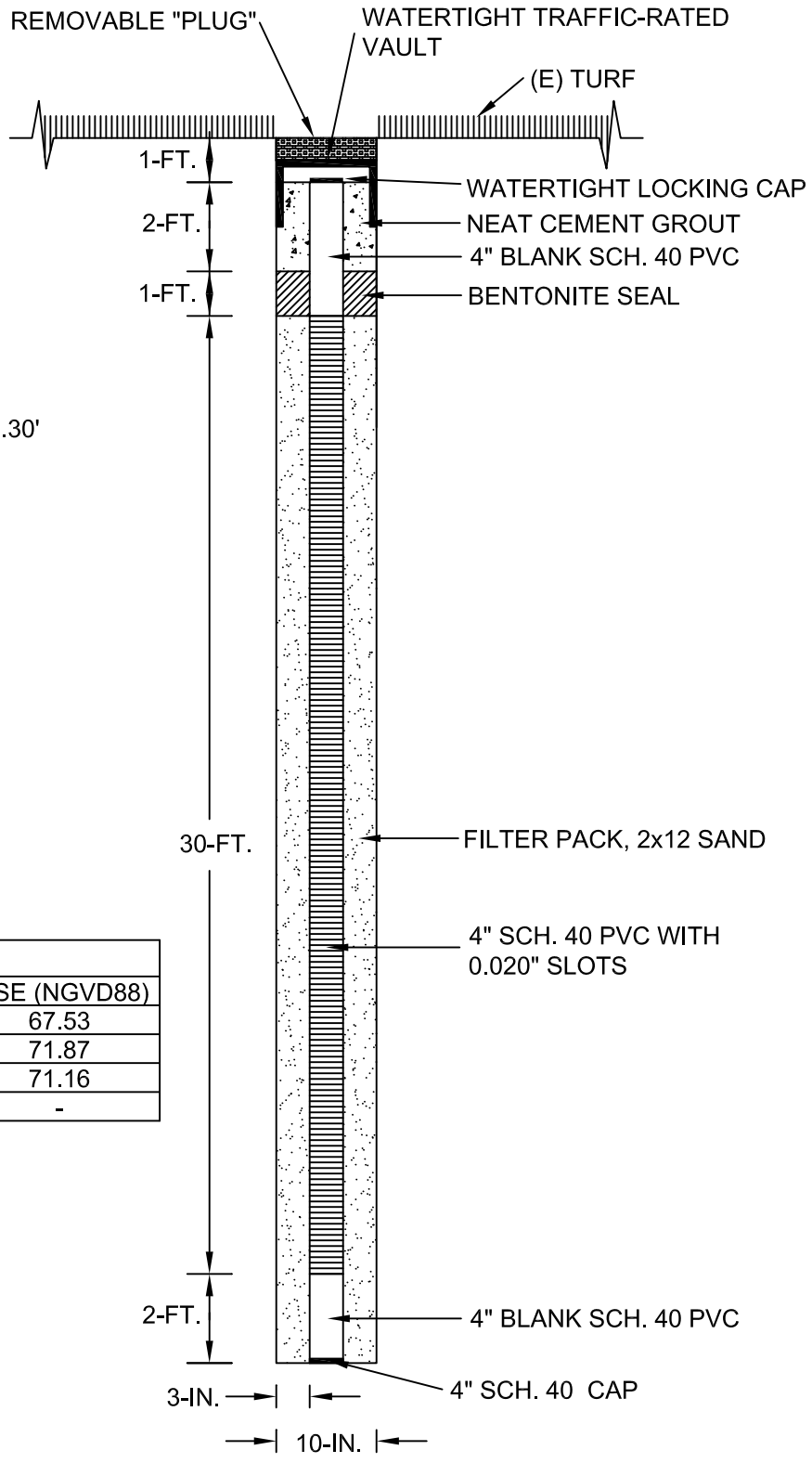
A-20
FIGURE



NOTES:

WELL SURFACE EL. (NGVD88) = 74.30'
TOTAL BORING DEPTH = 36' BGS
TOTAL CASING DEPTH = 36' BGS
TOTAL SEAL THICKNESS = 3'
SCREEN DEPTH = 4' - 34' BGS
GROUT MIX:
5 GAL MAX H2O : 94# CEMENT

WATER LEVEL DATA		
DATE	DEPTH (BGS)	WSE (NGVD88)
11/27/2012	6.77	67.53
12/2/2012	2.44	71.87
12/5/2012	3.15	71.16
TBD	-	-

AS-BUILT 4-INCH GROUNDWATER MONITORING WELL - "MW-2B"

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MW-2B AS-BUILT CONSTRUCTION DETAIL

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Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/28/12

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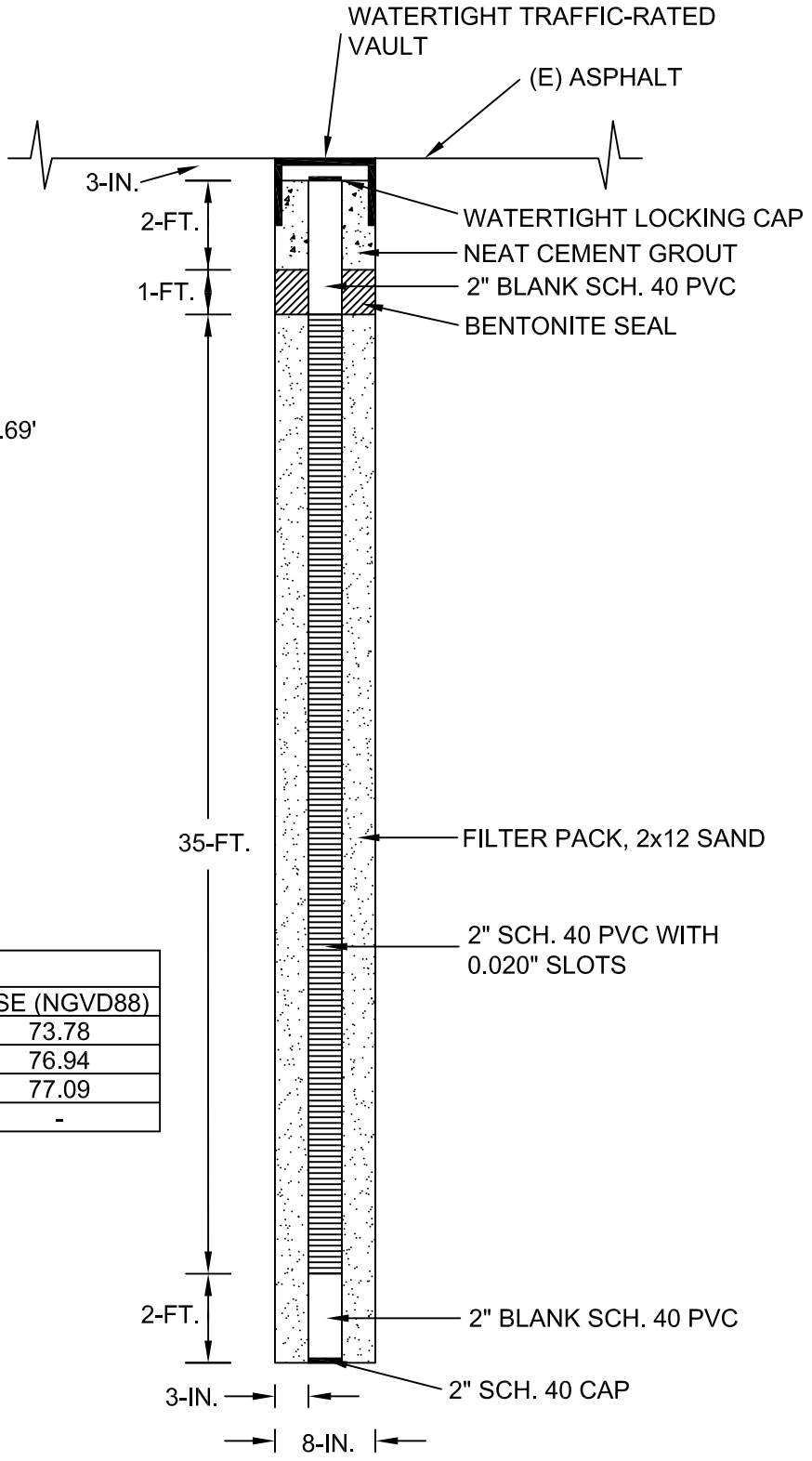
A-21
FIGURE



NOTES:

WELL SURFACE EL. (NGVD88) = 80.69'
TOTAL BORING DEPTH = 40' BGS
TOTAL CASING DEPTH = 40' BGS
TOTAL SEAL THICKNESS = 3'
SCREEN DEPTH = 3' - 38' BGS
GROUT MIX:
5 GAL MAX H2O : 94# CEMENT

WATER LEVEL DATA		
DATE	DEPTH (BGS)	WSE (NGVD88)
11/27/2012	6.91	73.78
12/2/2012	3.74	76.94
12/5/2012	3.59	77.09
TBD	-	-

AS-BUILT 2-INCH GROUNDWATER MONITORING WELL - "MW-3"

(NO SCALE)

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FILE: 215.16 MWDetail.dwg

MW-3 AS-BUILT CONSTRUCTION DETAIL

Town of San Anslemo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/28/12

Drawn MFJ
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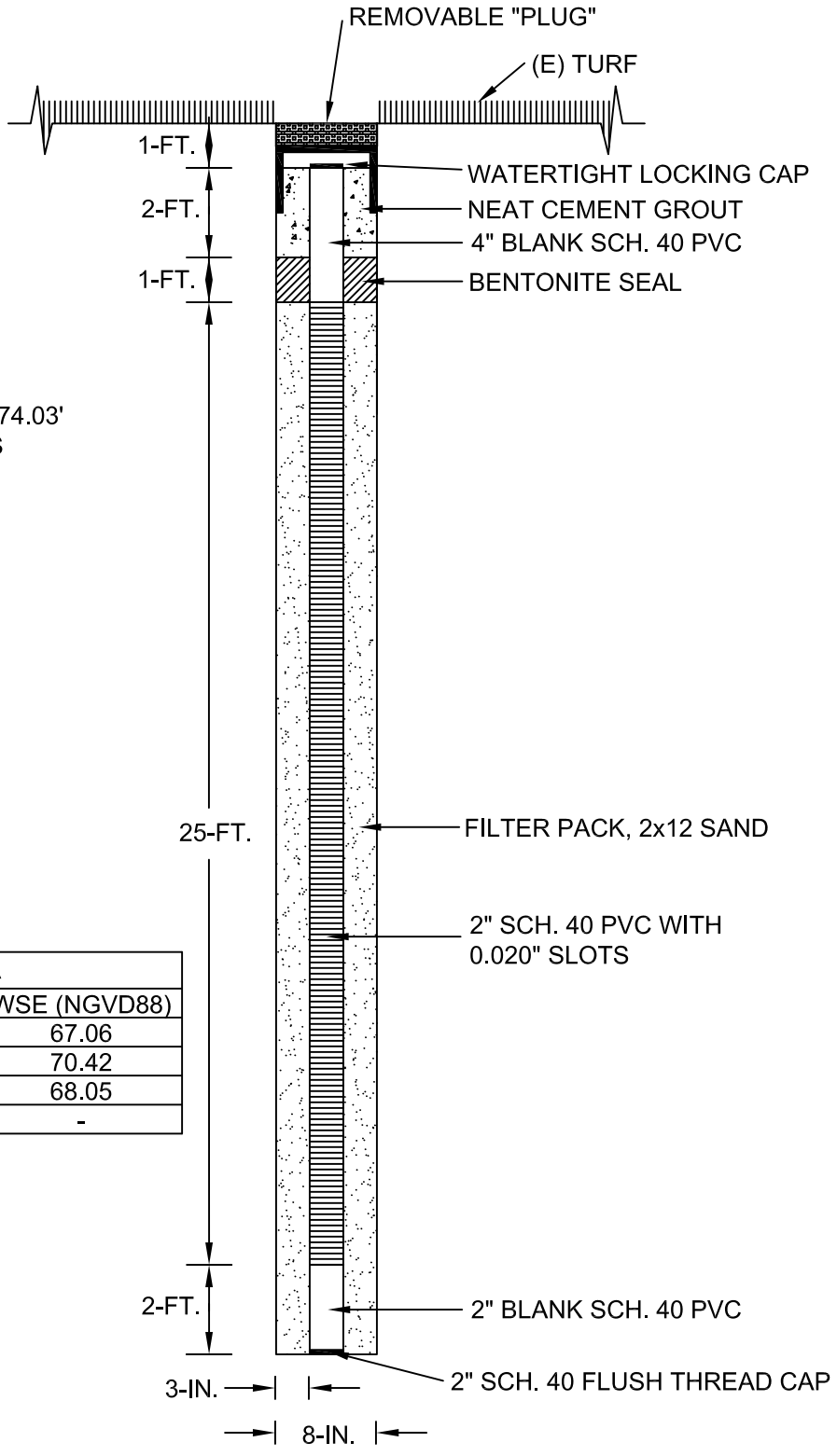
A-22
FIGURE



NOTES:

WELL SURFACE EL. (NGVD88) = 74.03'
TOTAL BORING DEPTH = 31' BGS
TOTAL CASING DEPTH = 31' BGS
TOTAL SEAL THICKNESS = 3'
SCREEN DEPTH = 4' - 29' BGS
GROUT MIX:
5 GAL MAX H2O : 94# CEMENT

WATER LEVEL DATA		
DATE	DEPTH (BGS)	WSE (NGVD88)
11/27/2012	8.97	67.06
12/2/2012	3.62	70.42
12/5/2012	5.98	68.05
TBD	-	-

AS-BUILT 2-INCH GROUNDWATER MONITORING WELL - "MW-4"

(NO SCALE)

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FILE: 215.16 MWDetail.dwg

MW-4 AS-BUILT CONSTRUCTION DETAIL

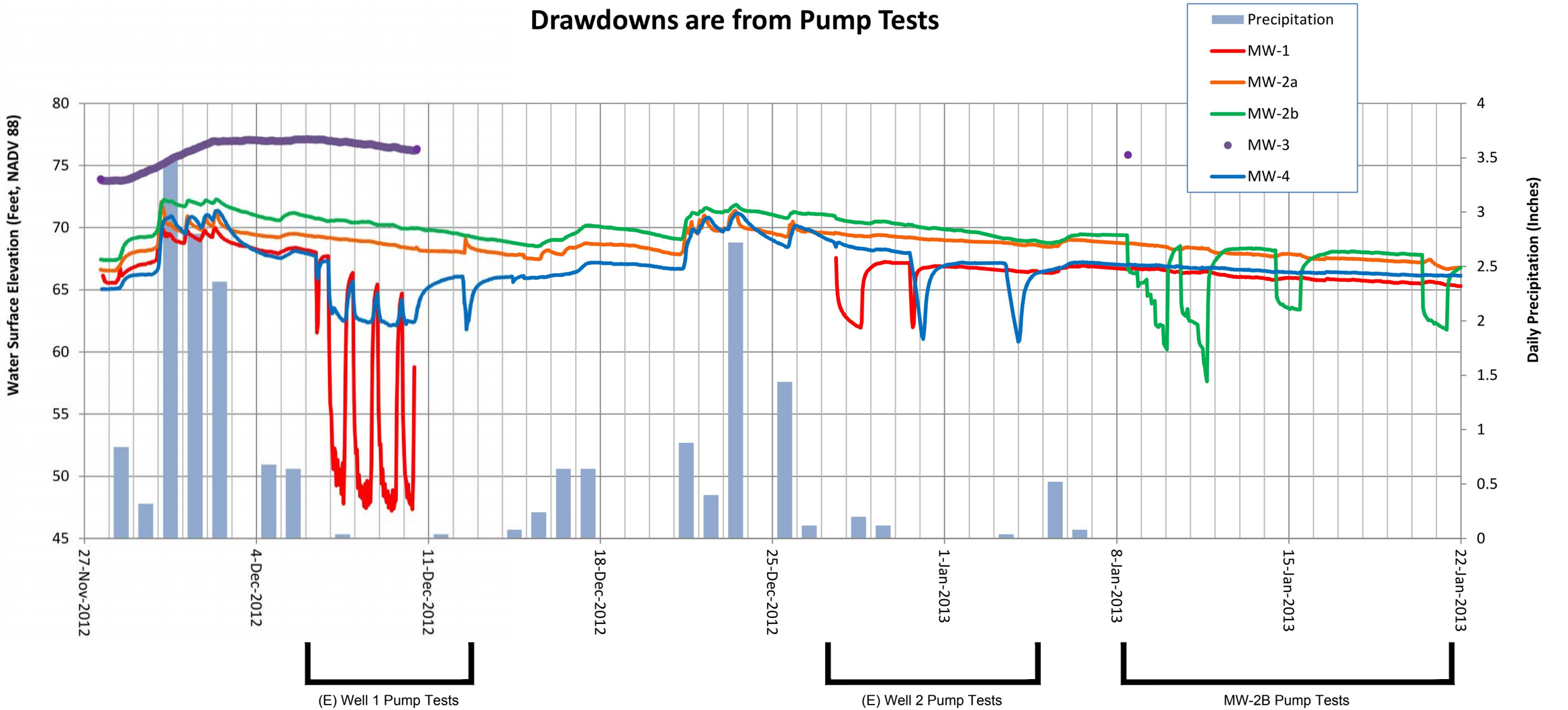
Town of San Anselmo
Memorial Park Detention Basin
San Anselmo, California

Project No. 215.16 Date: 12/28/12

Drawn MFJ
Checked

A-23
FIGURE

Memorial Park Monitoring Well Water Surface Elevations
Drawdowns are from Pump Tests



Miller Pacific ENGINEERING GROUP	504 Redwood Blvd. Suite 220 Novato, CA 94947 T 415 / 382-3444 F 415 / 382-3450 www.millerpac.com	PRELIMINARY GROUNDWATER DATA PLOT
 FILE: 215.16 Monitoring Well Details.dwg		Town of San Anselmo Memorial Park Detention Basin San Anselmo, California Project No. 215.16 Date: 1/29/13
		Drawn EDT Checked
		A-24 FIGURE

Memorial Park Aquifer Pump Test
Preliminary Report

Gerhard Epke
San Anselmo Department of Public Works

Introduction

In December and January 2012-2013 I conducted a series of pump tests in San Anselmo's Memorial Park to determine properties of the underlying aquifer. The pump tests and their quantitative interpretation are not yet completed- one more test remains to be done. This document, however, reports the observed sustainable yields for each of the three pumping wells, to be used as background information for designing the proposed detention basin there.

Setting/Methods

Memorial Park and Sorich Creek sit in a clay-filled sedimentary basin a short distance upstream from the mainstem Corte Madera Creek. See the accompanying Preliminary Geotechnical Investigation report by Miller Pacific Engineers for a more detailed geophysical description of the region. The series of pump tests was conducted with a total of seven wells distributed throughout the park (see **Figure 1**). Two of these pumping wells have been in place since the 1970s and were historically used for irrigation water supply. Both of these irrigation wells are approximately 40 feet deep, 8.5 inches across, and contain in-situ submersible pumps. They are both cased in steel, which in 40 years has become heavily oxidized. To reduce the likelihood of getting poor pump test results from clogging, I had these two wells rinsed with a mild acid solution for 24 hours. The irrigation wells were also fitted with adjustable valves and flow meters. The other five wells were drilled in late 2012 for the purpose of sampling, monitoring, and testing the park's subsurface characteristics. Four of these new wells are 2-inch diameter and one is 4 inches. After being drilled, each well was cleaned (or 'developed') and fitted with a submersible pressure transducer.

Three of these wells, IR-1, IR-2, and MW-2b, were used for pumping. For each of the three pumping wells I conducted a step test to determine the sustainable yield, followed by a 24-hour constant rate test wherein I recorded the drawdown results in adjacent monitoring wells.

Results

Results from the various tests conducted indicate that the maximum sustainable yield from each of the three wells pumped is between 4 and 4.5 gallons per minute (gpm). IR-1 is around 4.5 gpm. IR-2 is closer to 4, and MW-2b is around 4.25 gpm. Following are descriptions of the different pump tests performed.

Irrigation Well-2 Step Tests (Test Numbers 1, 2, 3) December 15-21, 2012

These first few pump tests were informative mostly in helping me understand the pump systems and general parameters for conducting tests. A regulating device within the control panel monitoring boxes attached to the tank turned the pumps off automatically when the flow became too low or when the amperage became too low. After removing this device I was able to control the discharges more precisely. Pump Test #3 showed that 2.3 gpm is sustainable but 6.1 is too high (see **Figure 2**).

Irrigation Well-2 Constant Rate Pump Test (Test 4) Dec 27-28, 2012

This was a successful constant rate test, conducted over 24-hours at about 4.9 gpm. MW-1 is so close to the pumping well that the two drawdown curves look very similar (see **Figure 3**). Notice, also, that the water levels do not stabilize after 24-hours, indicating that 4.9 gpm is above the sustainable yield.

Irrigation Well-1 Step Tests (Test 5), Dec 30, 2012

On December 30th I began a step test at the other irrigation well, #1, which is located Northeast of the other irrigation well, towards the Log Cabin. The results, which are graphed in **Figure 4**, indicate that the sustainable pumping rate is between 3 gpm and 5 gpm.

Irrigation Well-1 Constant Rate Test (Test 6), January 3-4, 2013

This was a 12-hour constant rate test because the selected pumping rate, 4.3 gpm, was too high. Results are shown in **Figure 5**. MW-4, the nearest monitoring well, exhibited a nice response curve, and a very slight response in MW-2a and MW-1 is also visible, see **Figure 6**. Redoing this test at a lower pumping rate is the last test that remains to be done for this portion of the project.

MW-2 Step Test (Test 7), January 8-16, 2013

This series of tests included two consecutive step tests and a subsequent constant rate test. They were conducted between January 8 and 16th with a submersible pump, meter and globe valve borrowed from Forster Pump and Engineering. Pumping was done from Monitoring Well 2b, which is 4". The equipment worked, although the flow rate had a tendency to decrease. There appear to be two step tests because the pump was unplugged during the middle of the night. The constant rate test was conducted at 3.9 gpm and seemed to be stabilizing after 24 hours (See **Figures 7 and 8**.)

MW-2 Constant Rate Test (Test 8), January 20-21, 2013

I conducted another constant rate test on MW-2b, again expecting to read the drawdown in MW-2a, but water flowed backward from the storm drain into one of the field's 'French' drains and recharged 2a. After a few hours I recognized the problem and changed the drainage, see **Figure 9**.

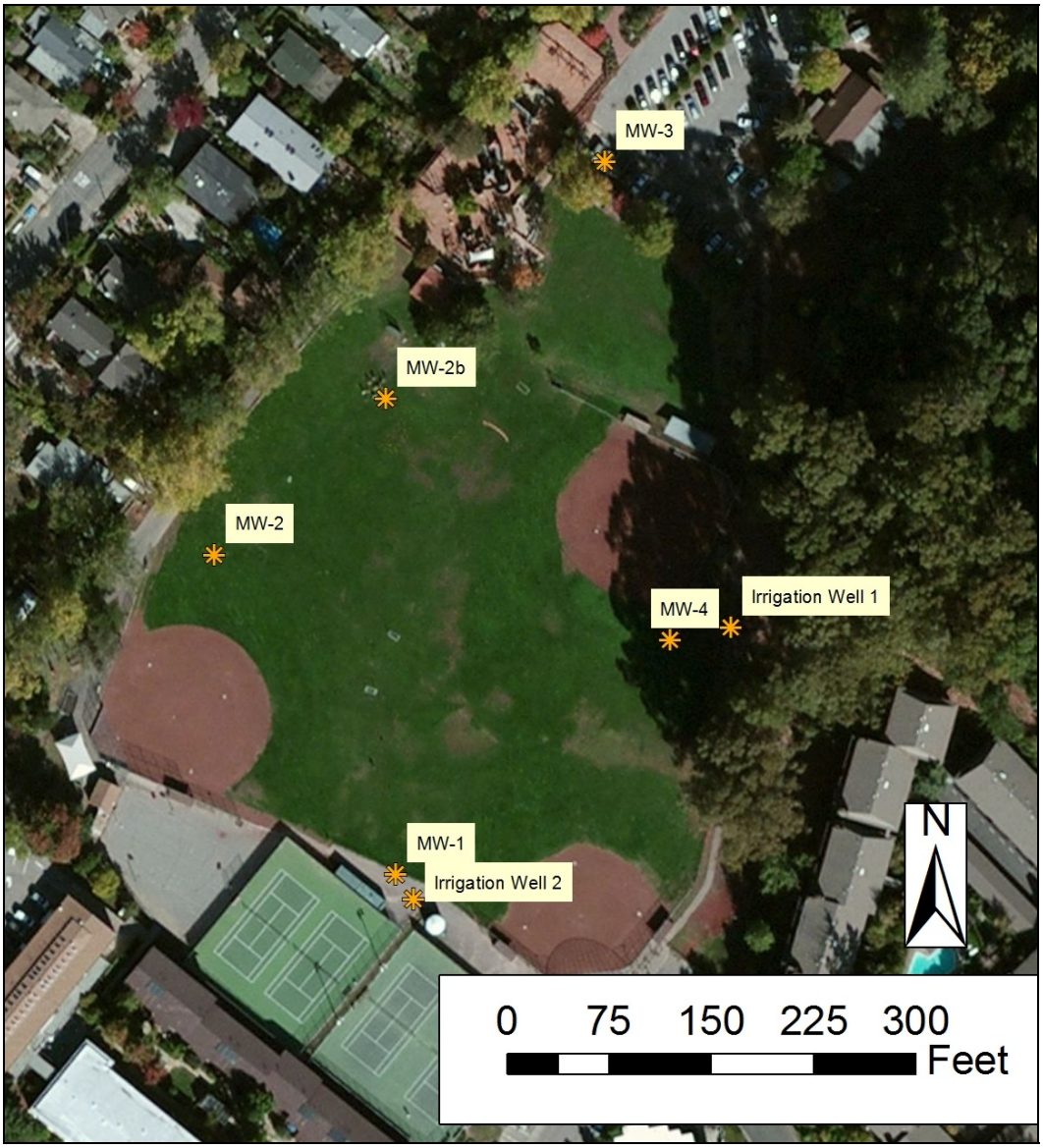


Figure 1. Map of Memorial Park Wells. MW-2b and the two existing irrigation wells were used for pumping. The other four wells are all 2-inch monitoring wells.

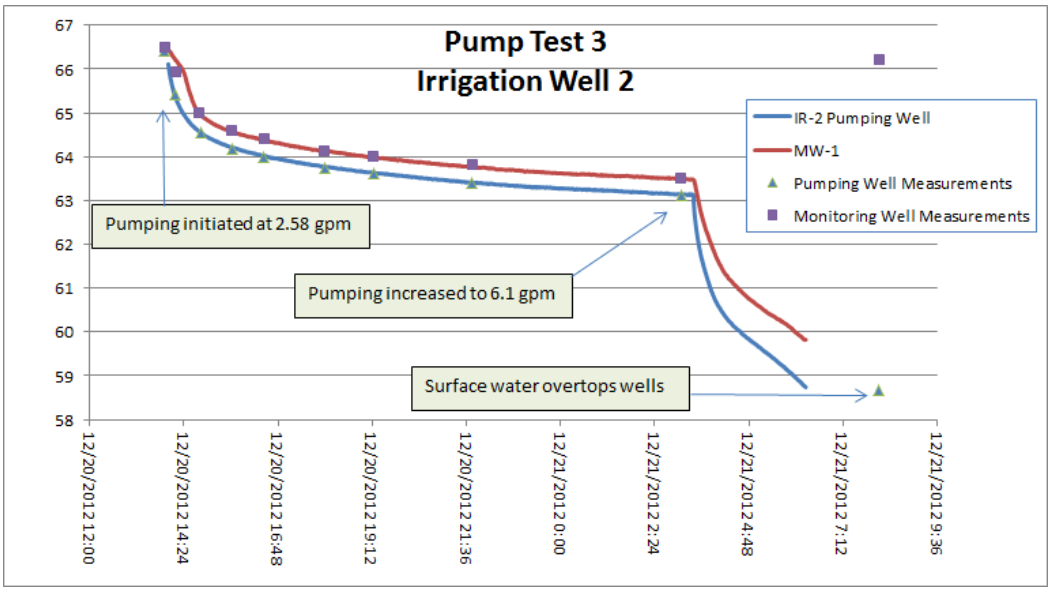


Figure 2. Step test at Irrigation Well 2, adjacent to the tank and tennis courts, and drawdown in MW-1

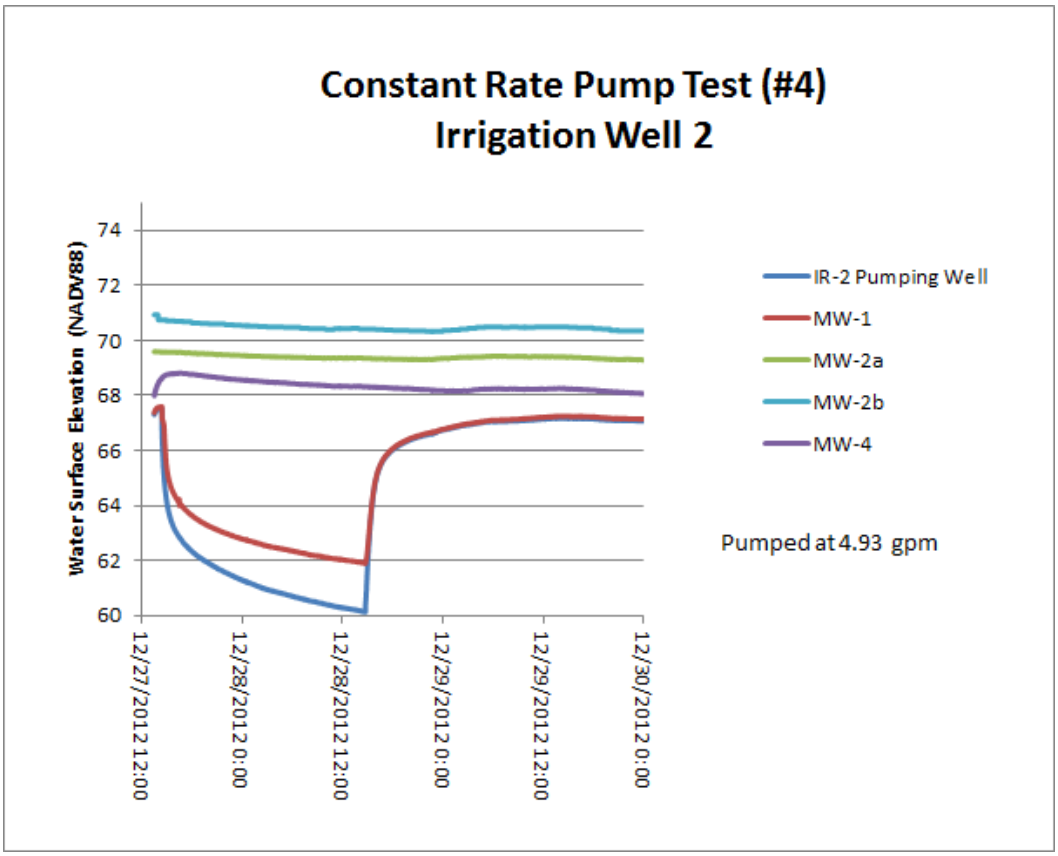


Figure 3. Irrigation Well-2 24-hour constant rate test. Notice that the water surface elevations do not stabilize during pumping.

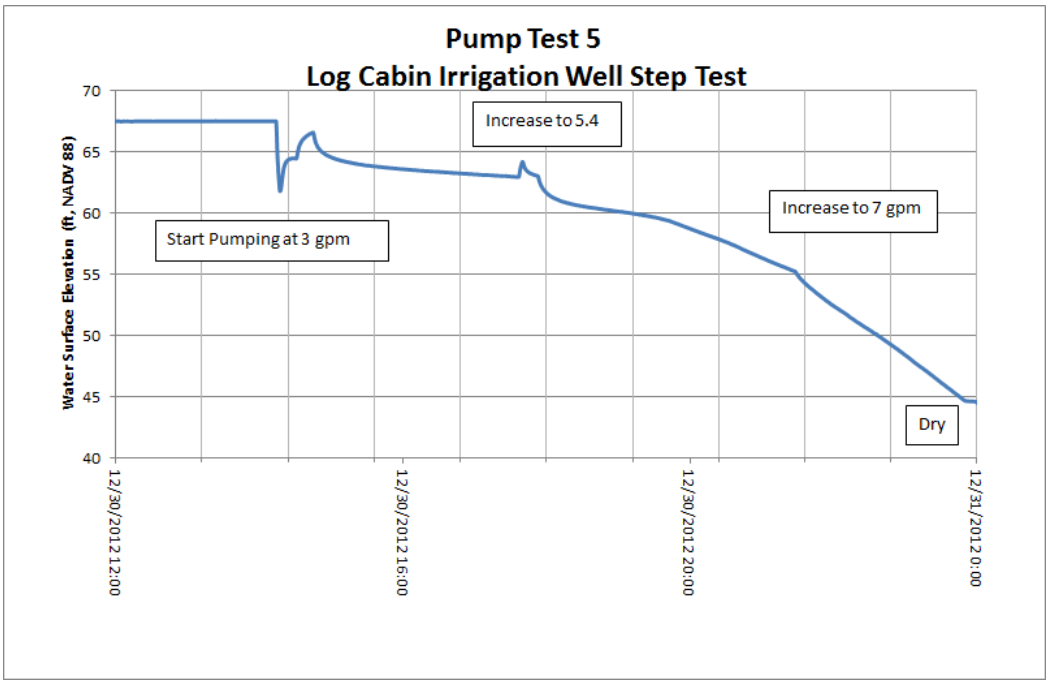


Figure 4. Step test results from Irrigation Well-1, located towards the log cabin.

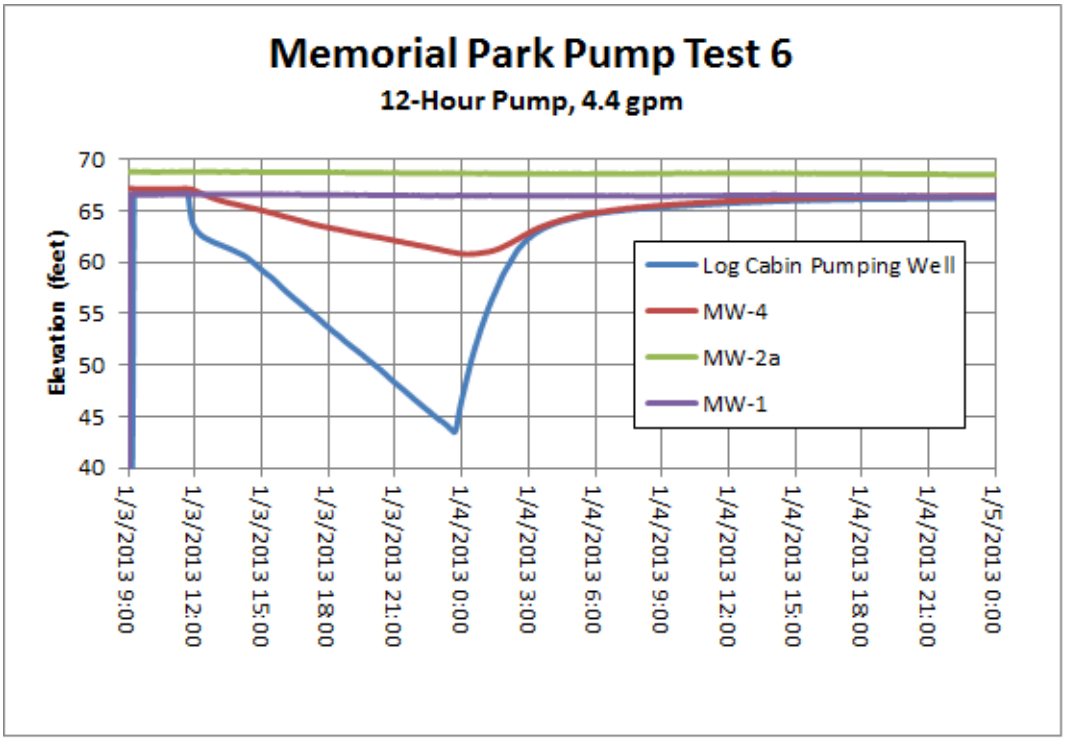


Figure 5. 12- Hour Constant Rate Test with IR-1.

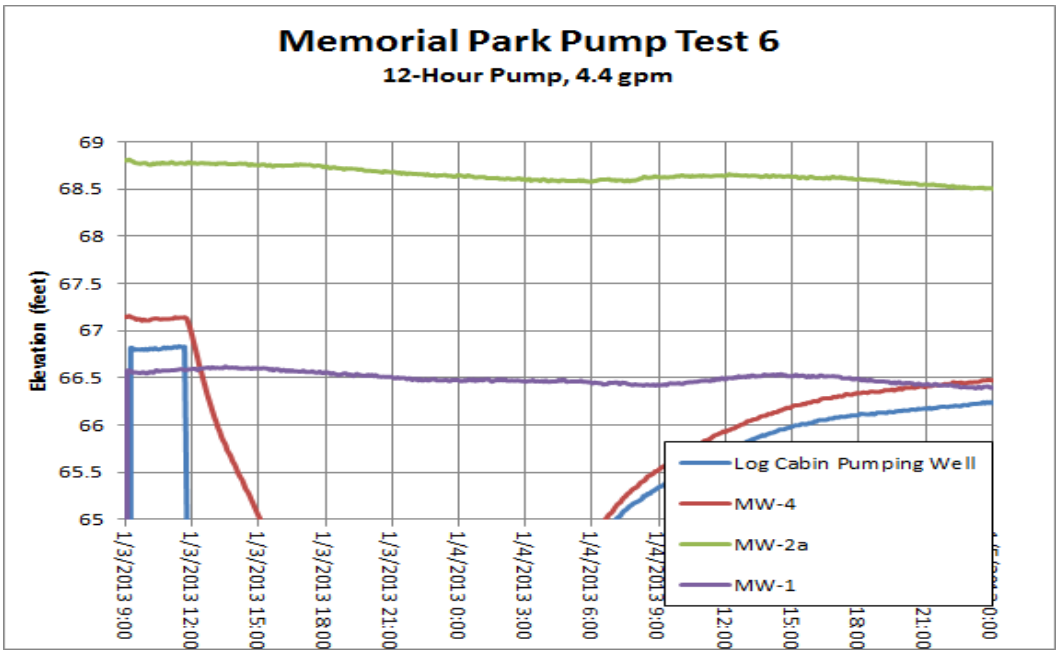


Figure 6. 12- Hour Constant Rate Test at the Log Cabin irrigation well (IR-1), zoomed to show the response in MW-2a and MW-1.

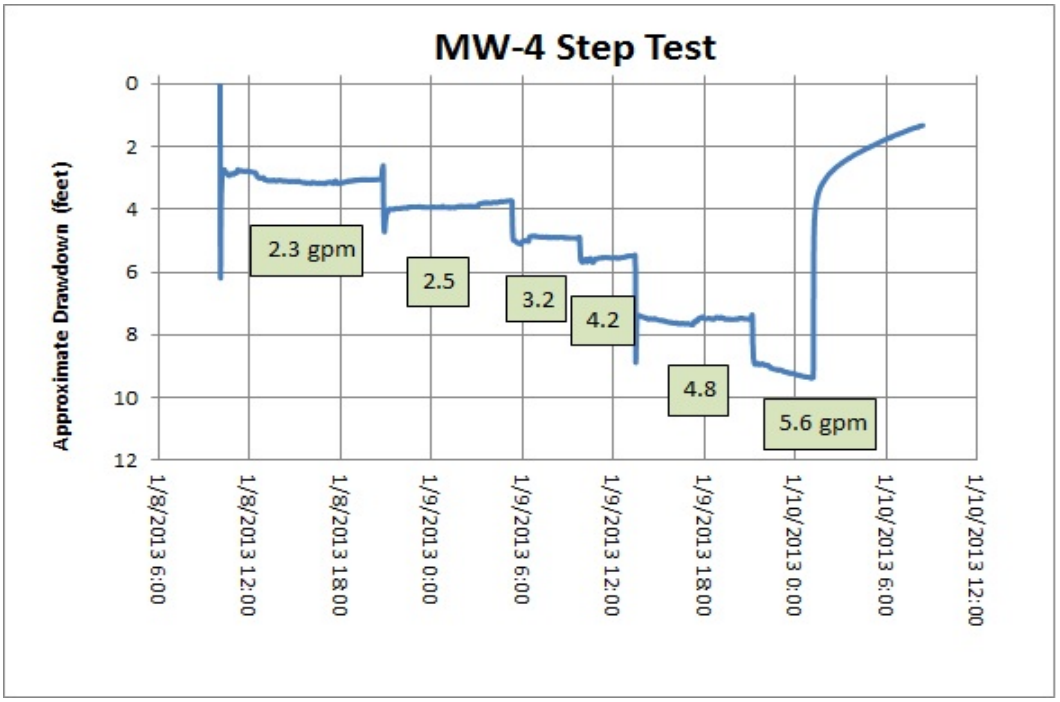


Figure 7. This step test was interrupted by someone unplugging the pump at 1 am, but it seems to indicate a sustainable pumping rate of somewhere between 4.8 and 5.6 gpm. Test 8, however, indicated that even 4.5 gpm was too high.

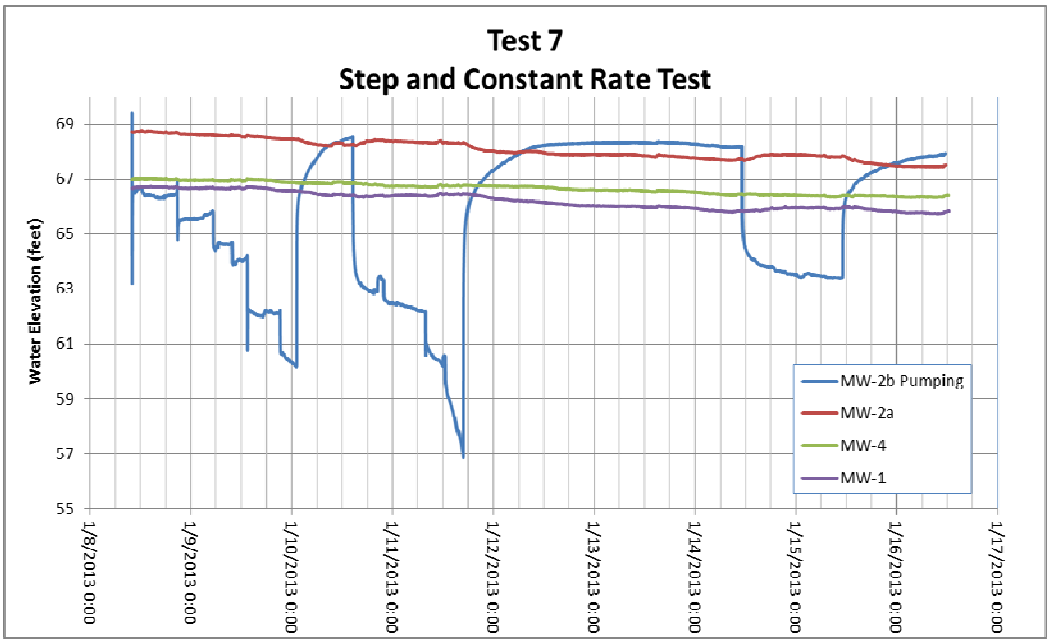


Figure 8. Step drawdown tests of MW-2b along with a constant rate test at 3.9 gpm.

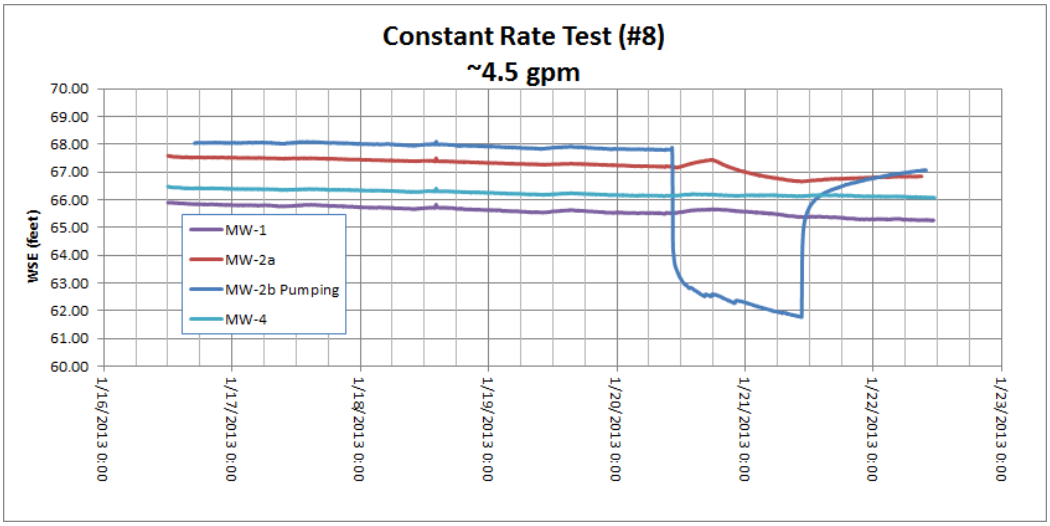


Figure 9. Another constant rate test pumping from MW-2b, this one at 4.5 gpm which seems to be slightly above the sustainable yield.

Appendix 5 to Attachment 3

Memorial Park Recreation Facility Assessment

RECREATION FACILITY ASSESSMENT

MEMORIAL PARK

TOWN OF SAN ANSELMO, CALIFORNIA

Abey Arnold Associates

January 2013

1005 A Street, Suite #305, San Rafael, California 94901 p 415-258-9580 f 415-258-9780 abeyarnold.com
CA Lic. #2616

Recreation Facility Assessment

A. Background:

Incorporated in 1907, the Town of San Anselmo began as a railroad stop in Marin County and has grown into a vibrant community of approximately 12,500 residents. San Anselmo's population surged with the prosperity of the 1920's as families moved in and businesses began locating within the town. In 1924, the Town purchased 7 acres of land to build 'Recreation Park', which was later renamed 'Memorial Park'. Adjacent to the site, the 'Log Cabin' was built by the American Legion and Boy Scouts of America in 1933, and coupled with Memorial Park the area became the center of recreation activity and remains today a significant historical and multi-generational community place.

According to the San Anselmo Historical Museum, Memorial Park's first recreation activity was baseball and by the 1930's, the sport was drawing competitive players from around Marin County and was home to a semi-pro team. Sunday games at Memorial Park were extremely popular community events, often drawing 500 spectators. Over the years, the Town has expanded the recreation offerings at the Park to include baseball and softball fields with soccer play overlayed into the outfield areas. Other improvements include a snack shack and restroom building, 4 tennis courts, basketball courts, children's play areas, picnic areas, and a passive use strolling garden called the 'Elder's Garden'.

At 8.75 acres, Memorial Park contains the most diverse recreational opportunities in San Anselmo in one large site. Its central location and proximity to residential neighborhoods make the park an easy excursion for families from San Anselmo and other nearby communities. On weekday mornings, Millennium Playground draws toddlers, their parents and caretakers and bustles on weekends with older children. The picnic area adjacent to the playground is often the site of birthday parties and other gatherings.

The Memorial Park baseball and softball fields are in use from February through May for youth sports practices and games (see Exhibit 1). After school youth sports such as soccer and flag football are scheduled for the fields in the fall. Tennis courts at Memorial Park are used year round for youth and adult instruction, match play, and drop-in play by residents. Sports fields and tennis courts within San Anselmo and the greater Marin County area receive heavy use due to lack of facilities and the popularity of sports activities. There is also a strong, embedded community culture of health and fitness due primarily to the proximity of breathtaking open space that encourages hiking, running and biking and other outdoor activity. Parking at Memorial Park can be challenging at peak times, forcing parents to park illegally in the nearby shopping center or circle the neighborhood for residential parking.

Community involvement and volunteerism have been a constant theme throughout the history of the Park. Millennium Playground was built in May 2000 to replace existing play equipment, spearheaded by two local parents that raised $220,000. The design and construction was a grassroots effort where San Anselmo children provided design ideas, town landmarks inspired features depicted on play structures and 1,500 community volunteers constructed the park in 1 week. Materials and services were donated

from local contractors, as was food from local eateries to feed the volunteers. Seatwalls and paving include donor insignia and custom mosaic tile decorations. The play structures consist of a series of 'fortresses' linked by a labyrinth of decks and steps that are made predominantly of wood, with accessories such as slides, swings, and climbing apparatus attached.

The Elder's Garden, located in the northwest corner of the Park, was constructed as a contemplative space that offers opportunities for school age children to learn about gardening. Elder's Garden was built and is maintained by a group of volunteers.

B. Current Park Conditions

While Memorial Park is well used and functional, improvements have not kept up with current safety and ADA accessibility standards and many park elements are in bad repair exacerbating maintenance needs. Although San Anselmo's General Fund supports the maintenance and upkeep of the town's parks, the park has suffered through heavy usage and deferred maintenance. Capital improvement funds are insufficient to cover the many upgrades needed. Areas of the park are in dire need of renovation to improve user experience, extend and expand the recreation programs available and accommodate more users. For example, areas of turf fields are soggy year round and do not drain correctly, most likely due to a combination of subgrade compaction and a limited ability to adjust the outdated irrigation system. To maintain a safe and usable field throughout the year, San Anselmo's Parks and Recreation Department is forced to close fields for use during December and January and restrict the field use to low intensity school-age soccer programs in February.

At Memorial Park, various use areas were added over a series of decades creating the multi-use park that stands today. Unfortunately, circulation and an ADA accessible path of travel, were either not required or added in an ad-hoc fashion, creating a site that is minimally compliant to some areas of the park, but not all. Much can be done to design and re-grade the site to offer accessibility to all use areas in a convenient way that is integrated with the overall circulation system of park pathways. In addition, the current park layout does not accommodate disabled persons who require wheelchair access adequate use of the site in a way that allows them to participate or observe activities by providing spaces for wheelchairs next to benches, bleachers and picnic areas. While Millennium Playground has some accessible elements, the majority of play elements are not accessible and more should be done to allow and encourage use by people with disabilities.

C. Proposed General Improvements to the Park

By redeveloping Memorial Park to provide dual-use as a multi-purpose park and flood control basin, the Town of San Anselmo can enhance the community's recreation experience with a facility that is safe, functional, and ADA compliant while preparing for potentially catastrophic storm water events. The current Concept Plan would lower the existing Memorial Park site approximately 10' and include a 9' berm to create a detention basin capable of capturing and detaining creek flows during a 100-year flood event. Given the Town's history of devastating storm-related floods, the most recent occurring in 2005, there is ample reason to actively plan for the future. Constructing a dual-use detention basin at Memorial Park will serve as an investment in the community by protecting San Anselmo homes,

business, and public facilities with necessary flood control while allowing for the redevelopment of the Park which is severely needed to keep pace with recreation demands and infrastructure requirements.

An upgraded field and irrigation system will increase public use of the Park by allowing the Parks and Recreation Department to expand the sports programs and use the fields for longer periods throughout the year while reducing field upkeep and maintenance costs. Pathways and park elements will be ADA accessible, accommodating to a larger extent people with disabilities compared to the current park. Park improvements will integrate elements of low impact design, including bioswales to reduce stormwater run-off, grey water collection for irrigation use, and drought tolerant native landscape plants. On the east side of the park, a historical creek currently buried in a culvert, will be daylighted and re-established and become part of a new 'Nature Grove' that will highlight the Town's intertwining respect and admiration of the natural environment that surrounds it.

All current park uses will be reincorporated into the redesign of Memorial Park and there are opportunities for elements of the Elder's Garden to be integrated into the Nature Grove. A comparison of use areas between the existing park and proposed park plan indicates that program elements remain virtually the same.

Table 1: Comparison of Existing and Proposed Park Elements

Existing Park Elements:	**Proposed Park Elements:**
3 Little League / Softball Fields	3 Little League / Softball Fields
1 Soccer Field (overlay)	1 Soccer Field (300' x 175' overlay)
1 Batting Cage	*(not part of proposed park plan)*
1 Snack Shack	1 Snack Shack with restroom attached
1 Restroom (2 men's and 2 women's stalls)	2 Restroom locations; each will include 2 stalls (M and W) and storage room.
4 Tennis Courts (2 lighted)	3 Tennis Courts, all lighted
1 Basketball Court (Full)	1 Basketball Court (Full)
Children's Play Area (pre and school age areas)	Children's Play Area (pre and school age areas)
Picnic Areas with Tables and Barbeques	Picnic Areas with Tables and Barbeques
Elder's Garden	*(will be incorporated into Nature Grove)*
Parking Lot (48 spaces)	Parking Lot (53 spaces)
	Nature Grove natural area adjacent to re-established historic creek.

D. Specific Park Improvements

To illustrate the need for improvements to Memorial Park, an analysis of current park conditions was performed and compared to the proposed concept plan to determine how key issues will be addressed.

1. Park Circulation, Parking and Restroom

The layout of site elements and circulation system of Memorial Park evolved over many decades, but needs to be re-evaluated to meet current user needs and space requirements.

Existing Deficiency:	Proposed Improvement:
ADA accessible path of travel does not extend to each park use area.	ADA accessible path of travel would be extended to each use area to comply with local, state and Federal requirements.
Uneven and hazardous paving surfaces due to cracking, ponding of water and differential subgrade settlement.	Re-design and construction to provide gradual grade transitions for safer pedestrian movement and direct stormwater to bioswales and retention areas reducing maintenance.
Parking lot at or near capacity during peak periods.	Parking lot expanded to accommodate 10% more cars.
One existing restroom on site that is not centrally located; needs to accommodate more users during peak park use.	One smaller restroom at north and south ends of park (2 restroom buildings total) to provide easier access for park users.

2. Site Drainage, Landscape and Irrigation

The landscape design and irrigation system at Memorial Park is a patchwork of improvements over many decades. Many mature trees and shrubs exist on site and the turf field has not been replaced in recent memory, with reseeding taking place instead.

Existing Deficiency:	Proposed Improvement:
Due to poor drainage, ADA accessibility and improper drainage is causing maintenance and safety issues such as soggy turf and uneven pavement settling.	Re-grade and re-design site to manage and minimize stormwater run-off by directing into bioswales and drain lines.
Turf grass needs replacement due to uneven growth and soggy areas due to poor drainage.	Correct drainage and grading deficiencies and replace turf grass with appropriate turf blend that regenerates well and requires moderate water.
Turf field irrigation system is outdated, inefficient and a constant source of maintenance attention due to leaking, etc.	Design and installation of new irrigation system will speed delivery of water to fields and use less water than current system and extend period of field use and require less man hours to maintain.
Landscape irrigation system is inefficient.	Re-design irrigation system to include use of grey water to irrigate landscape plants, reducing potable water usage.

3. Baseball and Softball Fields

Although beloved and well used, the baseball and softball field facilities are in need of major upgrades. The proposed design for Memorial Park would address the current deficiencies in the baseball and softball fields, including the following:

Existing Deficiency:	Proposed Improvement:
Areas surrounding bleacher and dugout areas are not ADA accessible and have insufficient clear space around bleachers for circulation of pedestrians and wheelchairs.	Path of travel and stationary wheelchair landing areas would be established adjacent to bleachers and other seating areas. Walkway widths would be widened to improve flow pedestrians and spectators.
The baseball field utilizes a dugout which is approximately 2' below-grade accessed by steps without handrails. Baseball and softball dugouts are relatively small and are not ADA accessible.	All dugouts would be enlarged to accommodate adult players and equipment as well as ADA access.
The southwest softball field includes raised, built-in concrete bleachers that lack safety railing. Bleachers for all fields are in need of replacement and relocation to bring in-line with current safety and accessibility standards.	Bleachers for baseball and softball fields will be replaced and relocated to allow for adequate clearance and safety requirements.
No drinking fountains adjacent to ball fields.	Drinking fountains to be added at each field.

4. Tennis Courts and Basketball Courts

The first 2 tennis courts at Memorial Park were built in the early 1960's (courts 1 and 2) and court lighting was added in the late 1960's. In the 1970's, 2 more courts (courts 3 and 4) were added. Using the State Bond funds for Park Improvement 2000, San Anselmo was able to re-surface courts 3 and 4 in 2007. Analysis of current tennis court lighting system has not been performed, but newer light fixtures offer improved energy efficiency and cut-offs to reduce light spillage into neighboring areas. Basketball facility consists of 2 full courts intersecting each other. All basketball standards show wear, but are usable.

Existing Deficiency:	Proposed Improvement:
Paving on tennis Courts 1 and 2 cracked in several places.	Relocate tennis courts. Improve longevity of courts by designing to meet high performance subgrade, grading and drainage requirements.
Basketball court layouts intersect each other.	Revise layout or remove one full court.
Basketball court is cracked in several places.	Improve longevity of courts by designing to meet high performance subgrade, grading and drainage requirements.

5. Millennium Playground

The Millennium Playground is a fantasy-themed playground with areas for two age groups: under seven and seven and over. The larger of the two areas, for older children, is a collection of unique, labyrinth and fortress-like structures that were built by community volunteers primarily with wood and a recycled plastic product with off-the-shelf items such as slides, swings and climbing apparatus attached. To reach the top of a structure, children navigate a series of steps and platforms and descend the structure using a slide. A Large concrete dinosaur hovers near the sand play area. Multiple swings were installed as part of the original design, but have since deteriorated and become a constant maintenance and safety concern. The pre-school age area incorporates bucket swings, bouncer-type equipment, a small play structure and sand pit.

The play area layout is linear with one point of entry serving both age group areas and separated by a low wood fence. Wood chip-type surfacing is used throughout both play areas as the safety surfacing. Benches and some trees line are placed at the perimeter of the play area. Outside the playground, low walls feature decorative animal-themed water spouts. Artistic mosaic flourishes adorn other walls and donor brick paving are evidence of the community spirit.

Existing Deficiency:	Proposed Improvement:
Wood chip depth varies at entrance to play areas creating non-ADA compliant area.	Play area to provide access ramps into play areas that use wood chip-type surfacing or provide resilient safety surfacing at-grade with adjacent paving.
Playstructure platforms, stairways, and other features do not meet current standards for playground safety.	Play areas to meet current ADA and safety requirements.
Some wood elements on playstructure are deteriorating, becoming loose and/or splintering.	Play areas to meet current ADA and safety requirements.
Linear layout and 'fortress-type' structures make it difficult to visually monitor of children, especially if both play areas are involved.	Re-design of play area to address re-use of existing elements (Dinosaur, Tower, etc.)
Sand play areas are not ADA accessible.	Play areas to meet current ADA and safety requirements.
Play area lacks adequate shade in the summer.	Play area to include overhead shade structures and/ or extensive shade trees.

6. Picnic Areas

There is one primary picnic area at the north end of the park which is frequently used and available for reservation through acquiring a permit from the Parks and Recreation Department. A casual grouping of picnic tables exists in the southwest corner of the park next to the softball field.

Existing Deficiency:	Proposed Improvement:
Paving surface at picnic areas is decomposed granite which has settled, creating low spots with large puddles and thresholds at adjoining paved areas which are not ADA compliant and tripping hazards.	Picnic to be contained within an accessible paving space with longitudinal and cross slopes of less than 2%.
3 Group Picnic Areas, 14 tables total.	5 Group Picnic Areas to serve a larger variety of park use areas. 31 tables proposed.
1 ADA accessible picnic table	ADA accessible picnic tables to make up a higher proportion of picnic tables.
Barbeques need replacement due to age and use.	Barbeques to be replaced and relocated for safety and accessibility.
Lack of adequate shade in warmer months.	Add shade trees in and around picnic areas to provide shade and to identify picnic space.
Southwest picnic area is not ADA accessible.	Remove tables or provide a designated picnic area space adjacent to the softball field that is ADA accessible.

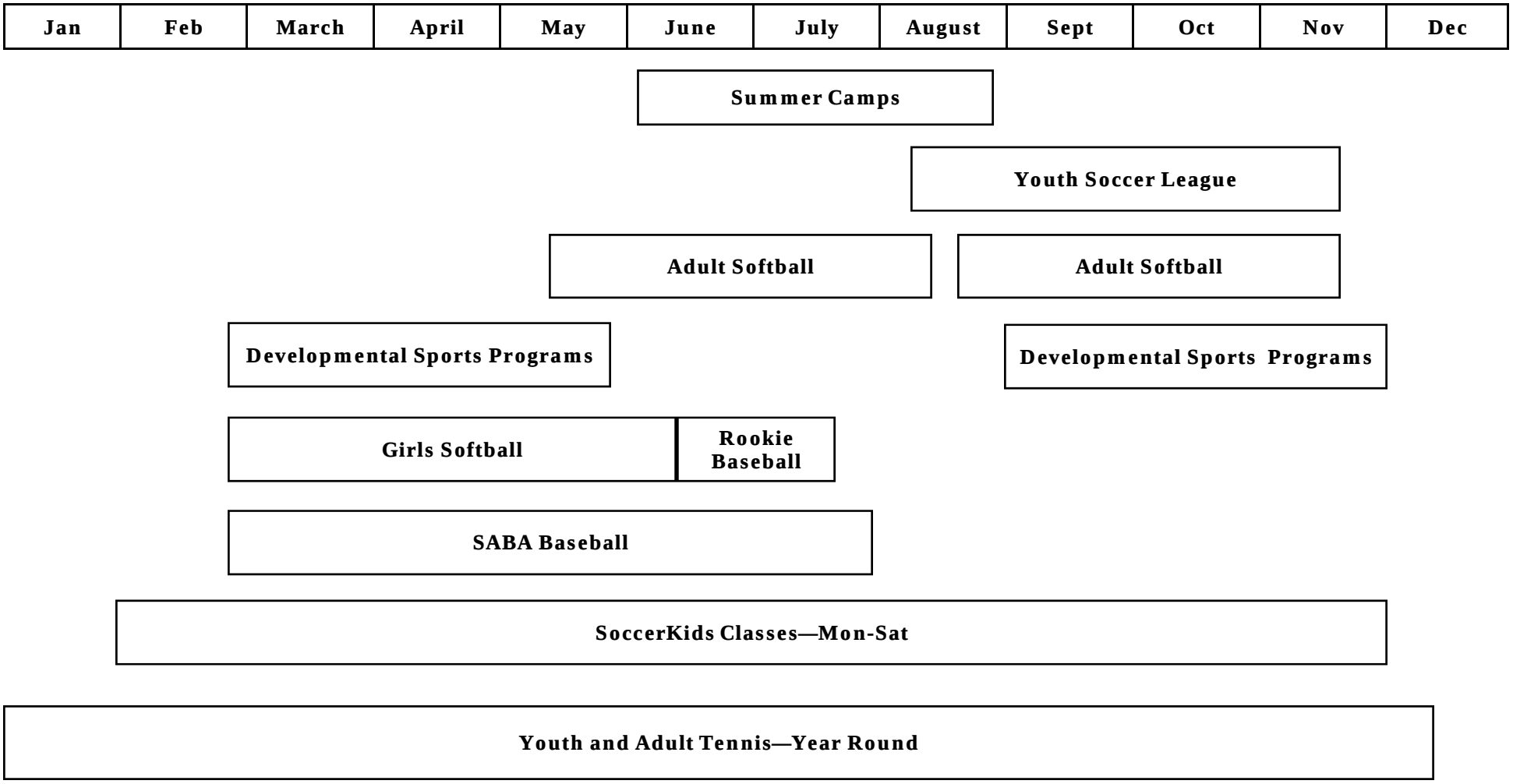
E. Monitoring Benefits

Measuring and determining benefits to park users and the community through improvement of park facilities can be achieved by comparing key metrics *before and after* park improvements are complete. After park improvements are completed, analysis of key metrics should reveal the following:

- Increase in number of hours programmed for park facilities.
- Increase in number of programs and/or participants in outdoor programs
- Increase in permits requested for facility reservation.
- Increase in tennis court key requests by community residents.
- Increase in cars using parking lots at peak times.
- Reduction in potable and overall water usage.
- Reduction in electricity usage.
- Reduction in maintenance hours devoted to Memorial Park for issues other than routine maintenance.
- Reduction in user complaints regarding facility safety and/or maintenance issues.

Exhibit 1 shows current average seasonal usage for Memorial Park's recreation programs.

MEMORIAL PARK SPORTS FIELDS—ANNUAL USE SUMMARY
ORGANIZED/SCHEDULED ACTIVITIES



Participation Numbers

Summer Camps: 1,100-1,300 total in all camps
Youth Soccer Leagues: 550 players/4o teams
Adult Softball: 12 teams, 140-150 players per season
Developmental Sports: 250-300 per season
Tennis Program: Year-round classes, 170-200 students

Girls Softball: 10 teams, 100-120 players
Boys Baseball (SABA): 17-20 teams, 180-220 players
Rookie Baseball: 4-6 teams, 60-70 players
SoccerKids: 45-60 kids per day, 5 days per week

Appendix 6 to Attachment 3

Public Meetings Information

Town of San Anselmo

Memorial Park Detention Basin Project

STAKEHOLDERS' MEETING

Saturday, November 3, 2012 – 9:00AM

Isabel Cook Community Center – Vista Room
1000 Sir Francis Drake Blvd. San Anselmo, CA

The Town of San Anselmo and the County of Marin are beginning discussions about the possibility of using Memorial Park as a detention basin to be activated when flooding is imminent. This is a complex project that will affect many people in our community.

The Town is convening a stakeholders' meeting to discuss the basic concepts of a detention basin in the park. Staff is interested in hearing your ideas, addressing concerns, and answering questions about this proposed project.

Flood Fee and Grant funding will be the primary sources of revenue for this project. The Town and County will be working together on grant applications, which will require a large amount of community involvement. Please don't hesitate to invite others who may be interested in being part of the process for this project.

For more information, contact David Donery at
ddonery@townofsananselmo.org or at (415)258-4640

Town of San Anselmo

Memorial Park Detention Basin Project

STAKEHOLDERS' MEETING

Saturday, November 3, 2012 – 9:00AM

Isabel Cook Community Center – Vista Room
1000 Sir Francis Drake Blvd. San Anselmo, CA

Publicity

The meeting notice was:

- delivered to all residents on San Francisco Blvd., both sides of the street between SF Drake and Veterans Way
- posted at the Isabel Cook Homes at the mailboxes
- posted at the Parkside Apts. at each set of mailboxes (6)
- delivered to the Log Cabin.
- delivered to representatives of the softball, baseball, tennis, soccer, eldersgarden and playground communities.

Announcement of the meeting was in the:

- Town Managers' newsletter
- Ross Valley Reporter
- Marin IJ
- San Anselmo Fairfax Patch
- News Flash on the Town website
- Town Facebook and Twitter sites

Memorial Park Detention Basin Project

STAKEHOLDER'S MEETING

Saturday, November 3, 2012 – 9:00AM

Isabel Cook Community Center – Vista Room

1000 Sir Francis Drake Blvd. San Anselmo, CA

AGENDA

1. Welcome and Introductions
    a. Elected Representatives
    b. Town Staff
    c. County Staff
    d. Project Engineering Staff
    e. Attendees

2. Brief History of Flooding Issues in San Anselmo

3. Overview of Flood Mitigation Planning Process to date

4. What is a Detention Basin?

5. Why Memorial Park?

6. Questions & Concerns

THE TOWN OF SAN ANSELMO

Memorial Park Detention Basin - Stakeholders' Meeting
Date: Sunday, November 3, 2012

	Name	Signature	email address (optional)
1	Stacey Kamp		Sakamp@comcast.net
2	ERIN BERGMAN		erinobergman@gmail
3	Mitch Young		mitchyoung@comcast.net
4	STEVEN BARTLEY		PANPAC1@COMCAST.NET
5	TONIA FAGUNDES		tonijjf@comcast.net
6	Tom Graves		thomas_graves@comcast.net
7	Sandy Guldman		sandra.guldman@gmail.com
8	Tom McInerney		tmm@odnas.com
9	Lori VACCARO		
10	Dwight Merriman		Kentfield CA
11	TAMSIN McVICKAR		San Anselmo CA
12	Louise L. Mathews		houston9150@yahoo.com
13	ROHANA MCLAUGHLIN		rohanamc@hotmail.com
14	Carey Lando		Clando@marincounty.org
15	Kathleen Holtzer		Katholtzer@yahoo.com
16	Sam Wilson		wilsonward@comcast.net
17	DAN MAGUIRE		dgmaguire@gmail.com
18	MARK MACHADO		SabaRez08@yahoo.com
19	Judy Van Kleeck		jvcave@yahoo
20	Rich Friedman		richfsports@yahoo.com

THE TOWN OF SAN ANSELMO

Memorial Park Detention Basin - Stakeholders' Meeting
Date: Sunday, November 3, 2012

	Name	Signature	email address (optional)
1	Greg Mihon	[signature]	gmihon@townofsananselmo.org
2	David Wrasoff	[signature]	WRINSOFF@IX.NETCOM.COM
3	Caralina Kvalstad	[signature]	drcaralina@gmail
4	Jeanne Baron	[signature]	iloveroux@comcast.net
5	RAFAEL ALONSO	[signature]	RAFAEL.ALONSO@COMCAST.NET
6	Bob Lewis	[signature]	bobcatpro@comcast.net
7	Doug Kelly	[signature]	dougkelly@performing-
8	Steve Burdo	[signature]	Stephen@Kathleenrussell.com
9	Ford Greer		
10	James Reilly	[signature]	
11	NANCY OSWALD.		NGOSWALD@HOTMAIL.COM
12			
13			
14			
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THE TOWN OF
SAN ANSELMO

San Anselmo News

Debra Stutsman, Town Manager
dstutsman@townofsananselmo.org
(415) 258-4652

October 19, 2012

Police Consolidation Update

As the anticipated date for consolidation with the Twin Cities Police Authority draws closer, the Town Council will be receiving an update on the process at every Town Council meeting, beginning with the October 23 meeting. If you are interested in learning more about what the consolidation will mean for San Anselmo, we invite you to come to our Town Council meetings. They are regularly held on the second and fourth Tuesday of the month, beginning at 7 p.m. in the Town Hall Council Chambers.

If you have any comments or questions regarding the consolidation efforts underway, please contact me at dstutsman@townofsananselmo.org or 258-4652.

Volunteers Needed

The following volunteer opportunities are available:

Open Space Committee – The Open Space Committee has the major responsibilities for the long-term planning of open space in and near San Anselmo, for the generation of community support and fund-raising to implement the plan. The Committee consists of eleven members and meets on the third Wednesdays at 7:30 pm in the Town Council Chambers. There are three vacancies.

Mosquito Abatement District Representative – The Board of Trustees of the Mosquito and Vector Control Districts consists of representative members who ensure the agency is responsive to the public health and comfort needs of the residents living within the district. The Board currently meets each month at 7:00 pm at the District Headquarters in Cotati. There is one seat available and residents are encouraged to apply.

For more information or an application, go to: http://www.townofsananselmo.org/index.aspx?nid=175 or contact Carla Kacmar at ckacmar@townofsananselmo.org or 258-4691. Applications for these openings should be submitted by Friday, November 2, 2012.

Library News

Renowned Bay Area storyteller Kirk Waller will share fun and not so scary Halloween tales at the San Anselmo Public Library on Monday, October 22, from 3:30-4:30pm. Kirk Waller will combine his talents for music, rhythm, and movement to create an unforgettable storytelling experience.

Families are welcome to come in costume. This event is best for children ages 4 and up and takes place in the Council Chambers.

Memorial Park Monitoring Wells

Next week you may notice some drill rigs working on the Memorial Park fields. This work is being done to install four monitoring wells that will be used to monitor groundwater levels in the park. This information is needed in order to apply for grant funding for the eventual use of the park as a detention basin for flood mitigation purposes. When the work is completed, the wells will be securely covered and not in the field of play.

The wells will need to be monitored for at least a year to determine what happens to the groundwater through the four seasons. This information will be critical in designing our new park.

In the meantime, there is a grant opportunity that we would like to apply for that would help us pay for the detention basin work and the park improvements. The application for the grant is due in January, 2013, but we do not anticipate that the project work would happen until at least 2016. There are a number of design, environmental and other permitting hurdles that must be satisfied first.

We are in the process of scheduling several public meetings that will solicit public input and options on the Memorial Park renovation and detention basin concept. We want to hear what our residents think about the proposal, what amenities our park must have and your ideas for other park needs.

Please keep an eye out in the newsletter for the dates of these upcoming meetings. If you have any questions or comments, we'd love to hear them. Just email or call me at dstutsman@townofsananselmo.org or 258-4652 and I'll make sure your comments get to the right people.

Marin Municipal Water District (MMWD) Work

In the next several weeks, MMWD will be doing some work on Red Hill Avenue, both in the eastbound and westbound directions in preparation for the Summer 2013 replacement of the water main running under the street. Work will include locating utilities, data collection, potholing and permanent repair of pavement. The work will be conducted between Tuesday, October 23 and Friday, November 2. Work will be limited to 10 a.m. to 3 p.m. in the commute direction so as not to slow traffic flow.

If you have questions or need further information, please contact Kevin McDonnell at MMWD at (415) 945-1976.

San Anselmo hosts public meeting on proposal to use Memorial Park as occasional catch basin

Posted: marinij.com

San Anselmo

The town of San Anselmo will hold a public meeting at 9 a.m. Saturday to discuss the possibility of using Memorial Park as a detention basin that would be put into use when flooding is imminent.

Flood fee and grant funding would be the primary sources of revenue for the project. The meeting will be in the Isabel Cook Community Center, 1000 Sir Francis Drake Blvd. in San Anselmo.

Send us your news: We want more news items from Marin's cities and towns. Email them to our City Desk at localnews@marinij.com, mail them to City Desk, Marin Independent Journal, 4000 Civic Center Drive, San Rafael, CA 94903, or fax them to 415-382-7209. For more information about towns in Marin, visit the IJ's website at marinij.com.

Ross Valley Reporter
11/14-20/12

Park stakeholders meet

San Anselmo News

Debbie Stutsman, town manager

On Saturday, Nov. 3, more than 30 people came to the Memorial Park stakeholders meeting to hear more about the possibility of utilizing Memorial Park as a detention basin in case of flooding. Participants heard a brief presentation on the Town's flooding history, the flood mitigation planning process to date, detention basins and their purpose, and why Memorial Park was chosen as one of the five possible sites for detention.

The main purpose of the meeting, however, was to hear comments and concerns and note the questions of participants. The entire community was invited, with special emphasis on the park stakeholders, which include the San Francisco Boulevard residents, Parkside Apartments, ICC Homes, Log Cabin, playground users, and sports groups, including tennis, baseball, soccer and softball.

The questions and concerns expressed at the meeting were thoughtful and insightful. A summary of the issues raised is provided below. More detailed information on the detention basin topic can be found at townofsananselmo.org/index.aspx?nid=669 as it becomes available.

What is the plan for making sure that current drainage is maintained or improved to ensure that neighboring properties aren't flooded?

Why can't you solve the flooding problem with stream modifications, such as enlarging the creek, rebuilding bridges, i.e. can we fix flooding without detention basins?

What are the construction impacts to neighbors, how long would the construction take, what would the park look like, and where would programs/games be held?

Who would assume liability for neighbors if they do experience adverse impacts from the basin?

How much water would be detained at Memorial Park?

If used for detention, who returns the park to its original state and how long would it take? Concerns were expressed about sewage and debris in the floodwater.

Would there be improvements to Memorial Park done in this process? Would artificial turf be used?

Who would be in charge of activating the use of the detention basin during imminent flooding?

Would the detention basin be designed for an earthquake and flood happening simultaneously?

Would this create a new flood plain and would it affect neighborhood property values and home insurance coverage?

Has thought been given to the potential effects of climate change?

Would native plants be utilized in the park, especially around the creek?

Answers to many of these questions will be uncovered as we move forward with the process. Because this is the very beginning of the project, we don't have complete answers to many of the questions. Rather, the questions will guide us as we work closely with the county and other professionals to install monitoring wells and submit for available state grant funding. Work done between now and the grant application deadline of January is only the first step and doesn't set a design in stone.

Holiday lights

Do you have holiday string lights? California Youth Energy Services (CYES), a program of the nonprofit organization Rising Sun Energy Center, will be hosting two holiday light swap events this season:

- Saturday, Dec. 1, noon-5 p.m. at the Northgate Mall
- Saturday, Dec. 8, 8 a.m.-noon. "Breakfast with Santa" San Rafael Community Center, 618 B St., San Rafael.

A light swap was held at the Albert J. Boro Community Center in San Rafael on Saturday, Nov. 10.

Bring in your old incandescent holiday lights, and they will swap them for brand new, energy-efficient LED holi-

See **SAN ANSELMO** *B6*

Town of San Anselmo

Memorial Park Dual-Use Facility

COMMUNITY MEETING

Monday, December 3, 2012 – 7:00PM

Town Hall Council Chambers
525 San Anselmo Avenue, San Anselmo, CA

The Town of San Anselmo and the County of Marin are beginning discussions about the possibility of using Memorial Park as a detention basin to be activated when flooding is imminent. This is a complex project that will affect many people in our community.

The Town is convening a community meeting to discuss the basic concepts of a detention basin in the park. Several conceptual drawings of the dual-use facility will be shown at the meeting. Staff is interested in hearing your ideas, addressing concerns, and answering questions about this proposed project.

Flood Fee and Grant funding will be the primary sources of revenue for this possible project. The Town and County will be working together on grant applications, which will require a large amount of community involvement. Please don't hesitate to invite others who may be interested in being part of the process for this project.

For more information, contact Gerhard Epke at
gepke@townofsananselmo.org or at (415)258-4653

1. Town newsletter 11/21/12
2. email list of interested parties
3. website
4. Public Notice bulletin board
5. Posted at ICC Homes & mailed
6. direct mail 300'

Memorial Park Detention Basin Project

COMMUNITY MEETING

Monday, December 3, 2012 – 7:00 PM

San Anselmo Town Hall, 525 San Anselmo Avenue,
San Anselmo, CA

AGENDA

1. Welcome and Introductions
    a. Elected Representatives
    b. Town Staff
    c. County Staff
    d. Project Engineering Staff

2. Brief History of Flooding Issues in San Anselmo (Sean)

3. Overview of Flood Mitigation Planning Process to date (James)

4. What is a Detention Basin and why Memorial Park? (Sean)

5. Presentation of alternative designs (Peter)

6. Questions & Concerns

THE TOWN OF
SAN ANSELMO

San Anselmo News

Debra Stutsman, Town Manager
dstutsman@townofsananselmo.org
(415) 258-4652

November 21, 2012

Memorial Park Dual Use Facility Community Meeting

Please join us on Monday, December 3, at 7 p.m. in the Town Hall Council Chambers to hear more about the possibility of using Memorial Park as both a park and a flood water detention facility.

This is the second in a series of meetings that is intended to provide an opportunity for the community to learn more about how detention basins work, ask questions, and express concerns. In addition, we will present several drawings that show possible configurations for the proposed dual use facility. Town staff, in conjunction with County Flood Zone 9 staff and Stetson Engineers, is working to prepare a grant application for possible funding for this project.

At this point in time, this project is very conceptual and we do want to hear your comments and concerns! If you have any questions, please call Gerhard Epke at 258-4653.

Police Consolidation Update Summary

Over the past three years the San Anselmo Police Department and the Twin Cities Police Authority have been collaboratively working together toward Police Consolidation through the sharing of services. This sharing of services has allowed each agency to increase the resources available to them while reducing redundancies.

This public process has encompassed eighteen public meetings, two State of the City/Town addresses, two joint Chamber of Commerce meetings, and the San Anselmo Strategic Planning meeting. Our sharing of services model was reported by the Marin County Civil Grand Jury as a model for other communities to follow. In addition, the process has been publicized on the websites of all three towns/city, appeared numerous times in individual newsletters and has been offered to our citizens via a printed brochure.

Throughout this process, we have maintained a fully operational 24/7 police station in San Anselmo, and will continue to do so once the consolidation is complete. A full complement of police officers is assigned to San Anselmo and conducts police operations out of the San Anselmo Police facility. Five fully equipped police cars are assigned to the San Anselmo Police Station along with three police motorcycles. These vehicles don't traverse back and forth

Debbie Stutsman

Contact Group Name: Memorial Park Detention Basin 12-17-2012

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THE TOWN OF SAN ANSELMO

Memorial Park Detention Basin - Community Meeting
Date: Monday, December 3, 2012

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18	Jeanne Lane + Bob Bornstein	jeanne_lane@comcast.net
19	Nathan & Devon Yanko	threeospades@yahoo.com
20	FRANK EGGER, PRESIDENT, RVSD	fegger@pacbell.net

THE TOWN OF SAN ANSELMO

Memorial Park Detention Basin - Community Meeting
Date: Monday, December 3, 2012

	Name	Email Address
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2	Jim and Gina Hughes	fitbadaft@gmail.com
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4	STEVEN BARTLEY, AMERICAN LEGION	PANPAC1@COMCAST.NET
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9	JOHN BARTOLOMI	johnbartolomi@hotmail.com
10	CANDY MITCHELL	candykness@comcast.net
11	Barry Spitz	BZSPITZ@aol.com
12	Pete Newcome	pbnewcome@gmail.com
13	RAFAEL Escandón	RAFAELE12@yahoo.com
14	Rebecca Bvgas	25 San Francisco Blvd; rlbvgas@gmail.com
15	Jonica Tagnesha	28 L.T. Blvd - SA.
16	Kathleen Walker	WAC004@yahoo.com
17	Erik Stromberg	estromberg@gmail.com
18	Lance L. Chrissie	tahoehawk@comcast.net
19	Cara Schumacher	cara.schumacher@gmail.com
20	Bob Lewis	bobenTpro@comcast.net

THE TOWN OF SAN ANSELMO

Memorial Park Detention Basin - Community Meeting
Date: Monday, December 3, 2012

	Name	Email Address
1	ROSEANN DAL BELLO	dalbello@SONIC.NET
2	Stan Bluhm	ssbluhm@gmail.com
3	BRET MORGAN	bret@bretmorgan-com
4	Louise M. Matheus	houston9150@yahoo.com
5	Doug Kelly	
6	Joshua Zucker	Joshua@Joshuazucker.com 1026 SFD BLVD.
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Town of San Anselmo

Memorial Park Dual-Use Facility

COMMUNITY MEETING

Tuesday, February 5, 2013 – 7:00PM

Town Hall Council Chambers
525 San Anselmo Avenue, San Anselmo, CA

The Town of San Anselmo and the County of Marin are beginning discussions about the possibility of using Memorial Park as a detention basin to be activated when flooding is imminent. This is a complex project that will affect many people in our community.

The Town is convening a third community meeting to discuss the basic concepts of a detention basin in the park. Several conceptual drawings of the dual-use facility will be shown at the meeting and are available on the Town's website at http://www.townofsananselmo.org/index.aspx?nid=669. Staff is interested in hearing your ideas, addressing concerns, and answering questions about this proposed project.

Flood Fee and Grant funding will be the primary sources of revenue for this possible project. The Town and County will be working together on grant applications, which will require a large amount of community involvement. Please don't hesitate to invite others who may be interested in being part of the process for this project.

For more information, contact Gerhard Epke at
gepke@townofsananselmo.org or at (415)258-4653

Photos of Memorial Park (January 28, 2013)

Looking southeast, baseball field and eucalyptus trees in background. Daylighted Sorich Creek generally follows alignment of the trees.

Looking west at Sunny Hill Drive which will be elevated, and tennis and basketball courts which will be replaced.

Looking north along alignment of buried culverted Sorich Creek which will be daylighted/restored.

Looking west at picnic area and childrens playground which will be replaced.

Undersized culvert at Los Angeles Road which will be removed/replaced with pre-fab single lane bridge and creek restored.

Looking south across park.