DRAFT REPORT

TASK 2.0, PRELIMINARY GEOTECHNICAL AND FOUNDATION ENGINEERING REPORT

Sonoma Marin Area Rail Transit Project
Petaluma River Bridge
Petaluma, California

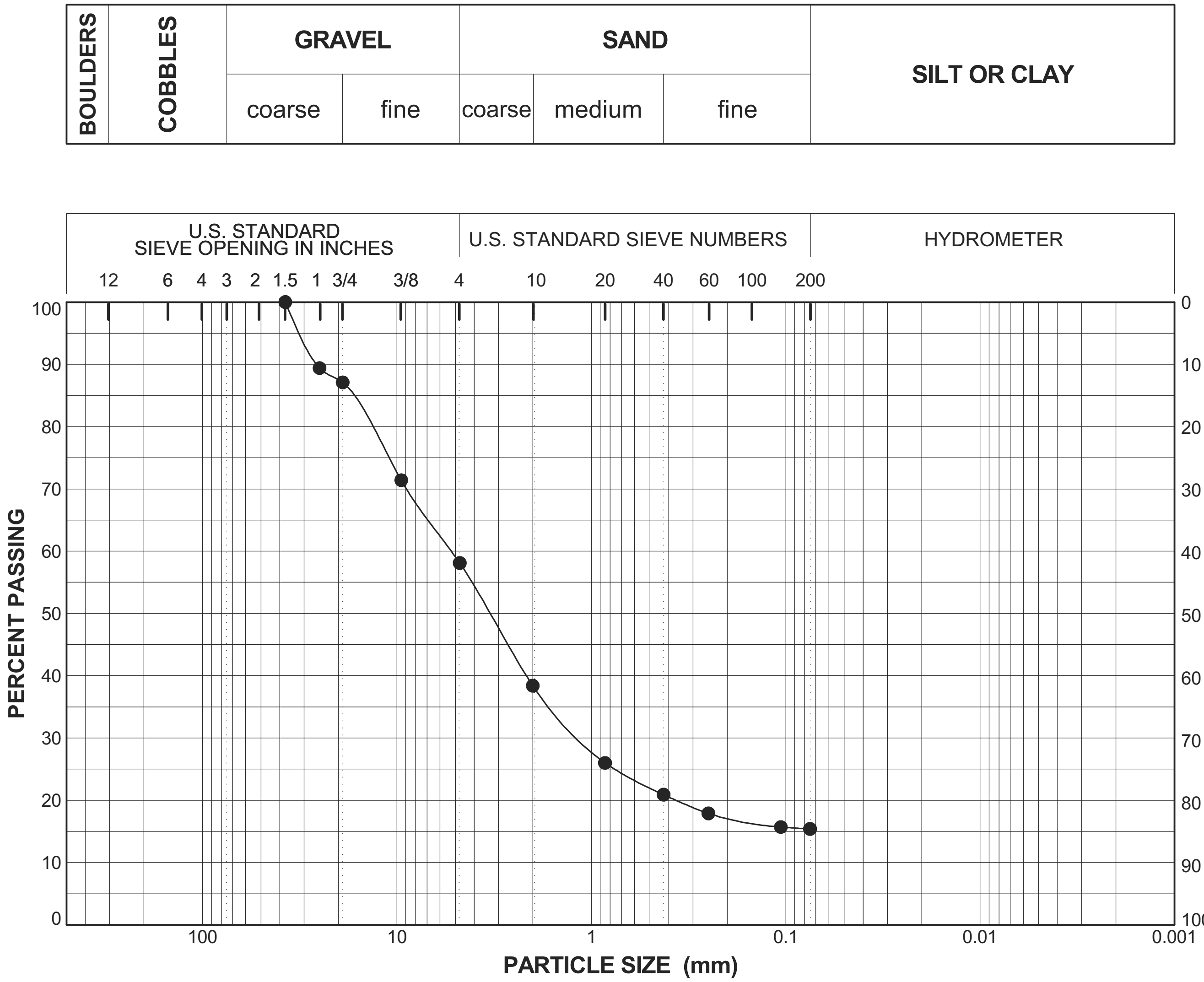
Prepared for
Sonoma-Marin Area Rail Transit District
490 Mendocino Avenue, Suite 102
Santa Rosa, CA 95401

December 10, 2010

URS

1333 Broadway, Suite 800
Oakland, CA 94612

26817889



Boring Number	Sample Number	Depth (feet)	Symbol	%G	%S	%F	Classification
PR-2	PR2-6	30-31.5	●	42	43	15	Clayey Sand with Gravel (SC)

SMART Major Bridges
Petaluma, California
26817624

PARTICLE SIZE DISTRIBUTION CURVES

URS

Figure B-2

Appendix E Scour Analysis

1243 Alpine Road, Suite 108
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Caulfield Lane over Petaluma River Moveable Bridge Project
City of Petaluma, CA
Contraction Scour

100-year Flow
Calculation guideline from HEC-18 5th Edition
Proposed Double Leaf Bascule Bridge

Units = (SI or English)	English	
Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	4.1	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	13.4	ft
Ychannel = depth of flow just upstream of bridge in channel =	13.1	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.8	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	10494	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	10494	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	198	ft
W2 channel = top width of the contracted channel section less pier widths =	199	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.4	ft/s
V* channel/ω channel =	0.4	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.59	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	13.0	ft
Ys channel = Y2 channel - Yo channel =	**0.0**	**ft**

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100-Year Flow with MHHW
Calculation guideline from HEC-18 5th Edition
Proposed Double Leaf Bascule Bridge

Units = (SI or English)	English	
Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	5.2	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	10.7	ft
Ychannel = depth of flow just upstream of bridge in channel =	11.1	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.7	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	10494	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	10494	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	193	ft
W2 channel = top width of the contracted channel section less pier widths =	193	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.5	ft/s
V* channel/ω channel =	0.6	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.64	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	11.1	ft
Ys channel = Y2 channel - Yo channel =	**0.4**	**ft**

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Units = (SI or English)	English	
Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	7.3	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	8.0	ft
Ychannel = depth of flow just upstream of bridge in channel =	8.7	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.5	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	10494	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	10494	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	180	ft
W2 channel = top width of the contracted channel section less pier widths =	180	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.7	ft/s
V* channel/ω channel =	0.8	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.64	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	8.7	ft
Ys channel = Y2 channel - Yo channel =	**0.6**	**ft**

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Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	4.9	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	14.5	ft
Ychannel = depth of flow just upstream of bridge in channel =	7.0	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.4	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	13694	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	13694	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	200	ft
W2 channel = top width of the contracted channel section less pier widths =	200	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.3	ft/s
V* channel/ω channel =	0.4	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.59	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	7.0	ft
Ys channel = Y2 channel - Yo channel =	**0.0**	**ft**

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Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	6.5	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	11.2	ft
Ychannel = depth of flow just upstream of bridge in channel =	11.4	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.7	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	13694	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	13694	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	185	ft
W2 channel = top width of the contracted channel section less pier widths =	194	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.6	ft/s
V* channel/ω channel =	0.7	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.64	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	11.1	ft
Ys channel = Y2 channel - Yo channel =	**0.0**	**ft**

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Contraction Scour

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Units = (SI or English)	English	
Ku = constant = 6.19 (SI) or 11.17 (English)	11.17	
g = acceleration due to gravity =	32.2	ft/s^2

Channel

Vchannel = Mean velocity of flow in main channel just upstream of bridge =	8.1	ft/s
D50channel = grain size in channel for which 50% of bed material is finer =	0.0108	ft
Yochannel = existing depth in the contracted channel section before scour =	9.1	ft
Ychannel = depth of flow just upstream of bridge in channel =	10.0	ft
VcD50channel = Ku*(Ychannel^(1/6))*(D50channel^(1/3))	3.6	ft/s
Contraction scour equation for channel =	**Live Bed Equation**	

Live Bed Equation

Q1 channel = Flow in the upstream channel transporting sediment =	13694	ft^3/s
Q2 channel = Flow in the contracted channel = transporting sediment =	13694	ft^3/s
W1 channel = top width of the upstream channel that is transporting bed material =	170	ft
W2 channel = top width of the contracted channel section less pier widths =	189	ft
ω channel = fall velocity of bed material based on D50 =	0.82	ft/s
S channel = slope of energy grade line in main channel =	0.0	ft/ft
V* channel = shear velocity in the upstream channel section = (Ychannel*g*S channel)^.5 =	0.7	ft/s
V* channel/ω channel =	0.9	
k1 channel = (if V*/ω <0.5, 0.59, if(0.5<=V*/ω<=2,0.64,0.69)) =	0.64	
Y2channel = average depth in contracted section after scour = Ychannel*((Q2 channel/Q1 channel)^(6/7))*((W1 channel/W2 channel)^k1 channel) =	9.3	ft
Ys channel = Y2 channel - Yo channel =	**0.2**	**ft**

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City of Petaluma, CA
Local Scour at Abutments - Froehlich or HIRE

100-year Flow
Calculation guideline from HEC-18 5th Edition
Proposed Double Leaf Bascule Bridge

Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Left Overbank = Abutment 1 (Northwest)

Water surface elevation	10.4	ft
Channel elevation	5.8	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	4.6	ft
L = length of embankment projected normal to flow =	20.0	ft
Ratio of projected embankment length to flow depth = L/y1 =	4.3	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	20.0	ft
ya = average depth of flow on the flood plain =	3.82	ft
Ae = flow area of the approach cross section obstructed by the embankment =	64.6	ft^2
Ve = flow velocity =	1.4	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	88	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.12	
Θ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (Θ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**8.7**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Right Overbank = Abutment 2 (Southeast)

Water surface elevation	10.4	ft
Channel elevation	9.6	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	0.8	ft
L = length of embankment projected normal to flow =	14.0	ft
Ratio of projected embankment length to flow depth =	18.1	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	14.0	ft
ya = average depth of flow on the flood plain =	2.15	ft
Ae = flow area of the approach cross section obstructed by the embankment =	41.0	ft^2
Ve = flow velocity =	1.0	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	42	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.12	
Θ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (Θ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**5.2**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Left Overbank = Abutment 1 (Northwest)

Water surface elevation	7.4	ft
Channel elevation	5.8	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	1.6	ft
L = length of embankment projected normal to flow =	12.3	ft
Ratio of projected embankment length to flow depth = L/y1 =	7.7	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	12.3	ft
ya = average depth of flow on the flood plain =	2.05	ft
Ae = flow area of the approach cross section obstructed by the embankment =	24.5	ft^2
Ve = flow velocity =	1.4	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	33	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.17	
ϴ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (ϴ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**5.4**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Left Overbank = Abutment 1 (Northwest)

Water surface elevation	11.6	ft
Channel elevation	5.8	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	5.8	ft
L = length of embankment projected normal to flow =	21.2	ft
Ratio of projected embankment length to flow depth = L/y1 =	3.7	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	21.2	ft
ya = average depth of flow on the flood plain =	4.99	ft
Ae = flow area of the approach cross section obstructed by the embankment =	81.1	ft^2
Ve = flow velocity =	1.8	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	147	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.14	
Θ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (Θ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**11.4**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Right Overbank = Abutment 2 (Southeast)

Water surface elevation	11.6	ft
Channel elevation	9.6	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	1.9	ft
L = length of embankment projected normal to flow =	59.7	ft
Ratio of projected embankment length to flow depth =	30.8	
Abutment scour equation to be used =	HIRE	

HIRE Live Bed Abutment Scour Equation

V = velocity of flow at upstream face of abutment =	0.6	ft/s
Fr = Froude Number = V/((g*y1)^.5) =	0.0793623	
Θ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (Θ/90)^0.13 =	1	
Ys = abutment scour = y1*(4*(Fr^0.33)*(K1/0.55)*K2) =	**6.1**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Left Overbank = Abutment 1 (Northwest)

Water surface elevation	7.9	ft
Channel elevation	5.8	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	2.1	ft
L = length of embankment projected normal to flow =	12.3	ft
Ratio of projected embankment length to flow depth = L/y1 =	5.8	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	12.3	ft
ya = average depth of flow on the flood plain =	2.48	ft
Ae = flow area of the approach cross section obstructed by the embankment =	30.7	ft^2
Ve = flow velocity =	1.9	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	58	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.21	
ϴ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (ϴ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**6.8**	**ft**

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Units = (SI or English)	English	
g = acceleration due to gravity =	32.2	ft/s^2

Right Overbank = Abutment 2 (Southeast)

Water surface elevation	7.9	ft
Channel elevation	9.6	ft
y1 = depth of flow at abutment on the overbank or in the main channel =	1.7	ft
L = length of embankment projected normal to flow =	8.3	ft
Ratio of projected embankment length to flow depth =	4.8	
Abutment scour equation to be used =	Froehlich	

Froehlich's Live Bed Abutment Scour Equation

L' = length of active flow obstructed by the embankment =	8.3	ft
ya = average depth of flow on the flood plain =	0.76	ft
Ae = flow area of the approach cross section obstructed by the embankment =	8.6	ft^2
Ve = flow velocity =	0.9	ft/s
Qe = flow obstructed by the abutment and approach embankment = Ae * Ve =	7	ft^3/s
Fr = Froude Number of approach flow upstream of the abutment =	0.18	
ϴ = abutment skew =	90	degrees
K1 = coefficient for abutment shape =	1	
K2 = coefficient for angle of embankment shape = (ϴ/90)^0.13 =	1	
Ys = abutment scour = ya*(2.27*k1*k2*((L'/ya)^0.43)*(Fr^0.61)+1) =	**2.4**	**ft**

Appendix F RSP Analysis

Caulfield Lane over Petaluma River Moveable Bridge Project

City of Petaluma, CA

Streambank Rock Slope Protection

Calculation guideline from Caltrans Highway Design Manual

Input from HEC-RAS for Proposed Bridge

100-year Flow with Stillwater

Input

Location along stream:	Upstream	Upstream Face	Downstream Face	Downstream	
V_{avg}	3.9	3.9	4.0	4.0	ft/s
g	32.2	32.2	32.2	32.2	ft/s^2
Depth based on	Average	Local	Local	Average	
y	13.2	5.1	1.4	13.3	ft
S_f	1.1	1.1	1.1	1.1	
C_s	0.3	0.3	0.3	0.3	
Cross section location:	Straight channel	Straight channel	Straight channel	Straight channel	
C_v	1.00	1.00	1.00	1.00	

For outside of bends, need R_c and W:

Note: these parameters also affect the V_{des}; for natural channels, $V_{des}=V_{avg}$ for $R_c/W>26$

Note: these parameters also affect the V_{des}; for trapezoidal channels, $V_{des}=V_{avg}$ for $R_c/W>8$

R_c	26	26	26	26	ft
W	1.0	1.0	1.0	1.0	ft
C_t	1.0	1.0	1.0	1.0	
S_g	2.65	2.65	2.65	2.65	
Type of channel:	Natural	Natural	Natural	Natural	
V_{des}	3.9	3.9	4.0	4.0	ft/s
K_1	0.72	0.72	0.72	0.72	
θ	33.7	33.7	33.7	33.7	degrees
SS	1.5	1.5	1.5	1.5	
D_{30}	0.1	0.1	0.1	0.1	ft
D_{50}	0.1	0.1	0.1	0.1	ft
D_{50}	0.8	1.0	1.5	0.8	inches
	I	I	I	I	RSP Class
	20 lb	**20 lb**	**20 lb**	**20 lb**	Median particle weight
	6	**6**	**6**	**6**	Median particle diameter (inches)

Caulfield Lane over Petaluma River Moveable Bridge Project

City of Petaluma, CA

Rock Slope Protection Calculations for Abutments

Calculation guideline from HEC-23 3rd Edition

Input from HEC-RAS for Proposed Bridge

100-year Flow with Stillwater

Location	Upstream	Upstream Face	Downstream Face	Downstream	
V	3.9	3.9	4.0	4.0	ft/s
g	32.2	32.2	32.2	32.2	ft/s^2
y	13.2	13.4	13.3	13.3	ft
Fr	0.19	0.19	0.19	0.19	
Equation	**Isbash**	**Isbash**	**Isbash**	**Isbash**	

For Froude Numbers $(V/(gy)^{1/2})$<=0.80, Isbash relationship (Equation 14.1)

$$D_{50} = \frac{yK}{(S_s - 1)}\left[\frac{V^2}{gy}\right]$$

y	13.2	13.4	13.3	13.3	depth of flow in the contracted bridge opening, ft
K	1.02	1.02	1.02	1.02	1.02 for vertical wall abutment, 0.89 or for spill-through abutment
S_s	2.65	2.65	2.65	2.65	specific gravity of rock
V	3.9	3.9	4.0	4.0	average velocity in contracted section, ft/s
g	32.2	32.2	32.2	32.2	gravitational acceleration, ft/s^2
D_{50}	0.3	0.3	0.3	0.3	median stone diameter, ft
D_{50}	3.6	3.6	3.6	3.6	median stone diameter, inches

I	I	I	I	RSP Class
20 lb	20 lb	20 lb	20 lb	Median particle weight
6	6	6	6	Median particle diameter (inches)

APPENDIX D –
Draft Preliminary Foundation Report

PRELIMINARY FOUNDATION REPORT

PROPOSED CAULFIELD LANE BRIDGE
PETALUMA RIVER

PETALUMA, CALIFORNIA

Prepared for

City of Petaluma
202 N. McDowell Boulevard
Petaluma, CA 94954

May 10, 2021

AECOM

4 N. Second Street, Suite 675
San Jose, California 95113

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1 INTRODUCTION

The City of Petaluma is proposing to construct a moveable bascule-style bridge across the Petaluma River at the approximate location shown on the accompanying Site Location Map (Figure 1). The proposed Caulfield Lane Bridge site is located approximately 800 feet upstream (west) of the US 101 bridge and approximately 1,200 feet upstream of the Sonoma-Marin Area Rail Transit (SMART) Haystack Landing Bridge. The proposed bridge would extend Caulfield Lane across the river to connect with Petaluma Boulevard South at Crystal Lane. Both the US 101 and Haystack Landing bridges were designed by AECOM and its legacy company URS, with the Haystack Landing bridge also being a moveable, bascule-style bridge.

The purpose of this preliminary geologic and geotechnical engineering study is to characterize the geologic, seismic and subsurface conditions within the proposed bridge footprint and assess, in a preliminary way, the geologic/seismic hazards and geotechnical engineering factors that might affect the feasibility of the project.

1.1 Purpose and Scope of Work

The purposes of this preliminary report are to document the geologic conditions in the vicinity of the project site, the subsurface conditions encountered in explorations previously completed by others on the north side of the river and at the aforementioned bridge sites downstream, as well as those revealed in a site-specific boring completed for this study in the south abutment area. Preliminary opinions also are presented about foundation support of the proposed bascule-style bridge.

The scope of work for this study included:

- Review of available as-built bridge drawings, logs of borings and laboratory test results for nearby sites, geologic maps, fault maps and geologic hazard maps, and other existing information.
- Drilling one soil and rock core boring in the south bascule pier area to supplement available exploratory information near the north riverbank.
- Preparation of this report, including:
  - Description of site geology and evaluation of geologic hazards;
  - Assessment of subsurface conditions based on existing information and one new exploratory boring;
  - Identification of potential geotechnical impacts on the project;
  - Development of preliminary seismic design criteria;
  - Estimates of foundation depth required to support the anticipated bascule abutment nominal axial compression load;
  - Discussion of scour and corrosion potential;
  - Construction considerations; and
  - Recommendations for geotechnical and geological studies needed for final design.

2 PROJECT DESCRIPTION

The total length of the Caulfield Lane Bridge is expected to be more than 290 feet to accommodate a clear navigation channel of 200 feet within the Petaluma River. A double-leaf bascule bridge is envisioned, with each span being about 110 feet in length as shown schematically on Figure 2. Both bascule abutments likely would be supported on groups of 6-foot-diameter cast-in-drilled hole (CIDH) piles, all with permanent steel casing. A similar foundation system was successfully employed for the Haystack Landing Bridge.

About 5 and 7 feet of embankment fill are anticipated to fill the gap between the current ground surface and the finished grade of the Caulfield Lane Bridge approaches on the north and south riverbanks, respectively.

3 GEOLOGY AND SITE CONDITIONS

3.1 Regional Geology

The project is located along the western margins of the Petaluma Valley within the central portion of the Coast Ranges geomorphic province of California. Northwest-southeast-trending valleys and ridges characterize the regional morphology of the Coast Ranges province. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas fault system between the Pacific and North American plates. Regional geologic mapping shows the Caulfield Lane Bridge site, as well as the two downstream bridge sites, to be underlain by manmade fill, Holocene Bay Mud deposits, Holocene alluvial fan deposits, Tertiary age volcanic rocks, and Jurassic-Cretaceous age Franciscan Complex rocks (Wagner et al, 2000; Armstrong, 1980). The regional geologic map (Figure 3) shows the approximate areal extent of these various geologic units.

As noted above, both the north and south approaches to the new bridge are anticipated to be raised with new fill added above existing fill, with underlying Bay Mud and alluvial fan deposits below. The "bedrock" that underlies the alluvial fan deposits and portions of the Bay Mud is the Jurassic-Cretaceous age Franciscan Complex. This unit is mapped by Wagner et al. (2000) as schist and phyllite; however, the Caltrans as-built Log of Test Borings (LOTB) for the US 101 bridge downstream, and previous site geologic mapping suggest the unit consists mainly of mélange consisting of tectonic mixtures of sheared shale, greenstone, greywacke and serpentinite with scattered blocks of blueschist. A geologic map of the site by Wentworth (1997) also shows this area as mélange. The only observed surface outcrops of the Franciscan Complex rocks occur on the south bank of Petaluma River at the US 101 crossing.

3.2 Seismotectonic Setting

The Caulfield Lane Bridge site lies between known active and potentially active faults. In general, earthquakes occur as a result of movement along active faults. For the purpose of activity classification, faults are generally grouped into the following categories by the California Division of Mines and Geology (renamed the California Geological Survey, CGS) (Jennings, 1994):

- Holocene: displacement has occurred within the last 10,000 to 11,000 years.
- Late Quaternary: displacement has occurred within the last 700,000 years, but evidence of Holocene activity is lacking.
- Quaternary: evidence of displacement within the last 1.6 million years, but evidence of Holocene activity is lacking.
- Pre-quaternary: no recognized evidence of displacement in the last 1.6 million years.

Generally, faults with Holocene movement are considered to be "active" while faults with late Quaternary to Quaternary movement are considered to be "potentially active".

Figure 4 shows active faults within the site region relative to the project. The closest active faults to the site are the Rodgers Creek-Healdsburg fault, San Andreas (north) fault, the northern end of the Hayward fault and the Maacama-Brush fault (Merriam and Shantz, 2007). The California Geological Survey (CGS, 2000) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. All of these faults are included as Alquist-Priolo (A-P) zoned faults.

The Rodgers Creek-Healdsburg fault is located about 4.6 miles (7.4 km) northeast of the site and the San Andreas (north) fault is located about 15.8 miles (25.4 km) southwest of the project alignment. More distant active faults include the north end of Hayward fault located about 18 miles (30 km) southeast of the site, and the Maacama-Brush fault located about 21.5 miles (34.6 km) northeast of the site. No mapped A-P zoned faults cross the bridge site.

3.2.1 Local Geology

A review of explorations completed at the project site and for the above-referenced bridge sites downstream was conducted to aid in characterizing the subsurface conditions within the bridge footprint. Consistent with the geology map of the area (Figure 3), the explorations revealed fill, Bay Mud and alluvial fan deposits (alluvium) overlying Franciscan Complex bedrock. Fill soils consisting of clay, sand, and gravel were encountered to a depth of about 10 to 18 feet along the outboard (north) edge of Petaluma Boulevard; fills were found to a depth of about 10 feet in the Petaluma River north levee. Fill soils up to about 10 feet in thickness were also encountered on the south (uphill side) of Petaluma Boulevard South under the US 101 bridge; this fill is believed to have been side-cast material from an old quarry roadway that was present on the slope south of Petaluma Boulevard South before construction of US 101 (see Figure 1 for the former quarry location).

During the Caltrans 1952 site investigation for the US 101 crossing of the Petaluma River, Bay Mud was encountered at the ground surface near the north bridge abutment and extended southward to the Petaluma River channel. However, borings completed by URS for its more recent replacement suggest the Bay Mud may have been removed in preparation for the north abutment fill embankment placement. Where encountered, the Bay Mud depth was found to range from about 10 feet to as much as 20 feet thick near the north bank of the river; it extended to about Elevation –5 to –15 feet (NAVD88) in the river the channel. The Bay Mud was found to overlie alluvial fan deposits consisting of interbedded stiff to very stiff silty to sandy clay and medium dense to dense silty to clayey sand with some gravel interbeds. The alluvium deposits at the US 101 Petaluma River crossing were as much as 40 feet thick and extended to about Elevation –25 feet (NAVD88) near the north riverbank and deeper to about Elevation –50 feet (NAVD88) near the north bridge abutment.

Franciscan Complex bedrock was revealed below the alluvial fan deposits and portions of the fill south of the river channel at the 101 crossing. The bedrock outcropped at the ground surface in the slope and US 101 bridge abutment south of Petaluma Boulevard South where exploratory pits and borings were made. The Franciscan Complex consists of mélange, a tectonic mixture of highly sheared metamorphic rock consisting of black shale and serpentinite with greenstone, greywacke, talc and scattered blocks of blueschist. The bedrock was highly weathered to clay near the ground surface in the south abutment area and became moderately weathered and very dense below a depth of about 10 feet to as much as 50 feet. Caltrans 1952 borings and test pits were terminated a few feet into the bedrock; however, URS 2009 borings were drilled as much as 51 feet into the Franciscan Complex bedrock.

Although not encountered in the borings or test pits at the US 101 Petaluma River crossing, the Franciscan Complex bedrock often contains randomly distributed blocks of hard blueschist ranging in size from a few inches to several tens of feet in diameter. These hard blocks are typically surrounded by the softer sheared matrix of shale and serpentinite, giving the Franciscan Complex mélange a Block-in-Matrix (BIM) classification. One of these large resistant blueschist blocks several feet in diameter was observed at the ground surface a few hundred feet west of the south bridge abutment, uphill of the south approach to the proposed Caulfield Lane bridge site, at the time of site reconnaissance for the US 101 Petaluma River bridge project. The area has since been developed with residential housing.

3.3 Potential Geologic Hazards

3.3.1 Surface Fault Displacement and Ground Shaking

The proposed bridge site does not cross any Alquist-Priolo Earthquake Fault Zones (Hart, 1975). Therefore, surface rupture due to faulting is not expected to occur. However, the short distance to nearby active faults including the Rodgers Creek-Healdsburg fault, San Andreas (north) fault, and the northern end of the Hayward fault does create a high risk for ground shaking from fault movement. The intensity of the ground shaking is dependent upon the size of the earthquake, the distance of the epicenter from the site, the direction that the earthquake propagates along the fault, and the site geologic conditions.

3.3.2 Landslide and Slope Failure

The ground surface slopes gently towards the Petaluma River in both approach areas of the proposed bridge site. Regional geologic maps by Wagner et al. (2000) and Wentworth (1997), as well as the landslide hazard area maps in the Sonoma County Hazard Mitigation Plan (2006), do not show any mapped landslides on the hills at or near the site.

A previous slope stability map of the project area found in the California Division of Mines and Geology publication “Geology for Planning in Sonoma County” (Armstrong, 1980) shows the entire hillside area south of Petaluma Boulevard South, with the exception of an area underlain by volcanic rock, as a large landslide area. The 1:62,500-scale map appears to show nearly all areas mapped as Franciscan Complex mélange as being landslide areas due to the relatively weak nature of this rock unit and its high susceptibly to slope failure. However, as mentioned above, this area was the site of a former rock quarry that has since and now is a residential housing development. Considering the south abutment of the proposed bridge would be more than 500 feet from the nearest hillside, the risk of it being affected by landsliding is considered very low. Nonetheless, small, local failures are common within exposed riverbanks and they could pose a risk.

3.3.3 Scour

WRECO estimates total scour depths at the Caulfield Lane Bridge site of 11.4 feet at Abutment 1 and 6.1 feet at Abutment 2, for the Stillwater Elevation boundary condition and recurrence interval of 500 years (WRECO, April 2021).

3.3.4 Flooding

The Petaluma River Channel is within a floodplain. According to FEMA mapping, the site is in Zone AE, defined as an area with a 1% annual chance of flooding..

3.3.5 Naturally Occurring Asbestos

Asbestos is a term used for several types of naturally occurring fibrous minerals generally found in ultramafic rocks. The most common type of asbestos is chrysotile. Serpentinite often contains chrysotile asbestos; it is a common rock type occurring in the Franciscan Complex and was found in several of the borings completed by Caltrans in 1952, by URS in 2009 for the US 101 crossing, and in the boring completed by AECOM in the south abutment area for the current study.

Serpentinite is typically grayish-green to bluish-black in color and may have a shiny appearance. The amount of chrysotile asbestos that is typically present in these rocks ranges from less than 1% up to about 25%, and sometimes more. Asbestos is released from serpentinite rock when it is broken or crushed. This can happen when land is graded for building purposes, or at quarrying operations. It is also released naturally through weathering and erosion. Once released from the rock, asbestos can become airborne and may stay in the air for long periods of time. There is potential for asbestos to be encountered during construction during CIDH pile drilling that extends through the overlying fill, Bay Mud and alluvium into the underlying Franciscan Complex bedrock.

3.3.6 Subsidence and Consolidation Settlement

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater or petroleum) or compression of soft, geologically young sediments. Groundwater extraction for high volume municipal and agricultural use has the potential to cause future ground subsidence in the region. However, such pumping is unlikely to have been done in areas underlain by Bay Mud. No active petroleum wells are present within many miles of the site (California Division of Oil, Gas, and Geothermal Resources, 2001).

Settlement can occur quickly when soil is loaded by a structure or by the placement of fill on top of it. Time-dependent settlement can also occur gradually when soil pore pressures, increased by vertical loading, gradually dissipate over time. This second type is termed consolidation settlement and it is typical for compressible Bay Mud deposits like those encountered at the bridge site. Preloading, as recommended by Miller Pacific in their 2011 update, and other methods of ground improvement can be used to minimize post-construction settlement.

4 SUBSURFACE CONDITIONS

4.1 Previous Nearby Investigations

Miller Pacific completed a preliminary geotechnical investigation for the Riverfront Residential Development in 2006 on the north side of the river. Boring 1 of their investigation was drilled nearest to the river, shown approximately on Figure 1; it was advanced from the ground surface (Elevation 14 feet) to a maximum depth of 38 feet (Elevation -24 feet). No datum reference was provided; however, NAVD88 is likely to have been used when the topographic mapping was done.

In 2010, URS (AECOM legacy company) completed a foundation investigation for the US 101 Petaluma River Bridge Replacement. Eight rotary wash borings, R-09-001 through R-09-008, were advanced to terminal depths of 18½ to 112 feet, at the approximate locations shown on Figure 1.

In 2009, URS also conducted a foundation investigation for the SMART Haystack Landing Bridge. The initial field exploration program included six rotary wash borings to depths ranging from 60 to 80 feet and seven CPT. In 2014, supplementary rotary-wash Boring B-101 was completed by AECOM (and logged by Kleinfelder) near proposed bascule Pier No. 4 on the north side of the channel; it extended to a depth of approximately 100 feet. The approximate locations of this previous exploration is also shown on Figure 1. Copies of the logs of Miller Pacific Boring 1, Borings R-09-005 and R-09-006 from the US 101 Petaluma River Bridge, and Boring B-101 from the Haystack Landing Bridge are included in Appendix A for convenience of reference.

In addition to conventional Standard Split Spoon (SPT) sampling, it should be noted pressuremeter testing was conducted in Boring B-101 at nine intervals between depths of 28 and 88 feet. The pressuremeter test results were used to further refine and maximize side shear and tip resistance parameters used in AECOM's CIDH pile design for support of bascule Pier No. 4.

4.2 Site Exploration

To supplement the available subsurface information described above, a single rotary-wash soil and rock core boring, R-21-001, was drilled in an accessible location on the south side of the river (bascule Abutment 2) to 112 feet (Figure 1), the purpose being to provide site-specific subsurface information for the current feasibility level study. The top of the boring was advanced with a hand auger and solid flight auger until groundwater was encountered, at which point rotary wash and rock core drilling methods were used to complete the boring to its terminal depth.

4.3 Soil Conditions

4.3.1 Fill

Dense silty sand with gravel fill was encountered from the ground surface (Elevation 10± feet) to a depth of about 8 feet (Elevation 2± feet) in Boring R-21-001. Hard conditions were experienced as the hand auger was advanced to at a depth of about 3½ feet; it is suspected a remnant feature of a small batch plant that existed in the general area until about 2009 might have been encountered. On the north side of the river, Miller Pacific Boring 1 revealed no fill when it was drilled in 2006. In 2011, an update to their preliminary report was issued, in which they mentioned earthwork for the residential development could result in the placement of as much as 10 feet of fill at the southern edge of the property, near the river. Records of the extent of fill placement for the residential development that since has been completed were unavailable at the time of this writing; however, elevations available on Google Earth Pro (accessed April 2021) suggest the ground surface is several feet higher than at the time Boring 1 was drilled in 2006.

4.3.2 Native

Occurring below the fill on the south riverbank and from the ground surface on the north side of the river (at the time Miller Pacific Boring 1 was drilled in 2006), the native soils consist of Bay

Mud underlain by alluvial fan deposits (alluvium). Miller Pacific Boring 1 revealed Bay Mud to a depth of 36 feet (Elevation -22± feet – assuming NAVD88), although they estimated the base of the stratum could extend as deep as 40 feet near the riverbank. Miller Pacific characterized the Bay Mud as "soft" and "highly compressible."

For the current feasibility level study, a Shelby tube sample of the Bay Mud beneath the south riverbank was selected for unconsolidated undrained triaxial (TXUU) compression and one-dimensional incremental consolidation testing. The TXUU test revealed an undrained shear strength of about 1.1 kips per square foot (ksf), whereas the consolidation test suggests the Bay Mud may be somewhat overconsolidated.

While the Bay Mud is underlain by clayey sand alluvium on both sides of the river, the top of the alluvium on the south side is positioned some 13 feet shallower at about Elevation -9 feet. The clayey sand alluvium grades coarser with increasing depth in Boring R-21-001, containing some small gravel. Unlike Miller Pacific Boring 1 that was terminated in the alluvium, Boring R-21-001 was found to be underlain by Franciscan Complex mélange at a depth of about 28½ feet (Elevation -18½± feet). The mélange is completely to moderately weathered and weak to a depth of about 45 feet (Elevation -35± feet), with properties comparable to a dense granular soil. The drilling method used for advancing Boring R-21-001 was switched to HQ-3 coring below 45 feet, where the rock quality somewhat improved. The cores recovered to its terminal depth of at 112 feet (Elevation -102± feet) ranged from Serpentinite to Blueschist and Serpentine Mélange and Shale Mélange, all with varying degrees of weathering and strength.

The log of Miller Pacific Boring 1 is presented in Appendix A, along with explorations previously completed for the US 101 Petaluma River and SMART Haystack Landing Bridges downstream of the current project site. The log of Boring R-21-001 is presented in Appendix B, along with copies of the TXUU and consolidation test results.

5 GROUNDWATER

Groundwater was measured in Boring R-21-001 when the auger was removed. It was found at the contact between the fill layer and underlying Bay Mud at about Elevation 2± feet. Miller Pacific did not measure the depth to groundwater in any of their borings on the north side of the river, but they opined it could be 10 to 15 feet below the site grade; in the case of Boring 1, drilled from Elevation 14 feet, the range would be equivalent to about Elevation 4 to -1 feet.

Most of the borings completed downstream of the site for the US 101 crossing of Petaluma River and for the SMART Haystack Landing Bridge used rotary wash drilling methods, which normally precludes groundwater measurement. However groundwater levels were measured in a few of the borings between Elevation 0.4 and 4 feet.

The Petaluma River is subject to tidal variations. A topographic map of the site dated April 2008 shows the river level at Elevation 0.65 feet and the 1952 LOTB sheet recorded the high tide river level at Elevation 5.2 feet @ D Street. NGVD29 is likely the datum used at the time of Caltrans 1952 investigation; adjusting to NGVD88, this would correspond to about Elevation 7.5 feet. Considering the previous measurements and expected tidal fluctuation, we believe a design groundwater level at Elevation 5 feet would be reasonable for the current site.

6 SEISMIC DESIGN INFORMATION AND RECOMMENDATIONS

The seismic design methodology assumed the feasibility level of the project is based on the following current Caltrans standards:

- Seismic Design Criteria (SDC), v2.0, April 2019
- Caltrans ARS Online, v3.0.2, January 2020

6.1 Ground Motions

Shear wave velocity measurements were beyond the scope of the current feasibility level study. However, the shear wave velocity of the upper 30 meters of the soil profile (V_{s30}) at the US 101 Petaluma River Bridge was estimated to be 366 meters/second (1,200± feet/second), whereas it was estimated to be 210 meters/second (700± feet/second) at the Haystack Landing Bridge site. This range of shear wave velocity was used with the Caltrans ARS Online (Version 3.0.2) tool to generate the site characteristics and fault parameters presented below in Table 6-1a. The ARS Online tool calculates a probabilistic spectrum based on a 5% probability of exceedance in a 50 years hazard level (975-year return period) and for 5% damping. The ARS was adjusted for near fault effects due to the close proximity of the site to active faults. The site is not located in a deep sedimentary basin, so a basin amplification factor is not required. Table 6-1b presents the results.

Table 6-1a Site Characteristics and Fault Parameters

Parameter	Value	
Site Latitude	38.229296°	
Site Longitude	-122.618111°	
Site V_S30	210 m/s	366 m/s
PGA	0.60 g	0.65 g
Mean magnitude	7.05	7.11
Mean site-source distance	16 km	14.1 km

Table 6-2b Acceleration Response Spectrum

Period (s)	Design Spectral Acceleration (g)	
	Vs30 = 210 m/s	Vs30 = 366 m/s
PGA	0.6	0.65
0.1	0.96	1.17
0.2	1.32	1.55
0.3	1.54	1.61
0.5	1.57	1.4
0.75	1.45	1.17
1	1.35	1
2	0.81	0.5
3	0.54	0.32
4	0.39	0.23
5	0.29	0.18

6.2 Potential Seismic Hazards

6.2.1 Seismic Compaction

Compaction settlement, or seismic densification, occurs when loose granular soils above the water table increase in density as a result of earthquake shaking. The soil densification can result in differential settlement because of variations in soil composition, thickness, and initial density. Relatively dense granular fill soils (silty sand with gravel fill) were encountered in R-21-001. They are underlain Bay Mud, medium dense clayey sand, and Franciscan Complex bedrock, all which are below the groundwater level. We believe the risk of compaction settlement of the local fills and underlying native materials due to seismic densification during strong ground shaking is low at this site.

6.2.2 Liquefaction Potential

Liquefaction is a phenomenon whereby sediments temporarily lose shear strength and collapse. This condition is caused by cyclic loading during earthquake shaking that generates high porewater pressures within the sediments. The soil type most susceptible to liquefaction is loose, cohesionless, granular soil below the water table and within about 50 feet of the ground surface. Liquefaction can result in loss of foundation support and settlement of overlying structures, ground subsidence and translation due to lateral spreading, lurch cracking, and differential settlement of affected deposits. Lateral spreading occurs when a layer liquefies at depth and causes horizontal movement or displacement of the overburden mass toward a free face such as a stream bank or excavation, or toward an open body of water.

In a regional study of the nine-county San Francisco Bay region for the U.S. Geological Survey, Witter et al. (2006) mapped the liquefaction susceptibility of the soils in the project vicinity. The alluvial fan and Bay Mud deposits from the south bank of the Petaluma River and extending north past SR 116 have been mapped as having a “moderate” liquefaction susceptibility (see Figure 5). Whereas, the Sonoma County Hazard Mitigation Plan (2006) shows the alluvium and Bay Mud deposits as having a “high” liquefaction hazard. The Franciscan Complex bedrock mapped south of the river is not susceptible to liquefaction.

Based on our review of the log of Miller Pacific Boring 1 and the conditions encountered in R-21-001 drilled for the current study, the alluvial fan deposits encountered below the Bay Mud consist of medium dense clayed sand below the south riverbank and dense clayey sand below the north riverbank, based on Miller Pacific’s qualitative description. The fines (clay and silt) fraction is in the range of 20 to 30 percent based on laboratory test results for two samples collected from Boring R-21-001, suggesting the alluvium below the south riverbank is somewhat cohesive and unlikely to liquefy. Nonetheless, more analysis of the local granular alluvium beneath the both riverbanks would be advisable when the project proceeds to final design.

6.2.3 Lateral Spreading

Lateral spreading occurs when a layer liquefies at depth and causes horizontal movement or displacement of the overburden mass toward a free face such as a stream or canal bank or excavation, or toward an open body of water. The potential for liquefaction and lateral spreading is expected to be low based on the blow counts in native soils encountered in R-21-001 and conditions encountered in nearby historic borings; but it too should be further evaluated during final for design of the proposed new bridge.

6.2.4 Seismic Slope Instability

CGS (2006) mapped the closest earthquake-induced landslide zone about 3 miles to the southwest of the project site. No landslides are mapped on the flat land near or in the immediate vicinity of the proposed bridge site. Due to the gently sloping nature of the area on both sides of the Petaluma River, we do not consider the site materials to susceptible to landsliding – either seismically induced or otherwise.

6.2.5 Tsunami and Seiche

According to the "Tsunami Inundation Map for Emergency Planning, Sears Point Quadrangle/Petaluma Point Quadrangle," the proposed Caulfield Lane Bridge site is located more than 11 miles outside of the western edge of the modeled inundation area. Therefore, the potential for tsunami and seiche inundation is nil.

6.3 Corrosion Potential

A sample of the granular fill encountered within the top eight feet of Boring R-21-001 was submitted for analytical testing to measure pH, resistivity, and sulfate and chloride concentrations, as these chemical properties could affect the corrosion rates of buried metal and reinforced concrete associated with the proposed bridge foundation. Assessment of soil corrosivity was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 3.0, dated March 2018.

Caltrans considers a site corrosive if one or more of the following conditions exist for the representative soil samples taken from the site:

- Chloride concentration is 500 parts per million (ppm) or greater and/or
- Sulfate concentration is 1,500 ppm or greater and/or
- pH is 5.5 or less.

The results of the tests are summarized below and presented Appendix B.

- Resistivity @ 15.5ºC = 1,591 ohm-cm
- Chloride = 56 mg/kg (ppm)
- Sulfate = 138 mg/kg (ppm)
- pH = 7.4

Based on the laboratory test results, the fill can be considered non-corrosive to buried concrete or steel based on the Caltrans guidelines. Samples of the Bay Mud and groundwater should be submitted during final design to assess its corrosion potential to the proposed foundations. It should be noted Caltrans considers a site to be corrosive if located within 1,000 feet of brackish water.

7 PRELIMINARY FOUNDATION RECOMMENDATIONS

7.1 General

The proposed bridge site is underlain by dense granular fill beneath the south riverbank, and possibly as much as 10 feet of relatively recent fill on the north riverbank placed as part of earthwork for the Riverbank Residential Development. The fills overlie soft to medium stiff Bay

Mud, medium dense to dense clayey sand alluvium, and highly to moderately weathered Franciscan Complex bedrock. The principal geotechnical issues at the site are:

- The potential for consolidation settlement of Bay Mud beneath both the north and south approaches to the proposed new bridge under the weight of the existing fill and proposed new fill needed for the bridge approaches. Miller Pacific advised that "up to 2 feet, or more, of settlement could occur under planned new loading of the Bay Mud deposits on this (Riverfront Residential Development) site." It appears that fill has been completed; the extent of consolidation completed under its weight thus far is unknown.
- Selection of the type and depth of foundation for support of the two bascule abutments that will be compatible with the underlying soil and bedrock conditions; and
- Issues associated with deep foundation construction due to shallow groundwater and soft Bay Mud that is prone to squeezing.
- The potential NOA in rock removed during foundation construction in the Franciscan Complex bedrock that underlies the bridge site.

Historically, pile foundations have been used to support the nearby bridges. CIDH piles with and without permanent casings, as well as driven steel pipe piles, have been used support the nearby US 101 Petaluma River Bridge and, as already discussed, large diameter CIDH piles were used to support bascule Pier No. 4 at the SMART Haystack Landing Bridge. Disposal of cuttings, handling of groundwater and quality control present constructability issues when installing CIDH piles, particularly when tip resistance is mobilized, as was done for the Haystack Landing Bridge. Installing CIDH piles near the river banks will require temporary casing or drilling fluid to minimize cave-in during construction. Disposal of used slurry also will incur additional costs.

7.2 CIDH Pile Embedment

The Structural Engineer envisions the use of CIDH piles similar in design to those constructed for the SMART Haystack Landing Bridge for support of both of the Caulfield Lane Bridge bascule abutments. We believe CIDH piles would be a feasible and practical choice.

The embedment length (specified tip) of the 6-foot-diameter CIDH piles that support bascule Pier No. 4 for of the Haystack Landing Bridge was based on a nominal axial compression demand of 4,810 kips derived in skin friction below the Bay Mud and end-bearing in the Franciscan bedrock. Assuming the nominal resistance demand would be similar for the Caulfield Lane Bridge, we estimate 6-foot-diameter CIDH piles would need to extend to about Elevation -76 feet for Bascule Abutment 2. This preliminary CIDH pile embedment estimate is based on the analysis presented on Figure 6. Since pressuremeter testing was beyond the scope of this feasibility level study, side friction and tip resistance parameters were based on Federal Highway Administration, American Association of State Highway and Transportation Officials and other accepted guidelines.

The bottom of the Bay Mud is expected to be deeper on the north side of the river by about 13 feet; therefore, a similar increase in the CIDH pile embedment for bascule Abutment 1 likely would be needed to meet the same nominal axial compression demand, assuming the underlying bedrock conditions are similar to those revealed on the south side of the river.

It should be noted special CIDH construction methods were required to achieve the nominal resistance demand at the Haystack Landing Bridge site. Among them were the installation of permanent steel casing that extended through the Bay Mud and alluvial sands into the Franciscan Complex bedrock, thereby minimizing the potential for the holes to squeeze or cave, and tremie placement of a special concrete mix designed to scour remaining loosened material from the bottom of the shafts. Post-grouting beneath the pile tips also could be required.

8 ADDITIONAL STUDIES

We recommend the following exploration and testing approach be taken as part of studies prior to developing final geotechnical engineering recommendations for Caulfield Lane Bridge foundation design.

8.1 Field Exploration

To supplement existing available data, we recommend:

1. A rotary-wash soil and rock core boring should be advanced to a depth of at least 110 feet at Bascule Abutment 2, primarily for the purpose of pressuremeter testing at 5 to 7 intervals below a depth of about 35 feet.
2. A second rotary-wash soil and core boring should be advanced on the north side of the river to further characterize the Bay Mud and alluvial soil conditions that underlie the bridge approach area and to evaluate the bedrock conditions in which support of bascule Abutment 1 will be developed. Drive and Shelby Tube samples should be recovered for geotechnical laboratory testing, as has been completed for Boring R-21-001 of this preliminary study. Pressuremeter testing should also be completed in this exploration as described above. In this way, side friction and tip resistance values can be further refined for evaluation of the required CIDH pile embedment depth/design tip elevation.
3. Advance a minimum of two cone penetration test (CPT) on each side of the river (i.e. a minimum of four CPT in total) to supplement the rotary-wash borings. The CPT will assist in evaluating the alluvial layer thickness and its susceptibility to earthquake induced soil liquefaction.
4. Obtain shear wave velocity profiles at one of the exploration locations on each side of the river with respect to depth by one of the following techniques (for estimating Vs_{30}, a key input parameter for Caltrans ARS Online tool):
   - Assuming bore holes are drilled by the rotary-wash method (no casing), a seismic wave suspension logger can be used
   - If steel casing is used during drilling, a down hole seismic velocity logger can be used
   - Alternatively, complete at least one Seismic CPT on each side of the river.
5. Use an auger to initially drill the borings until groundwater is encountered or to a depth of 20 feet whichever is shallower; continue advancing borehole with rotary-wash/rock coring.

8.2 Corrosion Testing and Analysis

We recommend additional testing and analysis be performed in general accordance with Caltrans requirements for the soils on the north side of the river to address the corrosion engineering aspects of piles and pile caps required for Bascule Abutment 1.

8.3 Laboratory Testing

All samples obtained from the field exploration should be reviewed and selected samples tested in the laboratory to confirm the field classifications. Test results should be used to help estimate the index properties and engineering parameters of the materials encountered. These tests tentatively should include moisture content, dry unit weight, Plasticity Index, unconfined compressive strength, unconsolidated undrained triaxial compression, one-dimensional incremental consolidation and grain size distribution.

8.4 Engineering Analysis

Based on the results of the field exploration and laboratory testing, as well as engineering judgment and experience, recommendations should be developed for the geotechnical aspects of project design including the following topics:

- Pile Foundations
  - Type
  - Axial compression and tension capacity
  - Design tip elevations
  - Resistance to lateral loads
  - Settlement of approach embankments and the potential for downdrag loading of the CIDH piles
  - Potential impact of scour and erosion
- Abutment grading and approach fill construction, including the need for preloading or ground improvement to mitigate settlement
- Corrosion testing and analysis
- Earthquake information update consistent with Caltrans Response Spectra Design Techniques or other acceptable methods
- Assessment of the potential for earthquake induced liquefaction and lateral spreading

8.5 Reporting

The results of the exploration and laboratory testing programs, and recommendations should be presented in a final design level geotechnical engineering report.

9 LIMITATIONS

This study is intended to aid in evaluating the geotechnical feasibility of the Caulfield Lane Bridge project. The opinions, conclusions and preliminary recommendations presented herein are based on the review of existing subsurface data, a single new boring drilled on the south side of the Petaluma River, engineering judgment and local experience at the nearby US 101 Petaluma River Bridge and Haystack Landing Bridge sites. The opinions, conclusions and preliminary recommendations herein presented assume the soil, bedrock, and geologic conditions do not deviate substantially from those revealed in the explorations.

Existing facilities, utilities, soils/bedrock conditions, road/structure distress, slope distress or groundwater/seepage conditions other than those noted herein have not been considered in the preparation of this report. Locating utilities and evaluating potential utility interference is outside the scope of this report. Individuals utilizing this report should inform AECOM if they are aware of any additional facilities or site conditions so that their presence and impact upon the project (or vice-versa) can be properly evaluated and recommendations modified to address geotechnical issues as necessary.

The opinions and preliminary recommendations presented in this report were developed with the standard of care commonly used by other professionals practicing at the same time, within the same locality and under the same limitations. No other warranties are included, either expressed or implied, as to the professional advice included in this report.

Sincerely,

S. Stephen Huang, G.E. #2150

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0 200 400
SCALE IN FEET

AECOM

Caulfield Lane over Petaluma River

Petaluma, California

Project Location Map

Job 60580130

FIGURE 1

May 2021

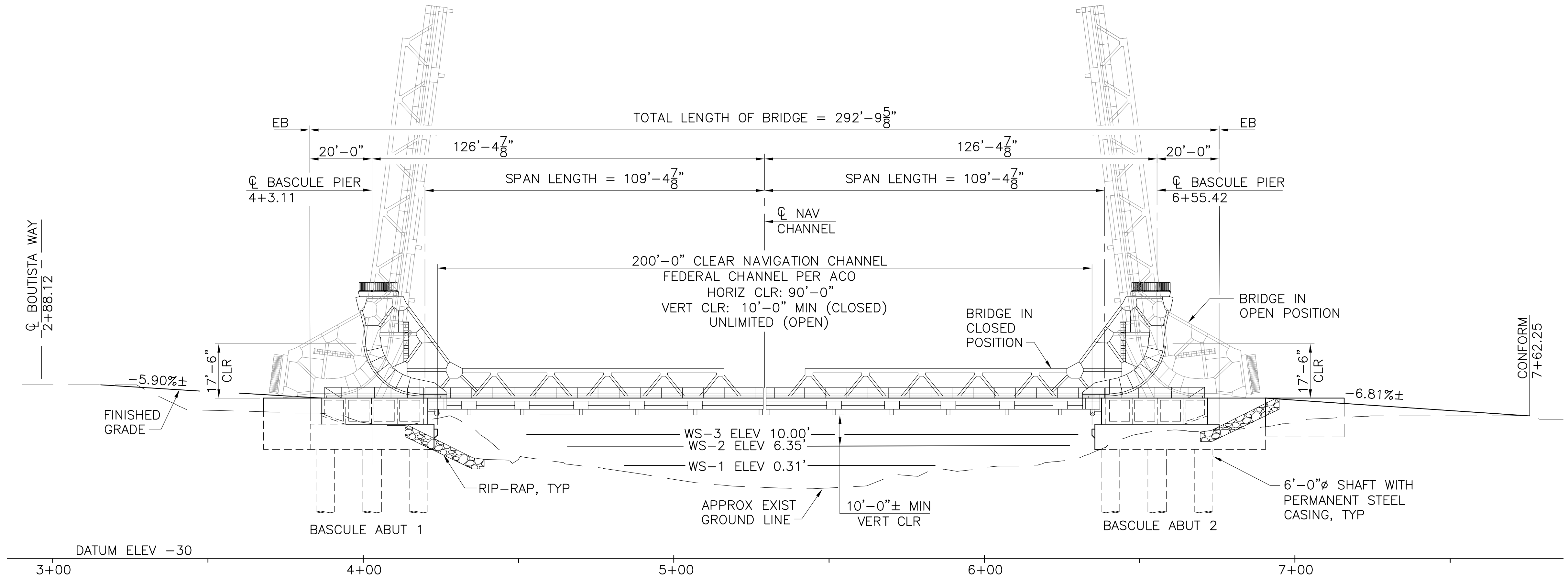
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER THOMAS R. BARNARD No. C46384 Exp. 03-31-21 CIVIL STATE OF CALIFORNIA

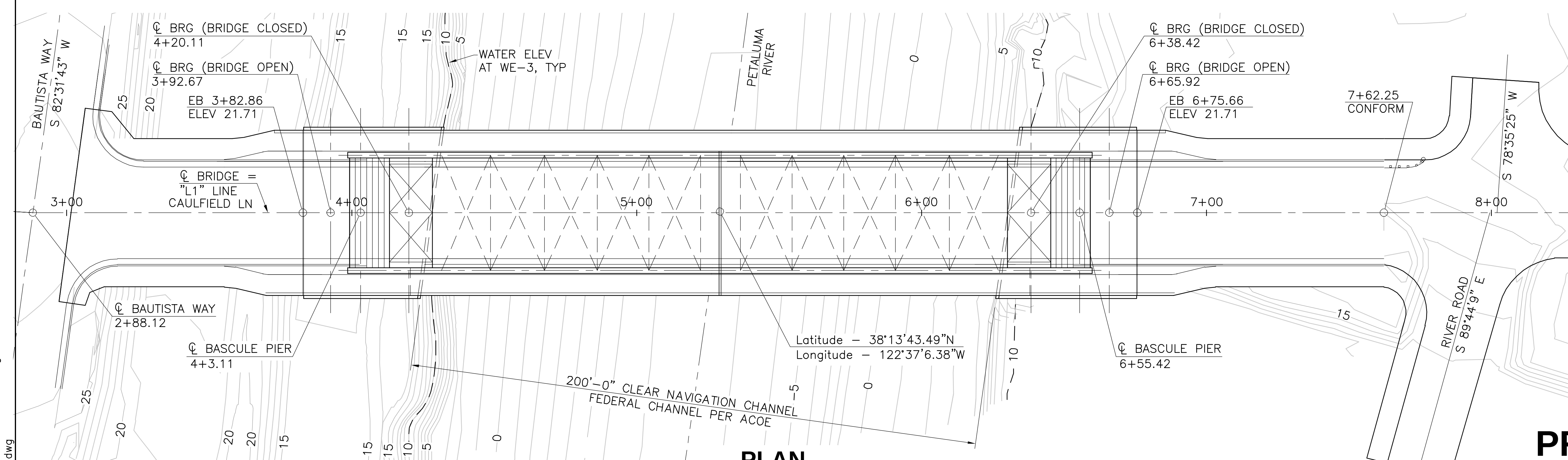
AECOM
Technical Services, Inc.
2020 L Street, Suite 300
Sacramento, CA. 95811



ELEVATION
SCALE: 1" = 20'

LEGEND

WS-1	MEAN LOWER LOW WATER, -0.31' NAVD88, PER NOAA/NOS
WS-2	MEAN HIGHER HIGH WATER, 6.35' NAVD88 PER NOAA/NOS
WS-3	100 YEAR BASE FLOOD ELEVATION, 10.00' NAV88, PER FEMA



PLAN
SCALE: 1" = 20'

PRELIMINARY

Figure 2

DESIGN OVERSIGHT	DESIGN	BY BARNARD T.	CHECKED	LOAD FACTOR DESIGN	LIVE LOADING: *HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD*		PREPARED FOR THE PUBLIC WORKS DEPARTMENT	THOMAS BARNARD PROJECT ENGINEER	BRIDGE NO.
SIGN OFF DATE	DETAILS	BY WALTZ T.	CHECKED	LAYOUT	BY	CHECKED			POST MILE
	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY	PLANS AND SPECS COMPARED			

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4

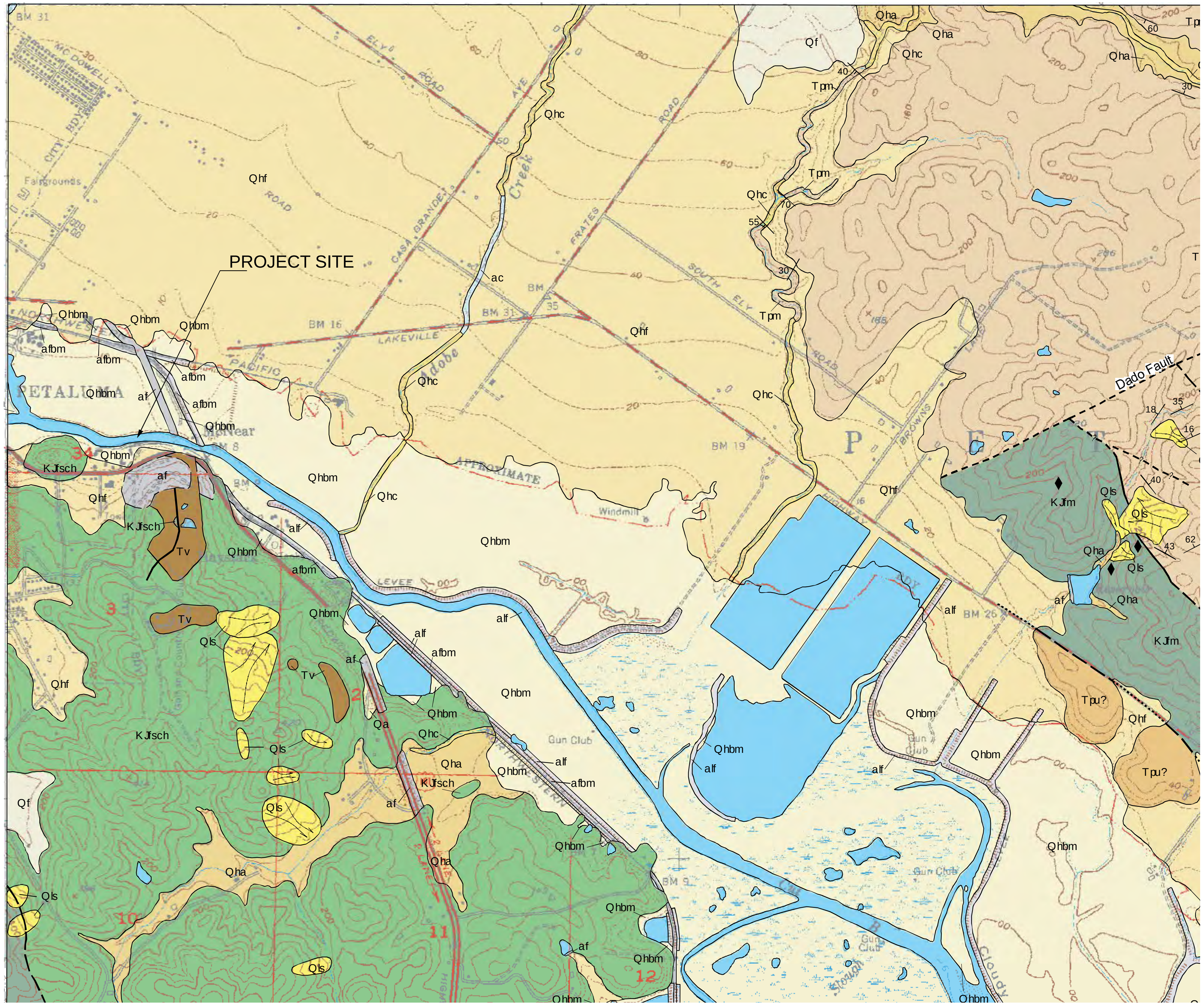
CU
EA

CAULFIELD LANE OVER PETALUMA RIVER

GENERAL PLAN AND ELEVATION

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

C:\CAD\Caulfield 60580130\S-01-C-CG-200' Clr.DWG Time:Nov20,2020-05:50pm
Login:WaltzT Dimscale:20 LTScale:1 Images:
Xrefs:"BDR.DWG""XCONT.dwg



LEGEND

af	Artificial Fill
afbm	Artificial Fill placed over Bay Mud
alf	Artificial Levee Fill
Qhc	Late Holocene to modern stream channel deposits
Qhbm	Holocene Bay Mud deposits
Qhf	Holocene alluvial fan desposits
Qls	Landslides
Tv	Tertiary Volcanic Rock
KJfsch	Franciscan Complex Rock

Source:
Wagner, D. L., Rice, S.R., Bezore S., Randolph-Loar, C.E., Allen J., and Witter R.C., 2002, Geologic map of the Petaluma River 7 1/2' quadrangle, Marin and Sonoma counties, California, a digital database: California Geological Survey.

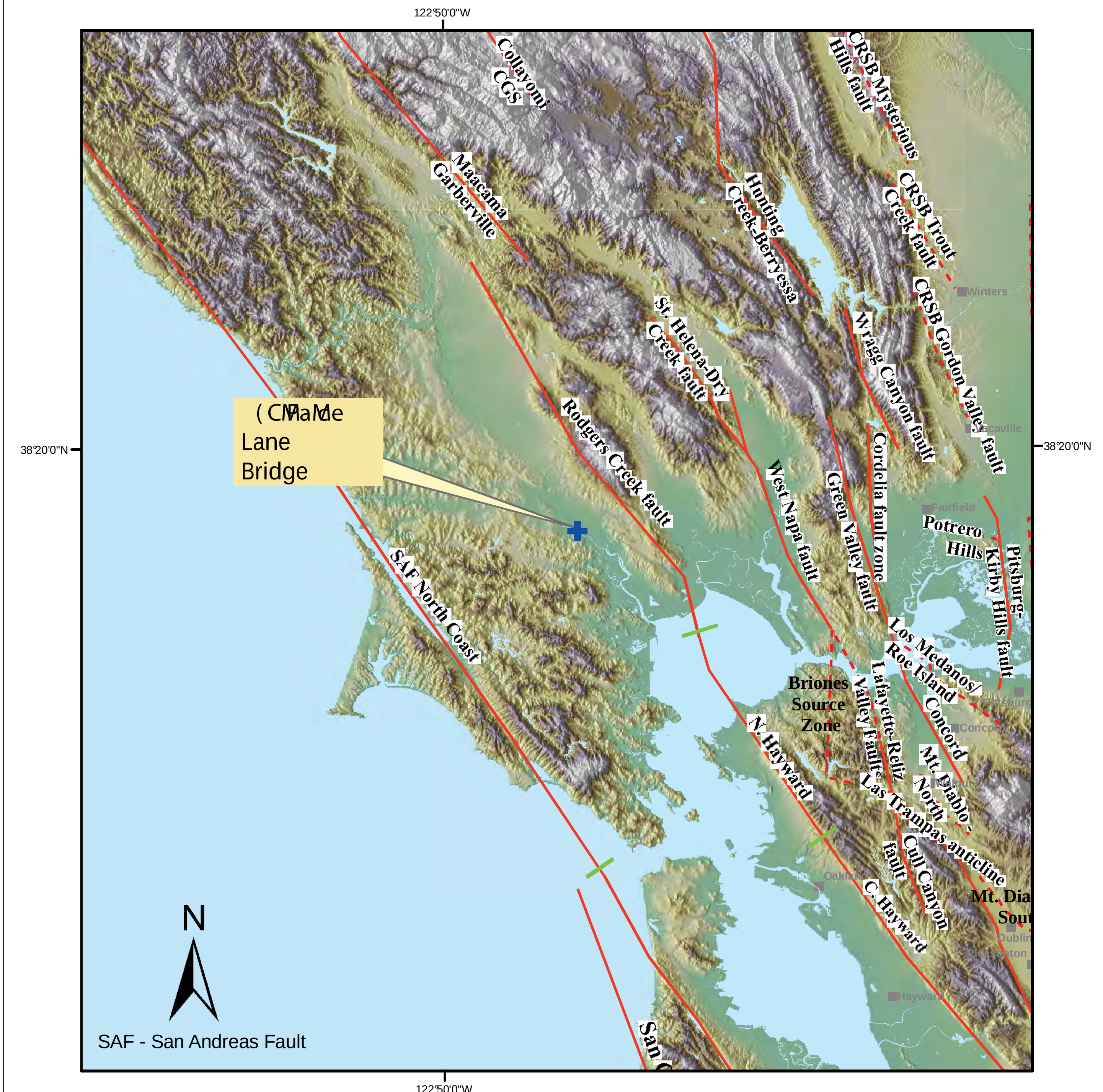
0 2000 4000
SCALE IN FEET

AECOM

Caulfield Lane over Petaluma River
Petaluma, California

Geologic Map

Job 60580130
FIGURE 3
May 2021



7 3.5 0 7 Miles

0 4.5 9 18 27 36 Kilometers

Fault Source: AECOM Seismic Source Model

Faults with surface rupture

Blind faults and zones

Segment boundary

AECOM

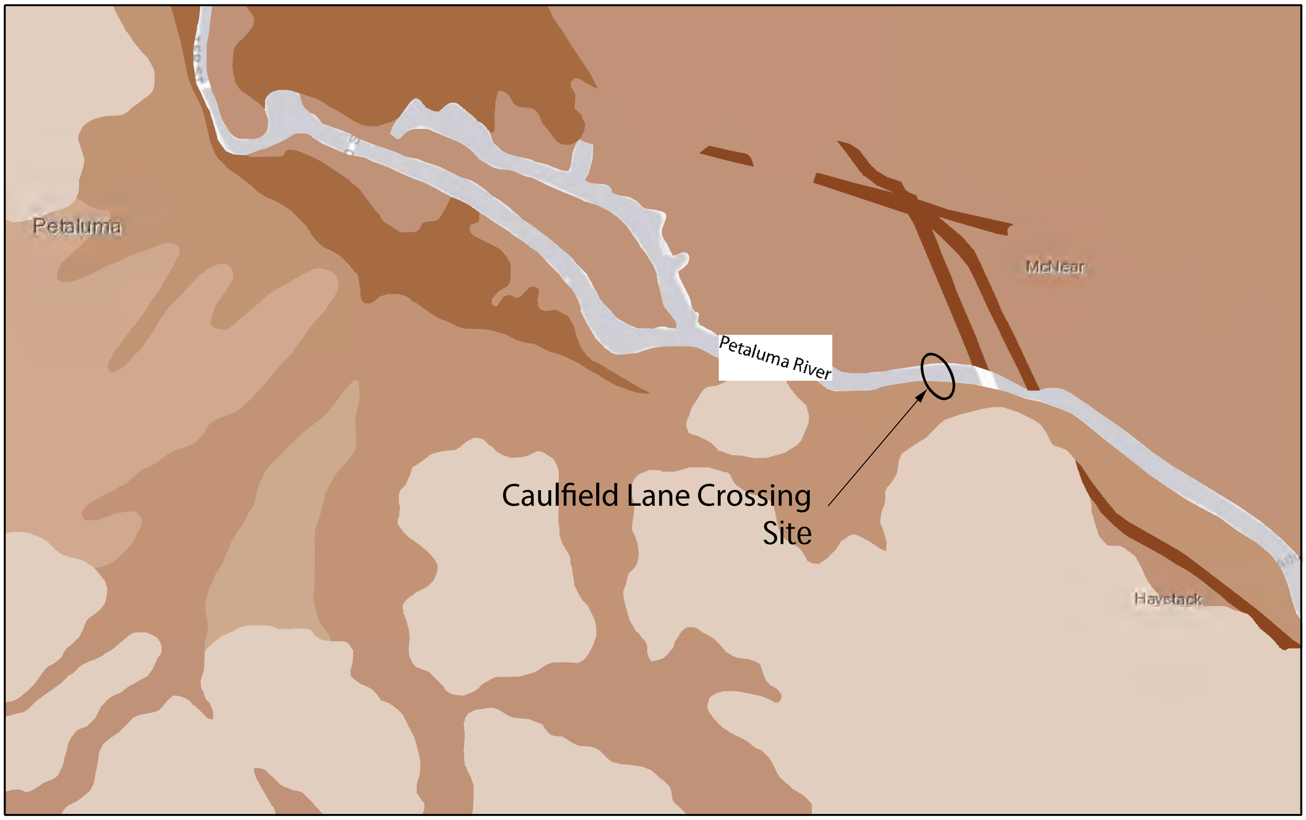
Caulfield Lane over Petaluma River
Petaluma, California

ACTIVE FAULTS IN THE SAN FRANCISCO BAY REGION

Job 60580130

FIGURE 4

May 2021



8/31/2020, 11:20:19 AM

Earthquake Liquefaction Susceptibility: Very low, Low, Moderate, High, Very high

1:18,056

0 0.1 0.2 0.4 mi

0 0.17 0.35 0.7 km

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user

MTC/ABAG

County of Marin, County of Napa, Esri, HERE | County of Marin, County of Napa, Esri, HERE |

AECOM

Caulfield Lane over Petaluma River

Petaluma, California

EARTHQUAKE LIQUEFACTION SUSCEPTIBILITY

Job 60580130

FIGURE 5

May 2021

CAULFIELD LANE OVER PETALUMA RIVER

5/5/2021

CIDH Pile Design Spreadsheet Bascule Abut 2

Based on R-21-001

Preliminary Embedment Estimate

Project Name: City of Petaluma - Caulfield Lane over Pet River
Project Number:
Bridge Name: New

LRFD strength limit state compressive capacity 2405 ton
LRFD strength limit state compressive capacity 21405 kN
Pile Diameter 72 inch
Pile Diameter 6.00 ft

Pile Type: CIDH
Pile Shape: Circular
Pile Surface Area 18.85 sq. ft/ft
Pile Tip Area 28.27 sq. ft.

Boring Surface El. (ft) 10.0
Design GWS El. (ft) 5.0
Unit Weight of Water (pcf) 62.4
Depth with no strength

Bearing capacity factor for gravel
(Berevantsev 1961) ϕ' > 35 deg N'q, max 70
qbase σ'v N'q

AASHTP Figure 10.8.2.2.2-4
settlement compatiblilty δbase / dia 1% 2% **3%**
qT / qT ult 0.3 0.6 0.8

Bottom of Pile Cap El. (ft) 6.0
Bottom of Fill El. (ft) 1
Scour El. (ft) NA

Tip resistance for sand (AASHTO Section 10.8.3.5.2c)
N60 < 50 nominal q_p 1.2*N60 ksf
15 pile dia 90 feet
Overburden: σ' max at 15 pile dia 6811

Layer No. (-)	Layer Elevation Top (feet)	Layer Elevation Bot. (feet)	Lateral Resists?	N_{SPT} (blows/ft)	Cohesion c (psf)	Adhesion Factor α	Ult. Load Transfer f_{si} (psf)	Layer Thickness (feet)	Depth to Layer Center (feet)	Effective Vert. Stress (Cen. Lay.) (psf)	β	f_{max} (psf)	Soil Type G= gran. C=cohes.	delta Lat. Res. Cohesive (ton)	delta Lat. Res. Friction (comp) (ton)	delta Lat. Res. Friction (tensile) (ton)	q_T (granular) (psf)	z/B (-)	Nc (cohesive) (-)	q_T (cohesive) (psf)	Bearing Capacity (B.C.) (ton)	Include B.C.?	Compression Cumulative Axial Res. (skin) (ton)	Compression Cumulative Axial Res. (skin) (kN)	Compression Cumulative Axial Res. (Tot) (ton)	Compression LRFD service-1 Limit State Compressive Capacity (ton)	Tension Cumulative Axial Res. (Skin) (ton)	Tension LRFD service-1 Limit State Capacity (ton)
		10.0																					0	0	0.0	2405	0	
1	10.0	2.0	n	39	0	0.55	0	8.0	4	386.4	1.2	0	c	0.0	0.0	0.0	32500	0.7	6.80	0	0	n	0.0	0	0.0	2405	0.0	
2	2.0	-5.0	n	3	200	0.55	0	7.0	11.5	855.6	1.0	0	c	0.0	0.0	0.0	2500	1.8	8.20	1640	23	n	0.0	0	0.0	2405	0.0	
3	-5.0	-9.0	n	3	200	0.55	0	4.0	17	1081.2	0.9	0	c	0.0	0.0	0.0	2500	2.5	9.00	1800	25	n	0.0	0	0.0	2405	0.0	
4	-9.0	-14.0	n	4	200	0.55	0	5.0	21.5	1311.6	0.9	0	c	0.0	0.0	0.0	3333	3.3	9.00	1800	25	n	0.0	0	0.0	2405	0.0	
5	-14.0	-19.0	n	16	0	0.55	0	5.0	26.5	1619.6	0.8	0	g	0.0	0.0	0.0	19200	4.2	9.00	0	81	n	0.0	0	0.0	2405	0.0	
6	-19.0	-30.0	y	62	0	0.55	0	11.0	34.5	2185.4	0.7	1545	g	0.0	160.2	112.1	152978	6.0	9.00	0	649	y	160.2	1426	809.0	2405	112.1	
7	-30.0	-50.0	y	200	0	0.55	0	20.0	50	3507.0	0.5	1913	g	0.0	360.5	252.4	245490	9.3	9.00	0	1041	y	520.7	4635	1561.9	2405	364.5	
8	-50.0	-102.0	y	200	0	0.55	0	52.0	86	6480.6	0.3	1620	g	0.0	794.0	555.8	453642	18.0	9.00	0	1924	y	1314.8	11701	3238.7	2405	920.3	
Bottom	-102.0																											

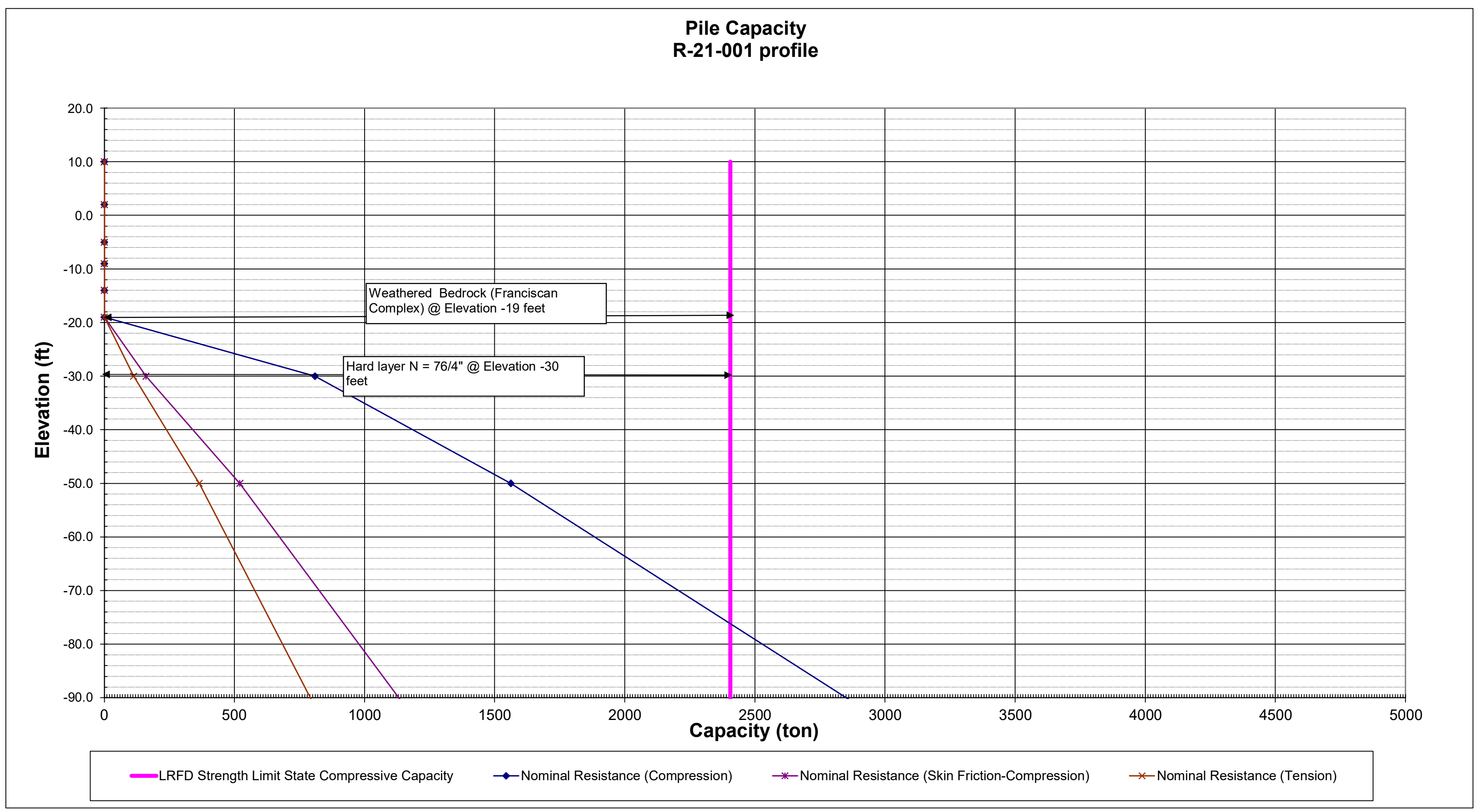


Figure 6

APPENDIX A

As-Built Boring Records

APPENDIX A

SUBSURFACE EXPLORATION AND LABORATORY TESTING

1.0 Subsurface Exploration – Auger Borings

We explored subsurface conditions over southern portions of the site by drilling three test borings on February 14, 2006 utilizing a track mounted drilling rig and 6-inch solid stem augers. The boring location is also shown on Figure 2. The borings were drilled to maximum depths of 41 feet below the ground surface.

The soils encountered were logged and identified by our Field Geologist in general accordance with ASTM Standard D 2487, "Field Identification and Description of Soils (Visual-Manual Procedure)." This standard is briefly explained on Figure A-1, Soil Classification Chart and Key to Log Symbols. The Boring Log is presented on Figures A-2 to A-7.

We obtained “undisturbed” samples using a 3-inch diameter, split-barrel modified California sampler with 2.5 by 6-inch brass tube liners. The sampler was driven with a 140-pound hammer falling 30 inches. The number of blows required to drive the samplers 18 inches was recorded and is reported on the Boring Log as blows per foot for the last 12 inches of driving. The samples obtained were examined in the field, sealed to prevent moisture loss, and transported to our laboratory.

2.0 Cone Penetration Test

The Cone Penetration Test (CPT) is a special exploration technique that provides a continuous profile of data throughout the depth of exploration. It is particularly useful in defining stratigraphy, relative soil strength and in assessing liquefaction potential. We performed four CPTs at the locations shown on the Site Plan, Figure 2.

The CPT is a cylindrical probe, 35 mm in diameter, which is pushed into the ground at a constant rate of 2 cm/sec. The device is illustrated on Figure A-1. It is instrumented to obtain continuous measurements of cone bearing (tip resistance), sleeve friction, and pore water pressure. The data is sensed by strain gages and load cells inside the instrument. Electronic signals from the instrument are continuously recorded by an on-board computer at the surface, which permits an initial evaluation of subsurface conditions during the exploration.

The recorded data is transferred to an in-office computer for reduction and analysis. The analysis of cone bearing and sleeve friction (i.e. friction ratio) indicates the soil type, the cone bearing alone indicates soil density or strength, and the pore pressure indicates the presence of clay. Variations in the data profile indicate changes in stratigraphy. This test method has been standardized and is described in detail by the ASTM Standard Test Method D3441 "Deep, Quasi-Static Cone and Friction Cone Penetration Tests of Soil." The interpretation of CPT data is illustrated on Figure A-8, and the CPT data logs are presented on Figures A-9 and A-10.

3.0 Laboratory Testing

We conducted laboratory tests on selected intact and bulk samples to verify field identifications and to evaluate engineering properties. The following laboratory tests were conducted in accordance with the ASTM standard test method cited and results are shown on the exploratory Boring Logs.

- Laboratory Determination of Water (Moisture Content) of Soil, Rock, and Soil-Aggregate Mixtures, ASTM D 2216; and,
- Density of Soil in Place by the Drive-Cylinder Method, ASTM D 2937;

The exploratory Boring Log, description of soils encountered, and the laboratory test data reflect conditions only at the location of the boring 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.

SOIL CLASSIFICATION CHART

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 gravely sands, little or no fines
		SP	Poorly-graded sands or gravely 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

- AL ATTERBERG LIMITS TEST
- SA SIEVE ANALYSIS
- HYD HYDROMETER ANALYSIS
- P200 PERCENT PASSING NO. 200 SIEVE
- P4 PERCENT PASSING NO. 4 SIEVE

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 TYPE

UNDISTURBED CORE SAMPLE: MODIFIED CALIFORNIA OR HYDRAULIC PISTON SAMPLE

STANDARD PENETRATION TEST SAMPLE

X DISTURBED OR BULK SAMPLE

ROCK OR CORE SAMPLE

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 locations and with the passage of time. Lines defining interface between differing soil or rock description are approximate and may indicate a gradual transition.

FILE: 1130.08SC_A-1.dwg

BORING 1

EQUIPMENT: Morooka MST-600 w/ 6" solid flight augers and clay teeth
DATE: 2/14/06
ELEVATION: 14 feet
*REFERENCE: Prelim. Topo Map provided by Steven J. Lafranchi and Assoc.

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
					0	0			CLAYEY SILT (MH) (BAY MUD) gray, moist, moderate plasticity, soft to medium stiff in upper five feet, then soft
					1				
						5			
		12	38.3	77	2		■		
					3	10			grades to saturated
					4				
						15			
					5				
					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)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1130.08BL2.dwg

Miller Pacific ENGINEERING GROUP	BORING LOG Basin Street - Riverfront Subdivision Petaluma, California	A-2
Project No. 1130.08	Date 3/15/06	Approved By:	Figure

BORING 1
(CONTINUED)

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	DESCRIPTION
						20			CLAYEY SILT (MH) (BAY MUD) gray, saturated, soft
					7				
						25			
					8				
					9				
						30			
					10				
						35			drilling stiffens
					11				CLAYEY SAND/SANDY CLAY (SC/CL) yellow, moist, dense
									Bottom of boring at 38 feet
					12				
						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)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1130.08BL2.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
Basin Street - Riverfront Subdivision
Petaluma, California

A-3

Project No. 1130.08 | Date 3/15/06 | Approved By:

Figure

BENCH MARK:
B.M: JK 121 Elev 81.98'
1" Iron pipe with a plastic plug and tack along the northbound shoulder of State Route 101 across from a "Sonoma-Napa-Right Lane" sign; 10.7 feet easterly of a metal beam guard rail and at top of slope.
NAVD 1988
B.M: JK122 Elev 52.65'
1" Iron pipe with a plastic plug and tack along the northbound median of State Route 101; 50' northerly of a "Petaluma Blvd South-3/4 mile" sign; 16 feet westerly of the edge of pavement and witnessed by a carsonite witness post.
NAVD 1988

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL — 7/29/11 DATE
PLANS APPROVAL DATE
Registered Professional Engineer — Stephen Huang — No. C 42289 — Exp. 03/31/12 — GEOTECHNICAL — State of California

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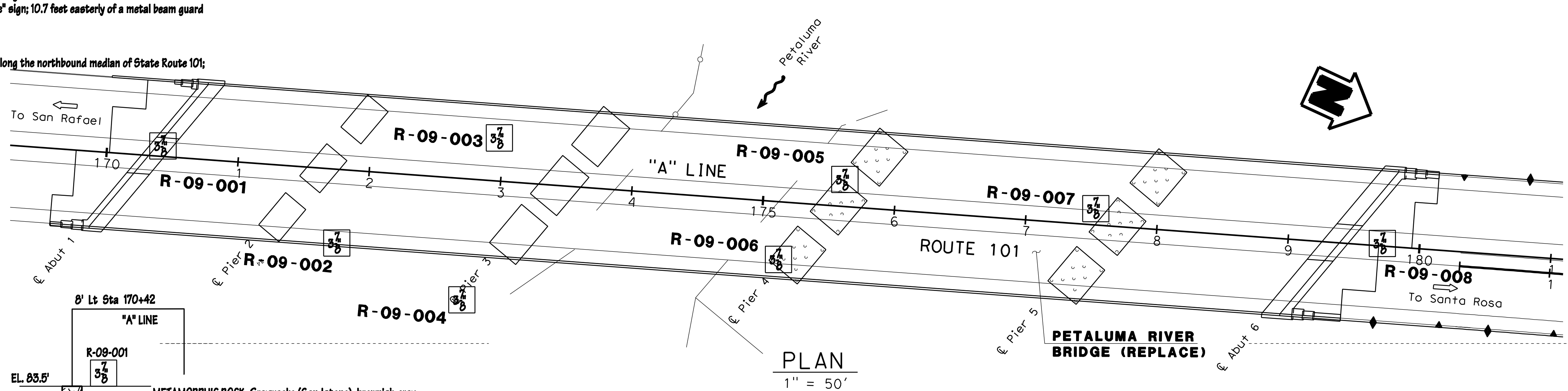
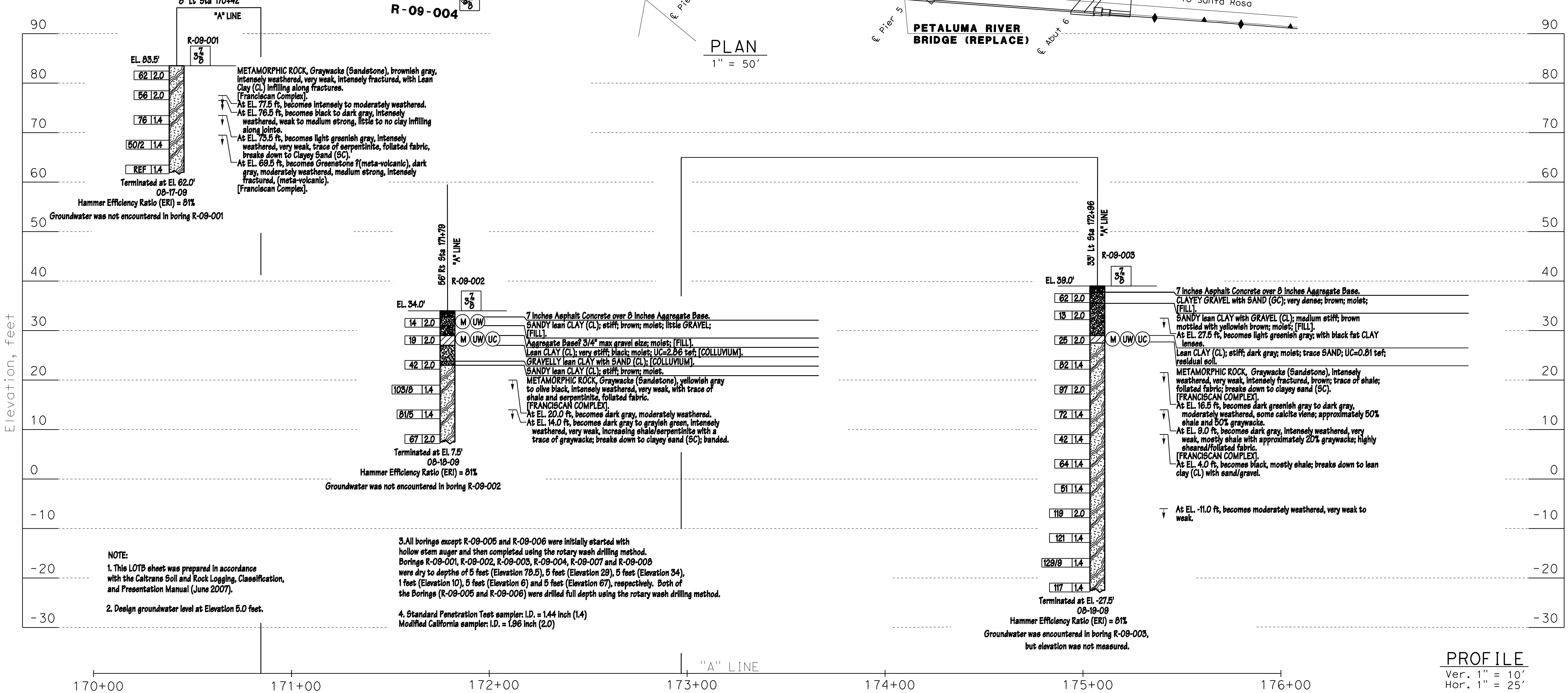
SAN JOSE, CA 95113

SONOMA COUNTY TRANSPORTATION AUTHORITY
490 MENDOCINO AVENUE, SUITE 206
SANTA ROSA, CA 95401



PLAN
1" = 50'



NOTE:

1. This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (June 2007).

2. Design groundwater level at Elevation 5.0 feet.

3. All borings except R-09-005 and R-09-006 were initially started with hollow stem auger and then completed using the rotary wash drilling method. Borings R-09-001, R-09-002, R-09-003, R-09-004, R-09-007 and R-09-008 were dry to depths of 5 feet (Elevation 78.5), 5 feet (Elevation 29), 5 feet (Elevation 34), 1 feet (Elevation 10), 5 feet (Elevation 6) and 5 feet (Elevation 67), respectively. Both of the Borings (R-09-005 and R-09-006) were drilled full depth using the rotary wash drilling method.

4. Standard Penetration Test sampler: I.D. = 1.44 inch (1.4)
Modified California sampler: I.D. = 1.96 inch (2.0)

PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	A. CHEUNG
SIGN OFF DATE	CHECKED BY	MANOHARAN

C. RAMBO
FIELD INVESTIGATION BY:
DATE:

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. 20-0295
POST MILES 3.23

PETALUMA RIVER BRIDGE (REPLACE)
LOG OF TEST BORINGS 1 OF 7

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL 7/29/11 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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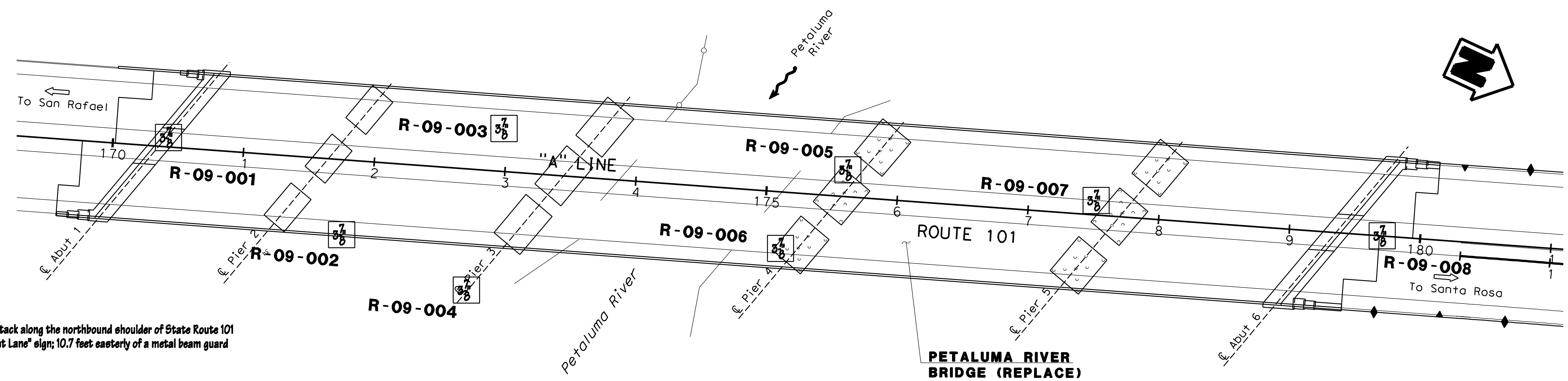
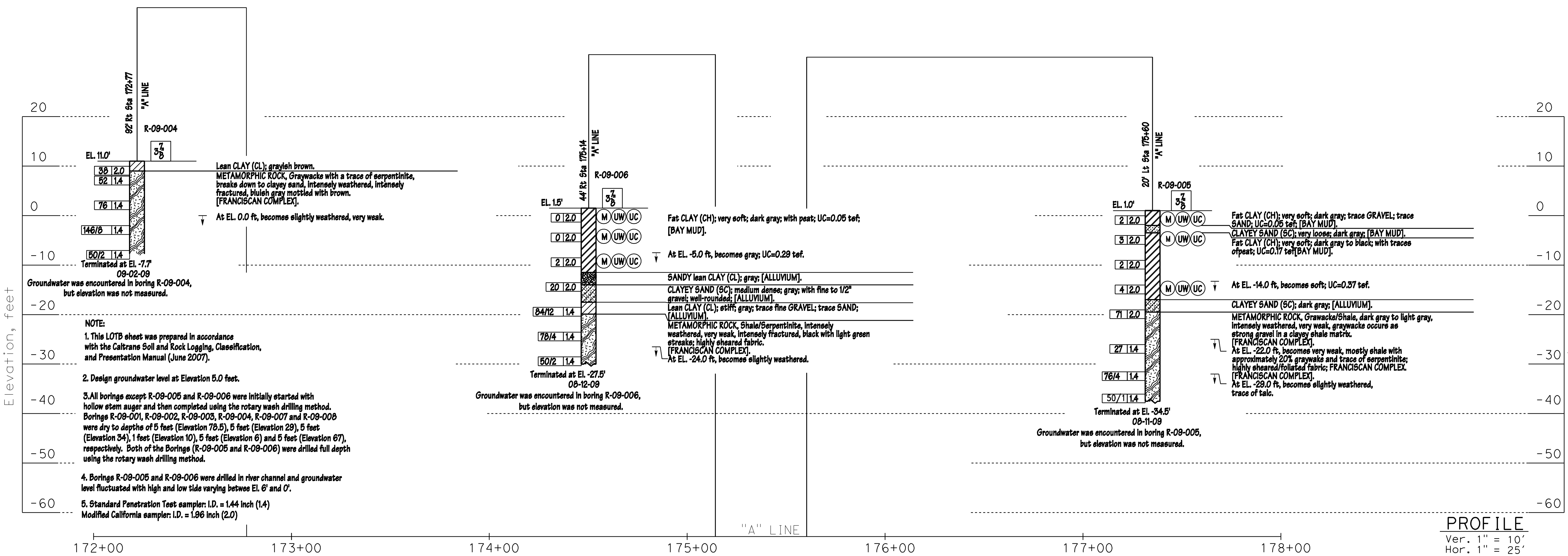
SONOMA COUNTY TRANSPORTATION AUTHORITY
490 MENDOCINO AVENUE, SUITE 206
SANTA ROSA, CA 95401



PLAN
1" = 50'

BENCH MARK:
B.M: JK 121 Elev 81.98'
1" Iron pipe with a plastic plug and tack along the northbound shoulder of State Route 101 across from a "Sonoma-Napa-Right Lane" sign; 10.7 feet easterly of a metal beam guard rail and at top of slope.
NAVD 1988
B.M: JK122 Elev 52.65'
1" Iron pipe with a plastic plug and tack along the northbound median of State Route 101; 50' northerly of a "Petaluma Blvd South-3/4 mile" sign; 16 feet westerly of the edge of pavement and witnessed by a carsonite witness post.
NAVD 1988



NOTE:

1. This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (June 2007).

2. Design groundwater level at Elevation 5.0 feet.

3. All borings except R-09-005 and R-09-006 were initially started with hollow stem auger and then completed using the rotary wash drilling method. Borings R-09-001, R-09-002, R-09-003, R-09-004, R-09-007 and R-09-008 were dry to depths of 5 feet (Elevation 78.5), 5 feet (Elevation 29), 5 feet (Elevation 34), 1 feet (Elevation 10), 5 feet (Elevation 6) and 5 feet (Elevation 67), respectively. Both of the Borings (R-09-005 and R-09-006) were drilled full depth using the rotary wash drilling method.

4. Borings R-09-005 and R-09-006 were drilled in river channel and groundwater level fluctuated with high and low tide varying betwee El. 6' and 0'.

5. Standard Penetration Test sampler: I.D. = 1.44 inch (1.4)
Modified California sampler: I.D. = 1.96 inch (2.0)

PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	A. CHEUNG	C. RAMBO
SIGN OFF DATE	CHECKED BY	MANOHARAN	FIELD INVESTIGATION BY: DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. 20-0295
POST MILES 3.23

PETALUMA RIVER BRIDGE (REPLACE)

LOG OF TEST BORINGS 2 OF 7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341 CONTRACT NO.: 04-264081

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES 5-5-10 10-28-10 5-20-11 7-29-11 SHEET OF

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USERNAME => Andrew_Cheung DATE PLOTTED => 9/7/2011 TIME PLOTTED => 12:16:36 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL 7/29/11 DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 03/31/12 — GEOTECHNICAL — STATE OF CALIFORNIA

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SAN JOSE, CA 95113

SONOMA COUNTY TRANSPORTATION AUTHORITY
490 MENDOCINO AVENUE, SUITE 206
SANTA ROSA, CA 95401

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NAVD 1988
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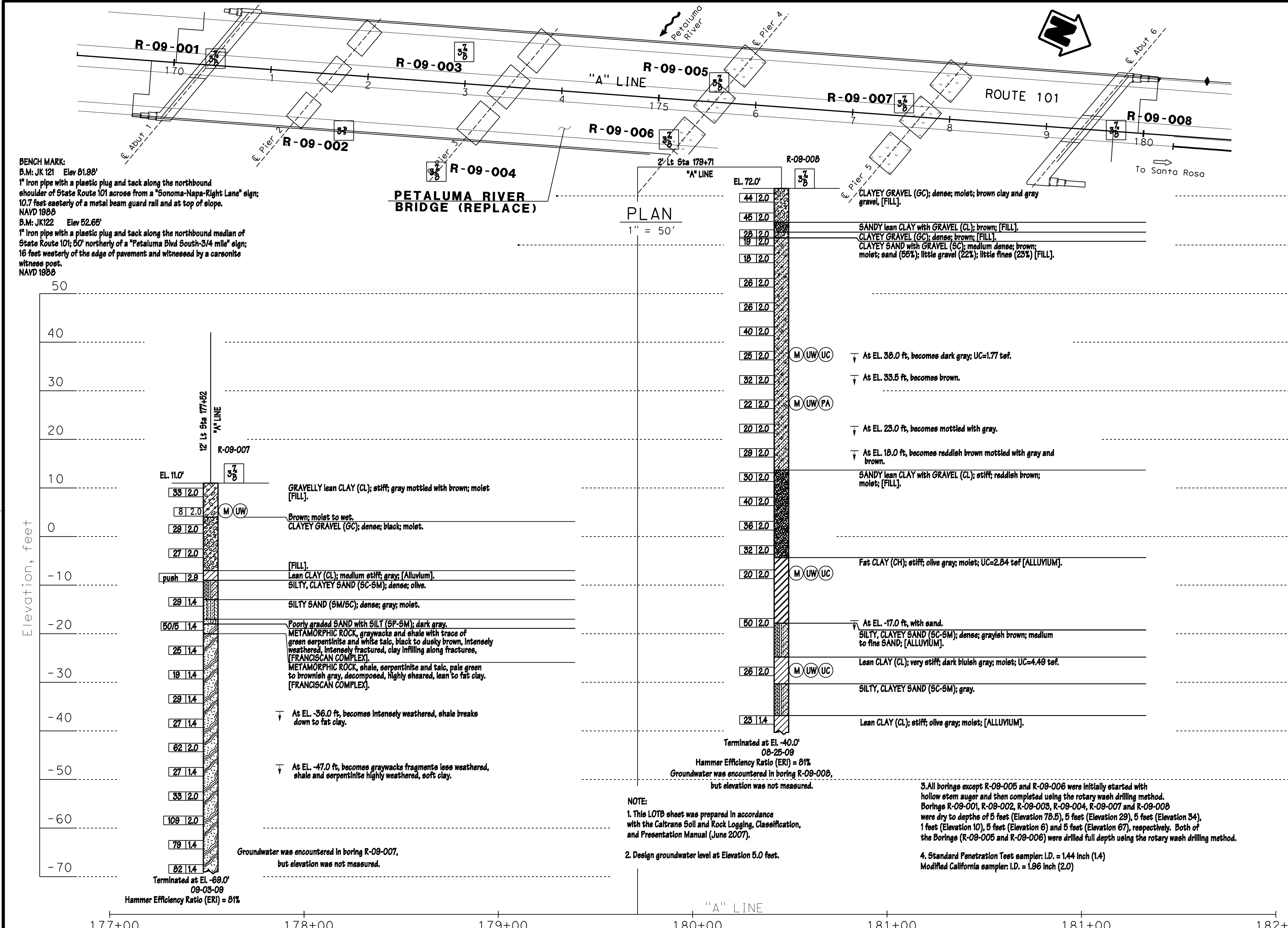
1" Iron pipe with a plastic plug and tack along the northbound median of State Route 101; 50' northerly of a "Petaluma Blvd South-3/4 mile" sign; 16 feet westerly of the edge of pavement and witnessed by a carsonite witness post.
NAVD 1988



NOTE:

1. This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (June 2007).
2. Design groundwater level at Elevation 5.0 feet.
3. All borings except R-09-005 and R-09-006 were initially started with hollow stem auger and then completed using the rotary wash drilling method. Borings R-09-001, R-09-002, R-09-003, R-09-004, R-09-007 and R-09-008 were dry to depths of 5 feet (Elevation 78.5), 5 feet (Elevation 29), 5 feet (Elevation 34), 1 feet (Elevation 10), 5 feet (Elevation 6) and 5 feet (Elevation 67), respectively. Both of the Borings (R-09-005 and R-09-006) were drilled full depth using the rotary wash drilling method.
4. Standard Penetration Test sampler: I.D. = 1.44 inch (1.4)
Modified California sampler: I.D. = 1.96 inch (2.0)

DESIGN OVERSIGHT	DRAWN BY: A. CHEUNG	C. RAMBO FIELD INVESTIGATION BY:	
SIGN OFF DATE	CHECKED BY: MANOHARAN	DATE:	

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG — PROJECT ENGINEER

BRIDGE NO. 20-0295 — POST MILES 3.23

PETALUMA RIVER BRIDGE (REPLACE)

LOG OF TEST BORINGS 3 OF 7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341 CONTRACT NO.: 04-264081

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES: 5-5-10, 10-28-10, 5-20-11, 7-29-11 — SHEET OF

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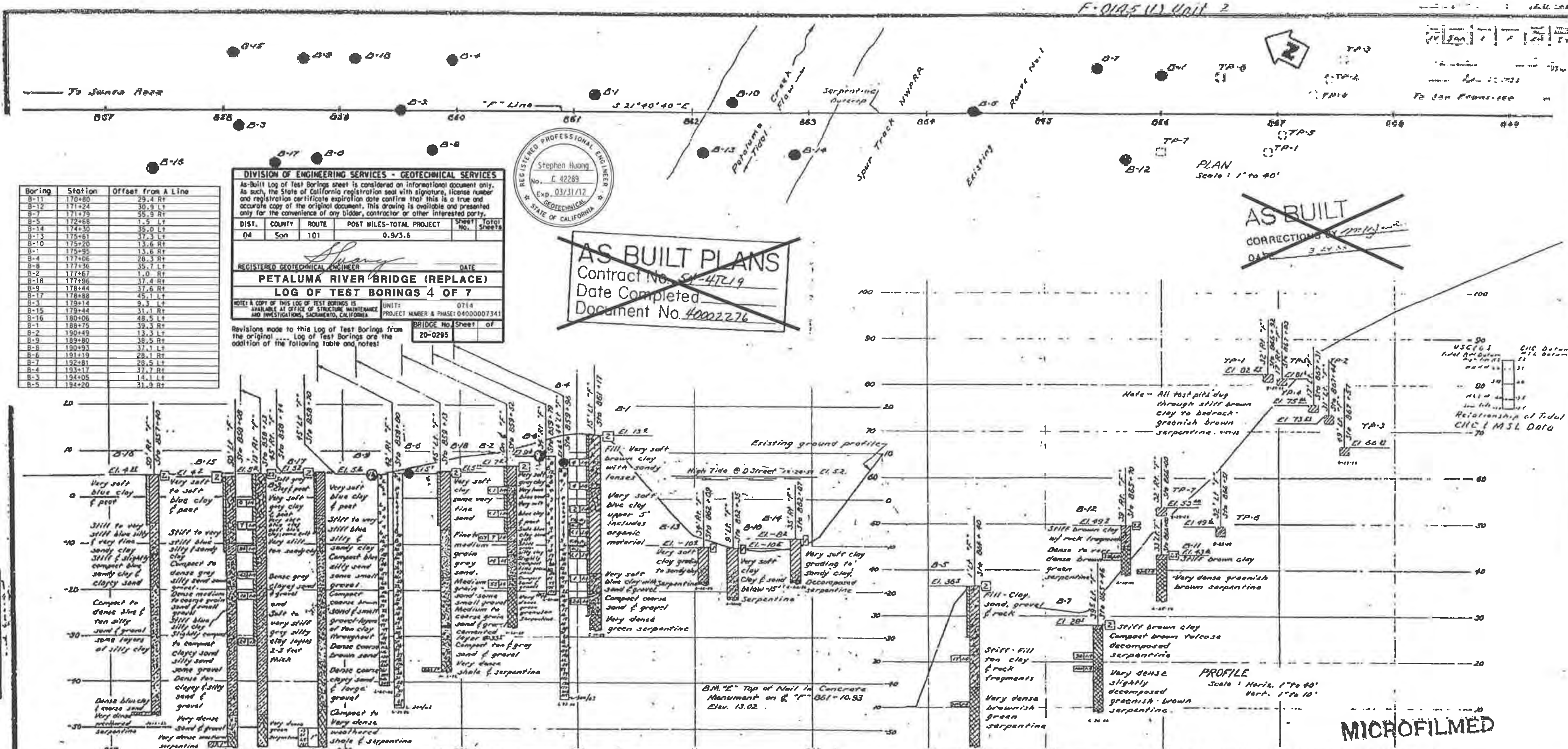
F-0195 (1) Unit 2



Boring	Station	Offset from A Line
B-11	170+80	29.4 Rt
B-12	171+24	30.9 Lt
B-7	171+79	55.9 Rt
B-5	172+68	1.5 Lt
B-14	174+30	35.0 Lt
B-13	175+61	37.3 Lt
B-10	175+20	13.6 Rt
B-1	175+95	13.6 Rt
B-4	177+06	28.3 Rt
B-8	177+36	35.7 Lt
B-2	177+67	1.0 Rt
B-18	177+96	37.4 Rt
B-9	178+44	37.6 Rt
B-17	178+88	45.1 Lt
B-3	179+14	9.3 Lt
B-15	179+44	31.1 Rt
B-16	180+06	48.5 Lt
B-1	188+75	39.3 Rt
B-2	190+49	13.3 Lt
B-9	189+80	38.5 Rt
B-8	190+93	37.1 Lt
B-6	191+19	28.1 Rt
B-7	192+81	28.5 Lt
B-4	193+17	37.7 Rt
B-3	194+05	14.1 Lt
B-5	194+20	31.9 Rt

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
04	Son	101	0.9/3.6		

REGISTERED GEOTECHNICAL ENGINEER — DATE

PETALUMA RIVER BRIDGE (REPLACE)

LOG OF TEST BORINGS 4 OF 7

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341

BRIDGE No.	Sheet	of
20-0295		

Revisions made to this Log of Test Borings from the original ____ Log of Test Borings are the addition of the following table and notes:

AS BUILT PLANS
Contract No. 04-4T219
Date Completed
Document No. 40002276

AS BUILT
CORRECTIONS BY
Date

BRIDGE DEPARTMENT

MICROFILMED

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

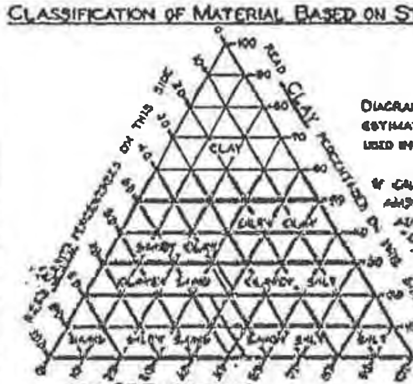


Diagram showing the basis for estimates of grade size distribution used in determination of class names

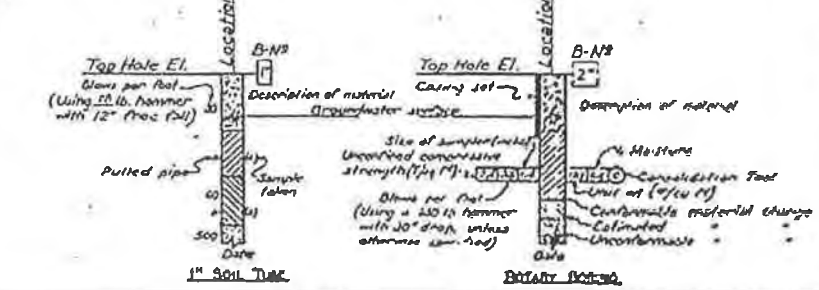
If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand". The terms "coarse", "medium" and "fine" when used to describe gravel, sand and silt pertain to standard grade size limits.

LEGEND OF EARTH MATERIALS

- Gravel
- Sand
- Silt
- Clay
- Sandy Clay or Clayey Sand
- Sandy Silt or Silty Sand
- Silty Clay or Clayey Silt
- Peat and/or Organic Clay
- Filled Material
- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

LEGEND OF BORING OPERATIONS

- Plan of any boring
- Penetrometer
- 2½" Cone penetrometer
- Sampler boring (dry)
- Rotary boring (wet)
- Auger boring (dry)
- Jet boring
- Core boring
- Test pit



NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

Penetrometer borings having a rate of penetration measured in seconds per foot are driven with a Nº 2 McKiernan-Terry air hammer at 115 psi.

BRIDGE ACROSS PETALUMA CREEK

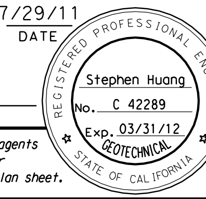
LOG OF TEST BORINGS

Scale: As Noted	Bridge 20-154	File	Drawing F-7619-24

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE ... UNDER MY DIRECTION AND CONTROL ...

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL 7/29/11 DATE



PLANS APPROVAL DATE

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SAN JOSE, CA 95113

SONOMA COUNTY TRANSPORTATION AUTHORITY
490 MENDOCINO AVENUE, SUITE 206
SANTA ROSA, CA 95401

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

CONSISTENCY OF COHESIVE SOILS

Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

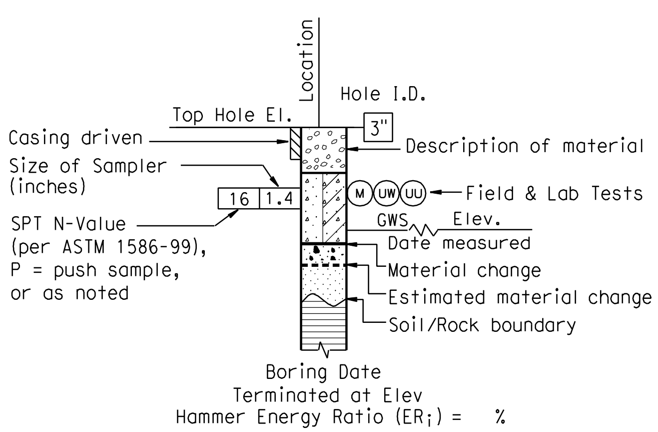
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size (square)	A	Auger Boring
Size (square)	R P	Rotary drilled boring Rotary percussion boring (air)
Size (diamond)	R	Rotary drilled diamond core
Size (rectangle)	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778-95)
(dashed square)	O	Other

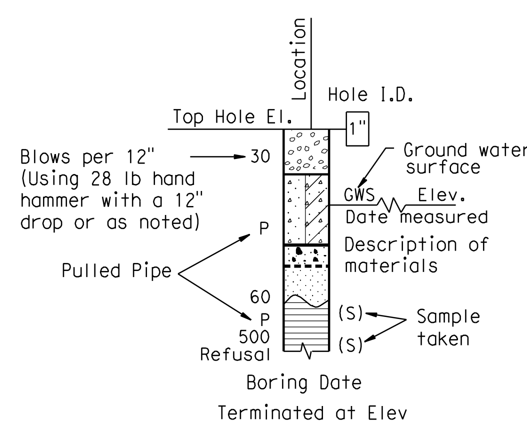
Note: Size in inches.

PLASTICITY OF FINE-GRAINED SOILS

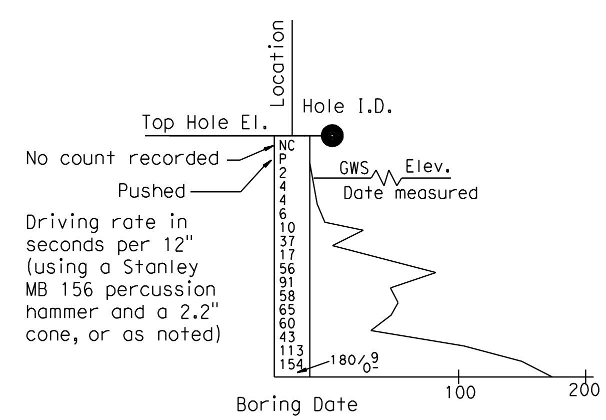
Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.



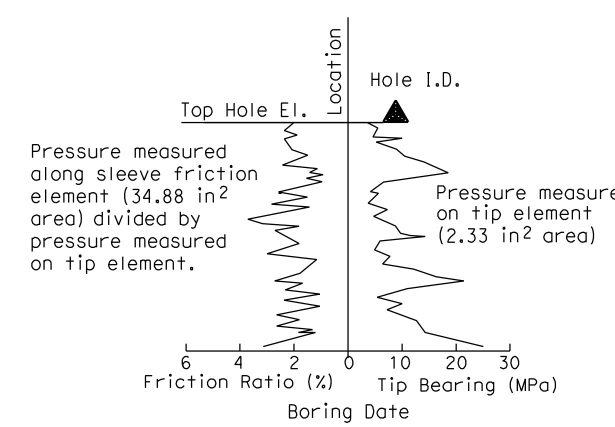
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

SOIL LEGEND

DESIGN OVERSIGHT	DRAWN BY	A. CHEUNG	C. RAMBO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG	BRIDGE NO. 20-0295	PETALUMA RIVER BRIDGE (REPLACE)
SIGN OFF DATE	CHECKED BY	MANOHARAN	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER	POST MILES 3.23	LOG OF TEST BORINGS 5 OF 7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341 CONTRACT NO.: 04-264081

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES 5-5-10 10-28-10 5-20-11 7-29-11 SHEET OF

FILE => ...\20-0295-z-ltb01.dgn

USERNAME => Andrew_Cheung DATE PLOTTED => 9/7/2011 TIME PLOTTED => 12:15:51 PM

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL 7/29/11 DATE

PLANS APPROVAL DATE

Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL REGISTERED PROFESSIONAL ENGINEER STATE OF CALIFORNIA

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SONOMA COUNTY TRANSPORTATION AUTHORITY
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SANTA ROSA, CA 95401

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic/Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTING

C	Consolidation (ASTM D 2435)
CL	Collapse Potential (ASTM D 5333)
CP	Compaction Curve (CTM 216)
CR	Corrosivity Testing (CTM 643, CTM 422, CTM 417)
CU	Consolidated Undrained Triaxial (ASTM D 4767)
DS	Direct Shear (ASTM D 3080)
EI	Expansion Index (ASTM D 4829)
M	Moisture Content (ASTM D 2216)
OC	Organic Content-% (ASTM D 2974)
P	Permeability (CTM 220)
PA	Particle Size Analysis (ASTM D 422)
PI	Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
PL	Point Load Index (ASTM D 5731)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301)
SE	Sand Equivalent (CTM 217)
SG	Specific Gravity (AASHTO T 100)
SL	Shrinkage Limit (ASTM D 427)
SW	Swell Potential (ASTM D 4546)
TV	Pocket Torvane
UC	Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850)
UW	Unit Weight (ASTM D 4767)
VS	Vane Shear (AASHTO T 223)

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		> 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

SOIL LEGEND

DESIGN OVERSIGHT	DRAWN BY	A. CHEUNG
SIGN OFF DATE	CHECKED BY	MANOHARAN

FIELD INVESTIGATION BY: C. RAMBO

DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. 20-0295
POST MILES 3.23

PETALUMA RIVER BRIDGE (REPLACE)

LOG OF TEST BORINGS 6 OF 7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341
CONTRACT NO.: 04-264081

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES: 5-5-10, 10-28-10, 5-20-11, 7-29-11 SHEET OF

FILE => ...\20-0295-z-ltb02.dgn

USERNAME => Andrew_Cheung DATE PLOTTED => 9/7/2011 TIME PLOTTED => 12:16:00 PM

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	Son	101	0.9/3.6		

GEOTECHNICAL PROFESSIONAL 7/29/11 DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

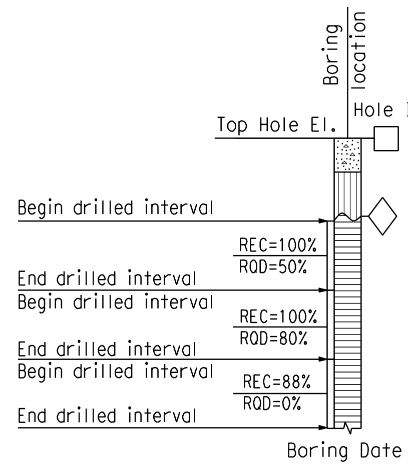
URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SONOMA COUNTY TRANSPORTATION AUTHORITY
490 MENDOCINO AVENUE, SUITE 206
SANTA ROSA, CA 95401

PERCENT CORE RECOVERY (REC) & ROCK QUALITY DESIGNATION (RQD)

$$REC = \frac{\sum \text{Length of the recovered core pieces (inches)}}{\text{Total length of core run (inches)}} \times 100\%$$

$$RQD = \frac{\sum \text{Length of intact core pieces} \geq 4''}{\text{Total length of core run (inches)}} \times 100\%$$



RELATIVE STRENGTH OF INTACT ROCK

Term	Uniaxial Compressive Strength (PSI)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

BEDDING SPACING

Description	Thickness / Spacing
Massive	Greater than 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8" to 1 ft
Thinly bedded	1-1/4" to 3-5/8"
Very thinly bedded	3/8" to 1-1/4"
Laminated	Less than 3/8"

LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

ROCK HARDNESS

Description	Criteria
Extremely Hard	Specimen cannot be scratched with a pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows.
Very Hard	Specimen cannot be scratched with a pocket knife or sharp pick. Breaks with repeated heavy hammer blows.
Hard	Specimen can be scratched with a pocket knife or sharp pick with difficulty (heavy pressure). Heavy hammer blows required to break specimen.
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure. Core breaks with moderate hammer pressure.
Moderately Soft	Specimen can be grooved 1/6" deep with a pocket knife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Specimen can be grooved or gouged easily by a pocket knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very Soft	Specimen can be readily indented, grooved or gouged with fingernail, or carved with a pocket knife. Breaks with light manual pressure.

FRACTURE DENSITY

Description	Observed Fracture Density
Unfractured	No fractures.
Very slightly fractured	Lengths greater than 3 feet.
Slightly fractured	Lengths from 1 to 3 feet with few lengths less than 1 foot or greater than 3 feet.
Moderately fractured	Lengths mostly in 4" to 1 foot range with most lengths about 8"
Intensely fractured	Lengths average from 1 to 4" with scattered fragmented intervals with lengths less than 4"
Very intensely fractured	Mostly chips and fragments with a few scattered short core lengths.

Combination descriptors (such as "Very intensely to intensely fractured") are used where equal distribution of both fracture density characteristics is present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions. Only two adjacent descriptors may be combined.

WEATHERING DESCRIPTORS FOR INTACT ROCK

Description	Diagnostic features					General Characteristics
	Chemical Weathering-Discoloration and/or oxidation		Mechanical Weathering-Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Texture and Solutioning		
	Body of Rock	Fracture Surfaces		Texture	Solutioning	
Fresh	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change.	No solutioning.	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved.	Minor leaching of some soluble minerals may be noted.	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved.	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in-situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Combination descriptors (such as "slightly weathered to fresh") are permissible where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant, identifiable zones can be delineated. Only two adjacent descriptors may be combined. "Very intensely weathered" is the combination descriptor for "intensely weathered to decomposed."

ROCK LEGEND

DESIGN OVERSIGHT	DRAWN BY	A. CHEUNG	C. RAMBO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG PROJECT ENGINEER	BRIDGE NO. 20-0295	PETALUMA RIVER BRIDGE (REPLACE)
SIGN OFF DATE	CHECKED BY	MANOHARAN	FIELD INVESTIGATION BY: DATE:			POST MILES 3.23	LOG OF TEST BORINGS 7 OF 7

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0714
PROJECT NUMBER & PHASE: 04000007341 CONTRACT NO.: 04-264081

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES 5-5-10 10-28-10 5-20-11 7-29-11 SHEET OF

FILE => ...\20-0295-z-ltb03.dgn

USERNAME => Andrew_Cheung DATE PLOTTED => 9/7/2011 TIME PLOTTED => 12:16:09 PM

Date Begin - End:	4/15/2014 - 4/16/2014	**Drill Company:**	Pitcher		**BORING LOG B-101**
Logged By:	JCR	**Drill Crew:**			
Hor.-Vert. Datum:	Not Available	**Drill Equipment:**	Fraste Multidrill XL	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Mud Rotary		
Weather:	Fair	**Auger Diameter:**	4-7/8 in. O.D.		

FIELD EXPLORATION / LABORATORY RESULTS

No Coordinates Available
No Elevation Available
Surface Condition: Gravel

Depth (feet)	Graphical Log	Description	Sample Type	Blow Counts(BC)= Uncorr. blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
		Silty Sandy GRAVEL (GM): Approx. 40% gravel, Approx. 30% sand, Approx. 30% fines, green brown, dry, medium dense, fine to coarse sand, subangular gravel up to 0.75" in diameter (FILL) woody debris at contact											Trash barrel to 3.5' Install casing to approximately 8.5'
5		**SILT/ CLAY (MH-CH)**: Approx. 100% fines, gray blue, wet, soft, (Bay Mud)											
10		shell fragments, organic fragments											Logged from cuttings only
15													
20		olive gray, clay in cuttings											
		CLAY (CH): Approx. 100% fines, olive gray brown, moist, soft to firm, trace fine grained sand (alluvium)											
25				BC=3 3 4	77%								
		SAND with Silt (SM): Approx. 5% sand, Approx. 95% fines, gray blue, yellow gray, wet, loose to medium dense, coarseness with depth (alluvium)		PP=2.75 BC=5 5 5	66%								Pressure test: 28' to 30.5'
30		**SAND with Gravel (SP)**: Approx. 80% sand, Approx. 20% fines, wet, dense, fine to coarse gravel, subrounded, gravel to 0.4" in diameter (alluvium)		BC=2 26 41	94%								Pressure test: 30.5' to 33' Switch to 3-7/8" tri-core
		Sandy CLAY (CL): Approx. 70% sand, Approx. 30% fines, low plasticity, gray olive, moist, firm, organic fragments, thin sand lense (alluvium)		BC=5 10	66%								

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Bright People. Right Solutions.

PROJECT NO.: 138314	BORING LOG B-101		PLATE
DRAWN BY: AG			A-3
CHECKED BY: JCR	Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California		
DATE: 4/22/2014			
REVISED:			PAGE: 1 of 3

Date Begin - End:	4/15/2014 - 4/16/2014	**Drill Company:**	Pitcher		**BORING LOG B-101**
Logged By:	JCR	**Drill Crew:**			
Hor.-Vert. Datum:	Not Available	**Drill Equipment:**	Fraste Multidrill XL	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	**Exploration Method:**	Mud Rotary		
Weather:	Fair	**Auger Diameter:**	4-7/8 in. O.D.		

FIELD EXPLORATION / LABORATORY RESULTS

No Coordinates Available
No Elevation Available
Surface Condition: Gravel

Depth (feet)	Graphical Log	Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
				20 PP=3.0									Pressure at 34.5' to 37' break for length
		SERPENTINITE: olive gray, blue, brown, moderate to slightly weathered, extremely weak (R0), pervasively sheared											
		yellow brown silty sand in cuttings											
40		gray blue											
				BC=50/6"	100%								Pressure test 43.5' to 46'
45													
		increased rock fragments in cuttings, rig chatter starting at 47.5' heavy rig chatter											
50													
		gray blue clay in cuttings,rig chatter at 52'											
				BC=17 18 23	44%								Pressure test 53.5' to 56'
55		blue green, gray blue, slightly weathered, extremely weak (R0), pervasively sheared											
		gray blue clay											
				BC=17 27 40	44%								Pressure test 58.5' to 61'
60		heavy rig chatter											
		smoother drilling at 63'		BC=34 44 50/5"	44%								
65													
		dark green, slightly weathered, extremely weak (R0), pervasively sheared, brittle, slakey and talcy		BC=30 50/5"	83%								Pressure test 68.5' to 71' smooth drilling

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PROJECT NO.: 138314	BORING LOG B-101	PLATE
DRAWN BY: AG		
CHECKED BY: JCR	Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California	A-3
DATE: 4/22/2014		
REVISED:		PAGE: 2 of 3

Date Begin - End:	4/15/2014 - 4/16/2014	Drill Company:	Pitcher	BORING LOG B-101
Logged By:	JCR	Drill Crew:		
Hor.-Vert. Datum:	Not Available	Drill Equipment:	Fraste Multidrill XL	Hammer Type - Drop: 140 lb. Auto - 30 in.
Exploration Plunge:	-90 degrees	Exploration Method:	Mud Rotary	
Weather:	Fair	Auger Diameter:	4-7/8 in. O.D.	

FIELD EXPLORATION / LABORATORY RESULTS

No Coordinates Available
No Elevation Available
Surface Condition: Gravel

Depth (feet)	Lithologic Description	Blow Counts(BC)= Uncorr. blows/6 in. Pocket Pen(PP)= tsf	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Density (pcf)	Passing No.4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (NV=No Value)	Plasticity Index (NP=No Plasticity)	Other Tests/ Remarks
	SERPENTINITE										
	gray blue, black, localized argillitic banding, cohesive, (R0/R1), very finely foliated	BC=20 37 50/3.5"	17%								
75											
	ARGILLITE: dark gray to black with green, localized serpentinized bands, slightly weathered, extremely weak-weak (R0-R1), pervasively sheared, foliated, cohesive	BC=14 31 46	33%								Pressure test 78.5' to 81'
80		BC=25 50/5"	46%								
	SERPENTINITE: dark gray, green, grayish blue, slightly weathered, extremely weak (R0), pervasively sheared	BC=20 31 50/3"	28%								
85											
	gray blue clay in cuttings 88'										Pressure test 88.5' to 91'
	slightly cohesive with talcy texture										
90	minor rig chatter										
	Harder drilling, at 94' moderate rig chatter										
95	Smoother drilling at 95', blue clay in cuttings										
		BC=20 42 50/4.5"	46%								
100											

The exploration was terminated at approximately 99.4 ft. below ground surface. The exploration was backfilled with cement grout on April 15, 2014.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 5 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 2 ft. below ground surface at the end of drilling.

GENERAL NOTES:

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 138314	BORING LOG B-101	PLATE
	DRAWN BY: AG		A-3
	CHECKED BY: JCR	Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California	
	DATE: 4/22/2014		
	REVISED:		PAGE: 3 of 3

SAMPLE/SAMPLER TYPE GRAPHICS

STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

GROUND WATER GRAPHICS

- ▽ WATER LEVEL (level where first observed)
- ▼ WATER LEVEL (level after exploration completion)
- ▽ WATER LEVEL (additional levels after exploration)
- OBSERVED SEEPAGE

NOTES

1. The report and log key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
2. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
3. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
4. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
5. In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
6. Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
7. If sampler is not able to be driven at least 6 inches, 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu≥4 and 1≤Cc≤3	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu<4 and/ or 1>Cc>3	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu≥4 and 1≤Cc≤3	GW-GM	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu<4 and/ or 1>Cc>3	GP-GM	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
				GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES		GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
				GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu≥6 and 1≤Cc≤3	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu<6 and/ or 1>Cc>3	SP	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu≥6 and 1≤Cc≤3	SW-SM	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu<6 and/ or 1>Cc>3	SP-SM	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
				SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES		SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
				SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	ML	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

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PROJECT NO.:	138314
DRAWN BY:	AG
CHECKED BY:	JCR
DATE:	4/22/2014
REVISED:	

GRAPHICS KEY

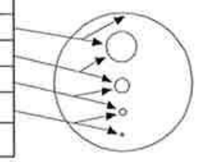
Sonoma Marin Area
Rail Transit Project (SMART)
Design Package DP2
Haystack Landing Bridge Site
Petaluma, California

PLATE

A-1

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #10	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller

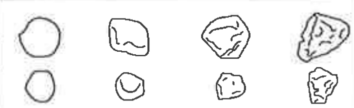


Munsell Color

NAME	ABBR
Red	R
Yellow Red	YR
Yellow	Y
Green Yellow	GY
Green	G
Blue Green	BG
Blue	B
Purple Blue	PB
Purple	P
Red Purple	RP

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges



PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit
High (H)	> 50	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump or thread can be formed without crumbling when drier than the plastic limit

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12- 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

NOTE: AFTER TERZAGHI AND PECK, 1948

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (Qu)(psf)	CRITERIA
Very Soft	< 1000	Thumb will penetrate soil more than 1 in. (25 mm.)
Soft	1000 - 2000	Thumb will penetrate soil about 1 in. (25 mm.)
Firm	2000 < 4000	Thumb will indent soil about 1/4-in. (6 mm.)
Hard	4000 < 8000	Thumb will not indent soil but readily indented with thumbnail
Very Hard	> 8000	Thumbnail will not indent soil

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 138314 DRAWN BY: AG CHECKED BY: JCR DATE: 4/22/2014 REVISED:	SOIL DESCRIPTION KEY Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California	PLATE A-1a

gINT FILE: C:\users\sgagakas\documents__all Cadd-Documents__cad-Work in Progress\138314-Dp3_smart\138314-Boringlogs.gpj R:KLF_STANDARD_GINT_LIBRARY_SR_1.2.GLB [GEO-LEGEND 2 (SOIL DESCRIPTION KEY)]

INFILLING TYPE

NAME	ABBR	NAME	ABBR
Albite	Al	Muscovite	Mus
Apatite	Ap	None	No
Biotite	Bi	Pyrite	Py
Clay	Cl	Quartz	Qz
Calcite	Ca	Sand	Sd
Chlorite	Ch	Sericite	Ser
Epidote	Ep	Silt	Si
Iron Oxide	Fe	Talc	Ta
Manganese	Mn	Unknown	Uk

BEDDING CHARACTERISTICS

TERM	Thickness (in.)	Thickness (mm.)
Very Thick Bedded	> 36	> 915
Thick Bedded	12 - 36	305 - 915
Medium Bedded	4 - 12	102 - 305
Thin Bedded	1 - 4	25 - 102
Very Thin Bedded	0.4 - 1	10 - 25
Laminated	0.1 - 0.4	2.5 - 10
Thinly Laminated	< 0.1	< 2.5

Bedding Planes — Planes dividing the individual layers, beds, or stratigraphy of rocks.
Joint — Fracture in rock, generally more or less vertical or traverse to bedding.
Seam — Applies to bedding plane with unspecified degree of weather.

DENSITY/SPACING OF DISCONTINUITIES

DESCRIPTION	SPACING CRITERIA
Unfractured	> 6 ft. (> 1.83 meters)
Slightly Fractured	2 - 6 ft. (.061 - 1.83 meters)
Moderately Fractured	8 in - 2 ft. (203.20 - 609.60 mm.)
Highly Fractured	2 - 8 in. (50.80 - 203.30 mm.)
Intensely Fractured	< 2 in. (< 50.80 mm.)

APERTURE

DESCRIPTION	CRITERIA [in.(mm.)]
Tight	< 0.04 (< 1)
Open	0.04 - 0.20 (1 - 5)
Wide	> 0.20 (> 5)

ADDITIONAL TEXTURAL ADJECTIVES

DESCRIPTION	RECOGNITION
Pit (Pitted)	Pinhole to 0.03 ft. (3/8 in.) (>1 to 10 mm.) openings
Vug (Vuggy)	Small openings (usually lined with crystals) ranging in diameter from 0.03 ft. (3/8 in.) to 0.33 ft. (4 in.) (10 to 100 mm.)
Cavity	An opening larger than 0.33 ft. (4 in.) (100 mm.), size descriptions are required, and adjectives such as small, large, etc., may be used
Honeycombed	If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form
Vesicle (Vesicular)	Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification

DISCONTINUITY TYPE

DESCRIPTION
Fault
Joint
Shear
Foliation
Vein
Bedding

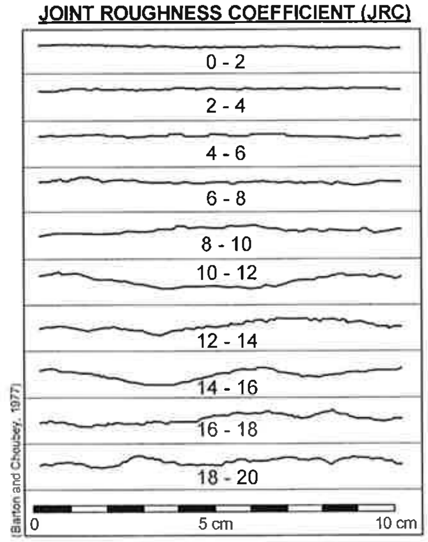
INFILLING AMOUNT

DESCRIPTION
Surface Stain
Spotty
Partially Filled
Filled
None

ROCK QUALITY DESIGNATION (RQD)

DESCRIPTION	RQD (%)
Very Poor	0 - 25
Poor	25 - 50
Fair	50 - 75
Good	75 - 90
Excellent	90 - 100

JOINT ROUGHNESS COEFFICIENT (JRC)



RQD — Rock-quality designation (RQD) Rough measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the drill core in lengths of 10 cm. or more.

DEGREES OF WEATHERING

DESCRIPTION	CRITERIA
Unweathered	No evidence of chemical/mechanical alternation; rings with hammer blow.
Slightly Weathered	Slight discoloration on surface; slight alteration along discontinuities; <10% rock volume altered.
Moderately Weathered	Discoloring evident; surface pitted and alteration penetration well below surface; Weathering "halos" evident; 10-50% rock altered.
Highly Weathered	Entire mass discolored; Alteration pervading most rock, some slight weathering pockets; some minerals may be leached out.
Decomposed	Rock reduced to soil with relict rock texture/structure; Generally molded and crumbled by hand.

RELATIVE HARDNESS / STRENGTH DESCRIPTIONS

GRADE		UCS (MPa)	FIELD TEST
R0	Extremely Weak	0.25 - 1.0	Indented by thumbnail
R1	Very Weak	1.0 - 5.0	Crumbles under firm blows of geological hammer, can be peeled by a pocket knife
R2	Weak	5.0 - 25	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer
R3	Medium Strong	25 - 50	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single firm blow of a geological hammer
R4	Strong	50 - 100	Specimen requires more than one blow of geological hammer to fracture it
R5	Very Strong	100 - 250	Specimen requires many blows of geological hammer to fracture it
R6	Extremely Strong	> 250	Specimen can only be chipped with a geological hammer

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PROJECT NO.: 138314	ROCK DESCRIPTION KEY	PLATE
DRAWN BY: AG		A-2
CHECKED BY: JCR	Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California	
DATE: 4/22/2014		
REVISED:		

ROCK GRAPHICS

ANDESITE
BASALT
BRECCIA
CALICHE
CARBONATE
CHALK
CHERT
CLAYSTONE
COAL
DIORITE
DOLOMITE
GABBRO
GNEISS
GRANITE
GYPSUM
IGNEOUS
LIMESTONE
MARBLE
METAMORPHIC
METASEDIMENTARY
METAVOLCANIC
MUDSTONE
MYLONITE
PHYLITE
RHYOLITE
SANDSTONE
SCHIST
SEDIMENTARY
SERPENTINE
SHALE
SILTSTONE
SLATE
TUFF
VOLCANIC
INTERBEDDED LIMESTONE-SHALE
INTERBEDDED SANDSTONE-CLAYSTONE
INTERBEDDED SHALE-CLAYSTONE
INTERBEDDED SHALE-SANDSTONE
INTERBEDDED SANDSTONE-CLAYSTONE
INTERBEDDED SILTSTONE-SANDSTONE
WEATHERED CLAYSTONE
WEATHERED LIMESTONE
WEATHERED SANDSTONE
WEATHERED SHALE
WEATHERED SILTSTONE

KLEINFELDER Bright People. Right Solutions.	PROJECT NO.: 138314 DRAWN BY: AG CHECKED BY: JCR REVISED:	ROCK GRAPHICS KEY Sonoma Marin Area Rail Transit Project (SMART) Design Package DP2 Haystack Landing Bridge Site Petaluma, California	PLATE A-2a

Rotary Wash Boring (R-20-001)

The rotary-wash boring was drilled to provide the information to evaluate the subsurface stratigraphy and to allow acquisition of quality soil samples for laboratory testing. The boring was drilled using a truck-mounted rig at the location indicated on the Site Location Map, Figure 1. An AECOM Geologist maintained a record of all field activities, classified the soils and using the Unified Soil Classification System (USCS), recovered rock cores, and prepared a log of the boring.

The drilling operation proceeded carefully, with particular attention to potential interference with utilities or other buried structures. During drilling, both disturbed and undisturbed samples were obtained for identification and laboratory testing. Soil samples were generally obtained at 5-foot intervals and at changes in strata. Samples were obtained using an unlined split spoon sampler (SPT), having an outside diameter of 2 inches, and lined Modified California (MC) sampler, having an outside diameter of 2½ inches. A 140-pound hammer falling through a distance of 30 inches was used to drive the samplers. The blow count recorded on the boring logs adjacent to the sample depth is the number of blows required to drive the sampler for the final 1 foot of a maximum 18 inch drive. Samples of Bay Mud were recovered using 3-inch diameter Shelby Tubes, advanced by hydraulic pressure. The Franciscan Complex bedrock was drilled using HQ 3 coring methods below a depth of 45 feet, which provides an 2.4-inch diameter core sample.

One of the objectives of the field investigation was to obtain relatively high-quality soil samples for laboratory testing. Effort was made to minimize sample disturbance during sample handling and transportation. After careful withdrawal from the ground, the sample was placed upright and the ends of the sample were cleaned of disturbed soil. If possible, pocket penetrometer tests were performed on the bottom end of cohesive soil samples. Both ends of the samples were covered with plastic caps, and carefully transported to AECOM's laboratory in San Jose. Rock core samples were placed in core boxes, photographed and transported AECOM's laboratory.

Laboratory Testing Program

A laboratory testing program was carried out to estimate the index and engineering properties of the subsurface strata encountered at the site. The laboratory testing program included conventional tests to confirm the existing information on the engineering characteristics of the major strata and to classifications on the log. These tests were performed at the AECOM's laboratory and by Cooper Testing Laboratory in Palo Alto, California.

Index Tests

Index tests were performed on both cohesive and cohesionless soil samples to aid in soil classification and in correlation with other engineering parameters. Index tests included Atterberg Limits, gradation analyses, moisture content and dry unit weight determinations. An Atterberg Limits test was performed on a sample of the clayey sand alluvium in accordance with ASTM D 4318. Particle analyses were performed on two sample of the clayey sand alluvium in accordance with ASTM D 422. The moisture content tests were performed in accordance with ASTM D 2216. Dry unit weight was determined in accordance with ASTM D 2937. The locations of these tests are indicated on the log of Boring R-20-001 (attached as in this appendix Figure B-1) adjacent to the appropriate sample depths.

A plasticity chart graphically presenting the results of the Atterberg Limits tests is included on Figure B-2. Grain size distribution curves are presented graphically on Figure B-3

Unconsolidated Undrained Triaxial Compression Test

The undrained shear strength was determined for one sample of the Bay Mud soil recovered from the 16 to 18-foot depth interval. The test was performed accordance with ASTM D2850. Results are presented graphically on Figure B-4.

Consolidation Test

A single consolidation tests was performed on the Bay Mud sample recovered between 16 and 18 feet to evaluate its compressibility characteristics. The consolidation test was performed in accordance with ASTM D 4186 and the test results are graphically presented on Figure B-5.

Corrosion Potential

A sample of the existing granular fill encountered within the top 8 feet of Boring R-20-001 was submitted to Cooper Testing Laboratory to assess its corrosion potential to buried steel and concrete. The results are presented on the Corrosivity Test Summary attached as Figure B-6

Date(s) Drilled	3/8/2021 - 3/9/2021	Logged By	T. Vande Voorde	Checked By	D. Simpson, A.M. Moore
Drilling Method	Solid stem auger, Rotary wash, HQ-3 rock core	Drill Bit Size/Type	4-in SSA, 5-in Tricone, 4-in Tricone, 3 7/8-in HQ diamond bit	Total Depth of Borehole	112.0 feet
Drill Rig Type	CME-55 (truck-mounted)	Drilling Contractor	Taber Drilling	NAVD 88 Ground Surface Elevation	10 feet (iphone)
Groundwater Level	7.7-ft prior to rotatry wash drilling	Sampling Methods	SPT, 2-in ID ModCal, Shelby tube, Rock core	Hammer Data	140lb, 30-inch drop automatic hammer, efficiency 78%
Borehole Backfill	Tremied neat cement grout to surface	Borehole Location	Crystal Lane on south shore of Petaluma River in gravel lot	Coordinate Location	N 38.22833 W 122.61833

Elevation, feet	Depth, feet	Rock Core: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Soil Samples: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
10	0								SILTY SAND WITH GRAVEL (SM), dense, dry, light olive brown (2.5Y 5/3), angular to well-rounded gravel to 1/2-inch, fine to coarse grained sand, non-plastic fines [FILL]						Hand auger to 5-ft.
	1														
8	2														
	3														
6	4														
	5								Becomes moist, mottled very dark grayish brown (2.5Y 3/2) with yellow, red, gray, sand grades coarser		S01	14, 19, 20	100		S01: bagged. Begin drilling with 4-inch SSA. Corrosion test.
4	6														
	7														Driller notes softer material and groundwater at 7.7-ft. Insert 5-inch casing to 14-ft. Begin RW drilling with 5-inch tricone bit.
2	8								FAT CLAY (CH), medium stiff, moist, dark greenish gray (10Y 4/1) to dark gray (5Y 4/1), high plasticity fines, smooth texture, trace organics [BAY MUD]						
	9														
0	10										S02	2, 2, 4	50		
	11														
-2	12														
	13														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: CAUFIELD_LANE_GINT.GPJ; 4/14/2021 R-20-001

Project: Caufield Lane Bridge Over Petaluma River
Project Location: Petaluma, CA
Project Number: 60580130

Log of Soil & Core Boring R-20-001

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								FAT CLAY (CH), medium stiff, moist, dark greenish gray (10Y 4/1) to dark gray (5Y 4/1), high plasticity fines, smooth texture, trace organics [BAY MUD] (continued)						
-4	14														
	15														
-6	16										S03	250 psi	100		Consolidation test. TXUU undrained shear strength 1.1 ksf
	17														
-8	18														
	19								SANDY LEAN CLAY TO CLAYEY SAND (CL/SC), medium dense / stiff, moist, dark gray, very fine to fine grained sand, low to medium plasticity fines, cohesive [ALLUVIUM]						
-10	20								CLAYEY SAND (SC), medium dense, moist, light yellowish brown (2.5Y 6/4), fine grained sand, low plasticity fines [ALLUVIUM]						
	21										S04	5 8 9	100		PI=12 LL=26 <#200=30% >#4=0%
-12	22														
	23														
-14	24								CLAYEY SAND WITH GRAVEL (SC), medium dense, moist to wet, yellowish brown (10YR 5/6), few fine gravels, medium to coarse grained sand, low plasticity fines [ALLUVIUM]						
	25														
-16	26										S05	5 5 11	44		<#200=22% >#4=24%
	27														
-18	28								MELANGE, light bluish gray (10B 7/1), completely weathered [FRANCISCAN COMPLEX]						
	29														

Project: Caufield Lane Bridge Over Petaluma River Project Location: Petaluma, CA Project Number: 60580130	Log of Soil & Core Boring R-20-001 Sheet 3 of 8

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	29								MELANGE, light bluish gray (10B 7/1), completely weathered to a Lean Clay with Sand (hard, moist, low plasticity), extremely weak to very weak, common blueschist fragments up to 3/4-inch, occasional greenstone [FRANCISCAN COMPLEX] (continued)						
-20	30										S06	16 22 40	61		S06: bagged Switch to 4-inch tricone at 30-ft.
	31														
-22	32														
	33														
-24	34								SERPENTINITE MELANGE, light blueish gray (10B 7/1), completely weathered to Clayey Sand, weak to very weak, with white calcite and greenish gray streams of serpentinite, sheared/crushed fabric [FRANCISCAN COMPLEX]						
	35										S07	14 18 36	100		
-26	36														
	37														
-28	38														
	39														
-30	40								Becomes highly to completely weathered, locally weak to moderately strong, visible rock fabric, can be crushed by hand		S08	50/5"	100		
	41														
-32	42														
	43														
-34	44														
	45														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: CAUFIELD_LANE_GINT.GPJ; 4/14/2021 R-20-001

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Number	MATERIAL DESCRIPTION	Soil Samples: Type / Number / Blows / 6 in. / Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	45		1		3		m, m	SERPENTINITE MELANGE, mottled greenish gray (10BG 5/1) with white, black, and green streaks, slightly weathered, moderately strong, highly fractured and partially healed, aphanitic matrix with calcite stringers and seams of serpentinite, friable [FRANCISCAN COMPLEX] (continued)	S09 / 50/1" / 0	1358	Switch to HQ-3 rock coring at 45.1-ft. 4-inch casing set to 30-ft.
-36	46	1		90	2	40	m			[16]	
	47				0		m	Has sheared fabric with occasional greywacke inclusions		1405 / 1408	
-38	48				2		1,m; 2	1: 60°, J, VN, Ca, Fi, Pl, SR 2: 80°, J/Sh, N-MW, Serp+H, Fi, Pl-Wa, SR			
	49	2		100	1	58	m; 3	3: 55°, J/Sh, VN, No, No, Pl, S-SR		[30]	
-40	50				1		m; 4	4: 40°, J, N, Cl, Pa, Pl, SR			
	51				2			Crushed			
-42	52				>6			Becomes moderately weathered, intensely fractured		1418 / 1422	
	53				>6			Disturbed			
-44	54	3		42	NA	6				[30]	
	55				NA						
-46	56				NA						
	57				>6			Intensely fractured Becomes locally highly weathered, friable		1432 / 1436	
-48	58	4		60	NA	12		Soft		[19]	
	59				NA			Becomes dark greenish gray with white, dark green, and dark gray, moderately weathered, moderately strong, highly fractured with some healed		1444 / 1450	
-50	60	5		64	>6	16	1, 2, 3	1: 60°, J, VN, Ca, Sp, Pl, SR 2: 70°, J, VN, Ca, Sp, Pl, SR 3: 30°, J, VN, Ca+Py, Sp, Pl, SR		[19]	
	61										

Fracture Drawing:

Project: Caufield Lane Bridge Over Petaluma River Project Location: Petaluma, CA Project Number: 60580130	**Log of Soil & Core Boring R-20-001** Sheet 5 of 8

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Soil Samples: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	61	5	1	64	NA	16	NR		SERPENTINITE MELANGE, mottled dark greenish gray and dark gray with white, black, and dark green, moderately weathered to locally highly weathered, moderately strong to locally very weak/soft, intensely fractured/brecciated and partially healed, common calcite and occasional greywacke, friable [FRANCISCAN COMPLEX] (continued)						
-52	62	6		96	>6	88*			BLUESCHIST AND SERPENTINITE MELANGE, mottled light gray and black, moderately to highly weathered, moderately strong, intensely sheared/brecciated and healed, occasional calcite veins, some fractures are slickensided [FRANCISCAN COMPLEX]					1458 1502	
	63				>6		1		1: 40°, J, N, Ca+Cl, Pa, Pl, SR					[21]	
-54	64		2		>6		m		With common irregular seams of green serpentinite and white calcite					1509 1513	*Rock does not meet soundness criteria for RQD calculation.
	65	7		100	>6	28*	m 1,2 3		1: 30°, J, VN, Ca, Sp, Pl, S-SR 2: 60°, J/Sh, MW, Serp+Ca, Fi, Pl, S-SR 3: 40°, J, VN, Ca, Sp, Pl, SR					[25]	
-56	66				>6		1 m								
	67	8		98	>6	76*	1		Becomes mainly dark gray, brecciated and partially healed, locally friable					1519 1522	
-58	68				>6		1		1: 70°, J/V, N, Serp+Ca, Fi, Pl (partially healed)						
	69				>6		2							[33]	Several fractures break open during handling.
-60	70				>6		3		2: 40°, J, VN, No, No, Pl, S-SR 3: 45°, J, VN, No, No, Pl, S-SR						
	71				>6		m								
-62	72	9		74	>6	22*	m m							1531 1536	
	73				>6										
-64	74				>6				Moderately wide, green serpentinite seam					[27]	
	75				>6		m								
-66	76				NA		NR								
	77													1547	

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	77		2		5		m, 1, 1	BLUESCHIST AND SERPENTINITE MELANGE, bluish gray with white, black, and dark green, highly weathered to locally moderately weathered, moderately strong to locally very weak, intensely fractured/brecciated and partially healed, locally sheared, some fractures are slickensided aphanitic, occasional greywacke, serpentinite and calcite [FRANCISCAN COMPLEX] (continued)					1551	
-68	78				>6		2, 2	1: 60°, J, VN, Ca, Pa, Pl, SR 2: 40°, J, VN, Ca, Pa, Pl, SR						
	79	10		91	>6	49*		Sheared					[23]	
-70	80		3		4		3, 3	3: 70°, J, VN, Ca, Pa, Pl, SR						
	81				>6		NR; m, m	Completely weathered Becomes highly weathered, weak to very weak, friable					1602 0816	End of day 3/8/2021 Begin day 3/9/2021
-72	82				>6		1, m	1: 85°, J, MW, Serp+Ca, Pa, Pl, SR						
	83	11		43	NA	0	NR						[28]	
-74	84				NA								0824	
	85				>6								0837	100% drill fluid return
-76	86	12		90	>6	0	1,1; NR	Moderately weathered 1: 60°, J, VN, Ca, Pa, Pl, S Disturbed					[24] 0842	
	87				>6		m						0847	
-78	88	13		72	>6	0	1,1, 1; NR	1: 30-50°, J/Sh, N, No, No, Pl, S Moderately weathered, strong					[17]	
	89				NA								0856 0900	
-80	90	14		36	NA	0	NR	Disturbed SHALE MELANGE, very dark gray to black, highly weathered, weak, highly sheared, clayey with shale fragments and serpentinite seams, many fractures are slickensided [FRANCISCAN COMPLEX]					[25]	
	91				NA								0906	
-82	92	15		100	1	84*	1	1: 40°, J/Sh, VN, No, No, Pl, S					0910	*Rock does not meet soundness criteria for RQD calculation.
	93													

Project: Caufield Lane Bridge Over Petaluma River Project Location: Petaluma, CA Project Number: 60580130	Log of Soil & Core Boring R-20-001 Sheet 7 of 8

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	93	15	3	100	0	84*			SHALE MELANGE, very dark gray to black, highly weathered, weak, highly sheared, clayey with shale fragments and serpentinite seams, friable, common calcite, many fractures are slickensided [FRANCISCAN COMPLEX] (continued)					[17]	
-84	94				0									0919	
		16		100		100*								0922	
	95				0									[38]	Got 0.2-ft back from a previous run.
-86	96				0									0926	
	97	17		100	0	100*								0932	
-88	98		4		0									[25]	
	99													0938	
		18		100	0	28*			Becomes less clayey, weak to moderately strong shale, highly fractured					0943	
-90	100				>6									[21]	Core stretched?
	101				0				Becomes highly to locally completely weathered, with stronger/harder corestones, clayey, friable					0950	
-92	102	19		100	0	100*								0955	
	103				0										
-94	104				0									[27]	
	105				0										
-96	106				0									1006	
	107	20		100	0	84*								1011	
-98	108				>6				Intensely fractured						
	109														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: CAUFIELD_LANE_GINT.GPJ; 4/14/2021 R-20-001

Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Recovery, %	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	109	20	4	100	1	84*			SHALE MELANGE, very dark gray to black, highly weathered to locally completely weathered, variably very weak to moderately strong, highly sheared/fractured, clayey with shale corestones, friable, common calcite [FRANCISCAN COMPLEX] (continued)					[30]	
-100	110				0										
	111				0										
-102	112								TOTAL DEPTH = 112.0 FEET					1021	
	113														
-104	114														
	115														
-106	116														
	117														
-108	118														
	119														
-110	120														
	121														
-112	122														
	123														
-114	124														
	125														

Report: GEO_CORE+SOIL_NO PACK_WITH LITH; File: CAUFIELD_LANE_GINT.GPJ; 4/14/2021 R-20-001

COOPER TESTING LABORATORY

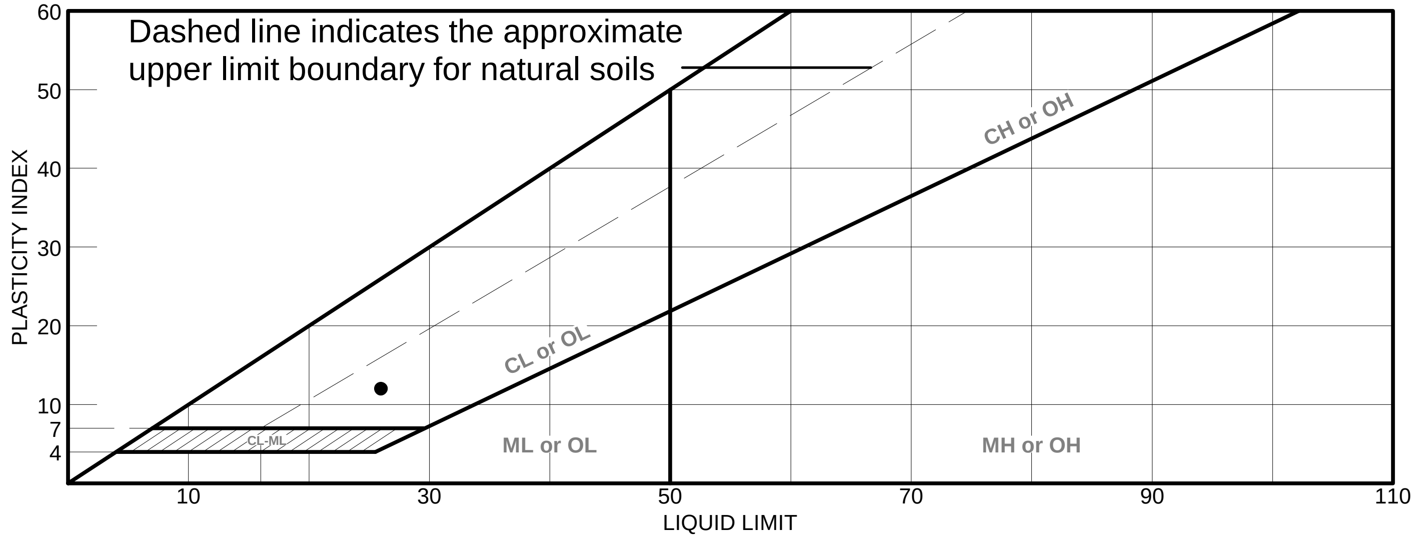
#200 Sieve Wash Analysis
ASTM D 1140

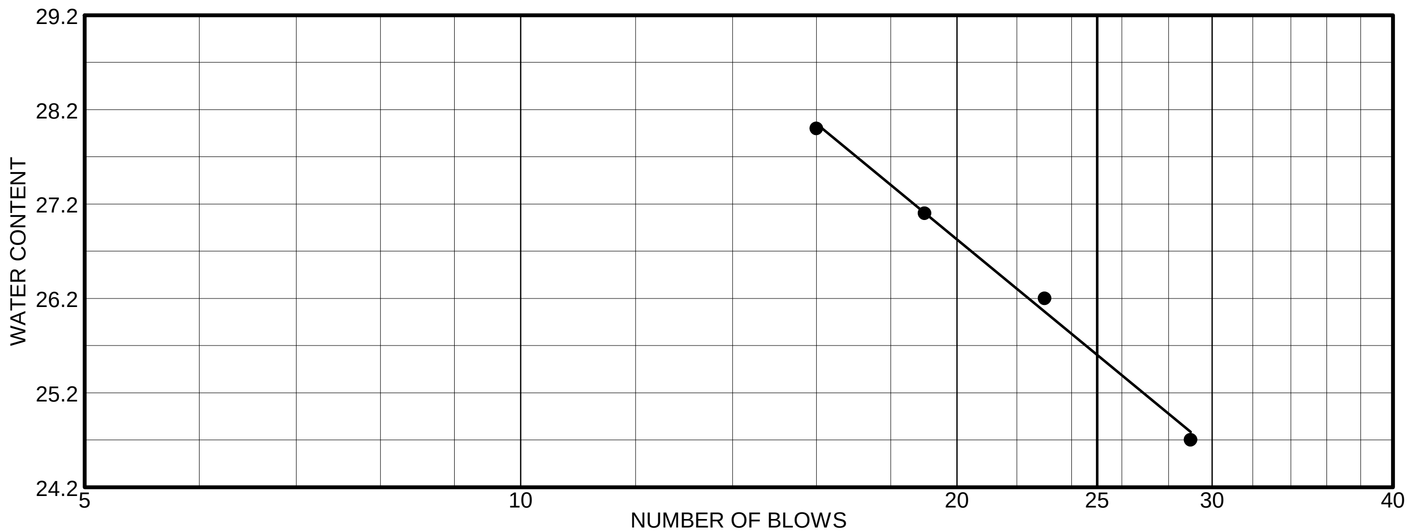
Job No.:	652-023	**Project No.:**	60580130	**Run By:**	MD
Client:	Signet Testing Labs	**Date:**	4/7/2021	**Checked By:**	DC
Project:	Caufiled Lane Bridge, Petaluma, CA				

Boring:	R-21-001	R-21-001						
Sample:	4	5						
Depth, ft.:	20	25						
Soil Type:	Olive Brown Lean Clayey SAND	Yellowish Brown Clayey SAND w/ Gravel						
Wt of Dish & Dry Soil, gm	391.6	568.9						
Weight of Dish, gm	174.0	176.5						
Weight of Dry Soil, gm	217.5	392.4						
Wt. Ret. on #4 Sieve, gm	0.0	95.6						
Wt. Ret. on #200 Sieve, gm	152.8	307.7						
% Gravel	**0.0**	**24.4**						
% Sand	**70.3**	**54.1**						
% Silt & Clay	**29.7**	**21.6**						

Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine the percentage, especially if there is only a trace amount, (5% or less).

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive Brown Lean Clayey SAND	26	14	12			

Project No. 652-023 **Client:** Signet Testing Labs

Project: Caufield Lane Bridge, Petaluma, CA - 60580130

● **Source:** R-21-001 **Sample No.:** 4 **Elev./Depth:** 20'

Remarks:

●

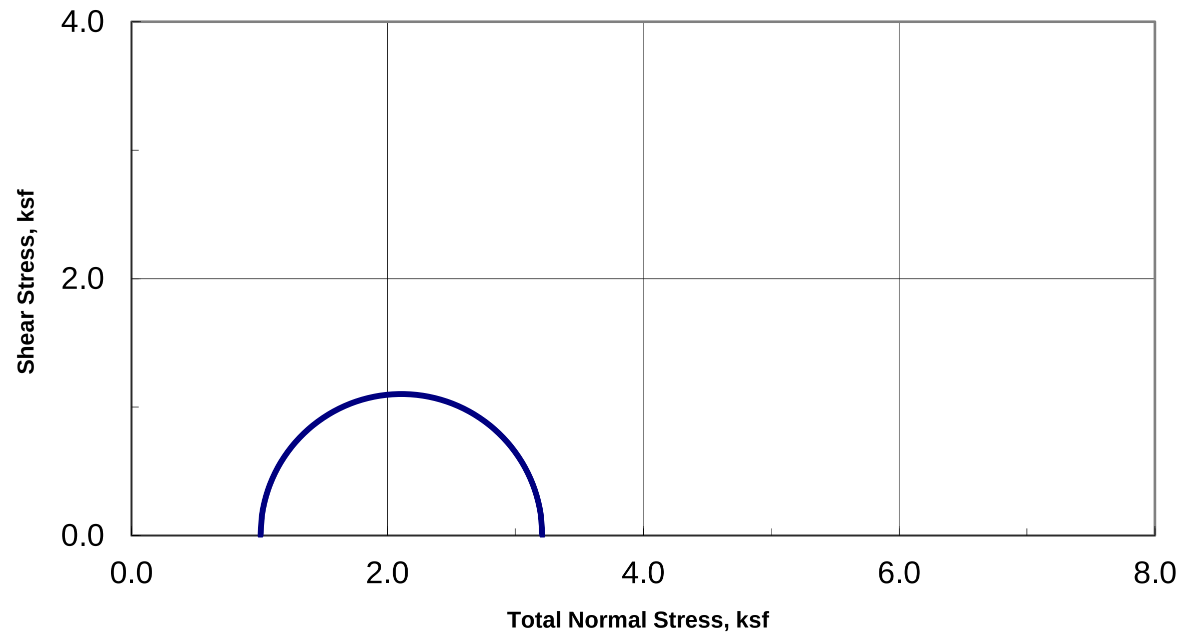
LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)

COOPER TESTING LABORATORY

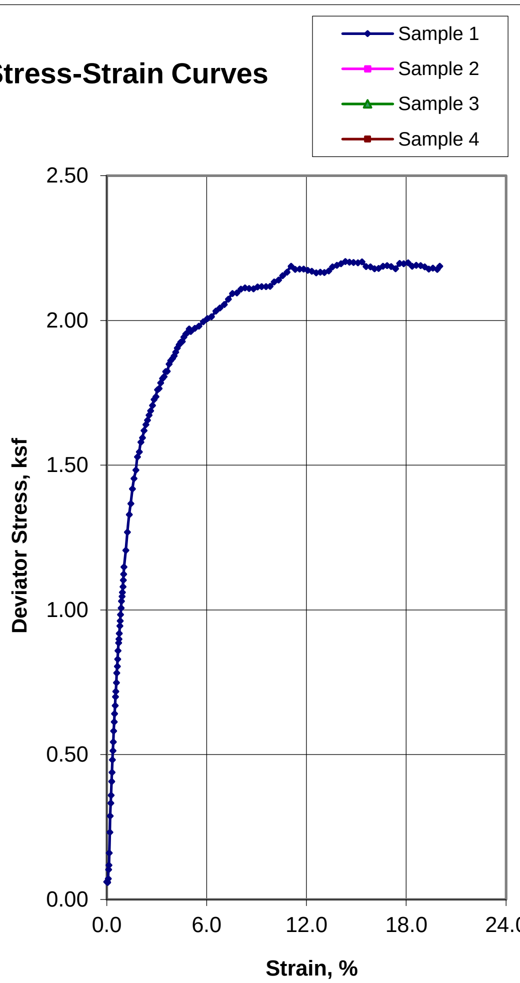
Figure B-3

Cooper Testing Labs, Inc.
937 Commercial Street
Palo Alto, CA 94303

Unconsolidated-Undrained Triaxial Test
ASTM D2850



Stress-Strain Curves



Sample Data	1	2	3	4
Moisture %	30.6			
Dry Den,pcf	93.3			
Void Ratio	0.874			
Saturation %	98.2			
Height in	5.99			
Diameter in	2.87			
Cell psi	7.0			
Strain %	14.33			
Deviator, ksf	2.203			
Rate %/min	1.00			
in/min	0.060			
Job No.:	652-023			
Client:	Signet Testing Labs			
Project:	60580130			
Boring:	R-21-001			
Sample:	3			
Depth ft:	15(Tip-4")			

Visual Soil Description

Sample #	
1	Gray CLAY
2	
3	
4	

Remarks:

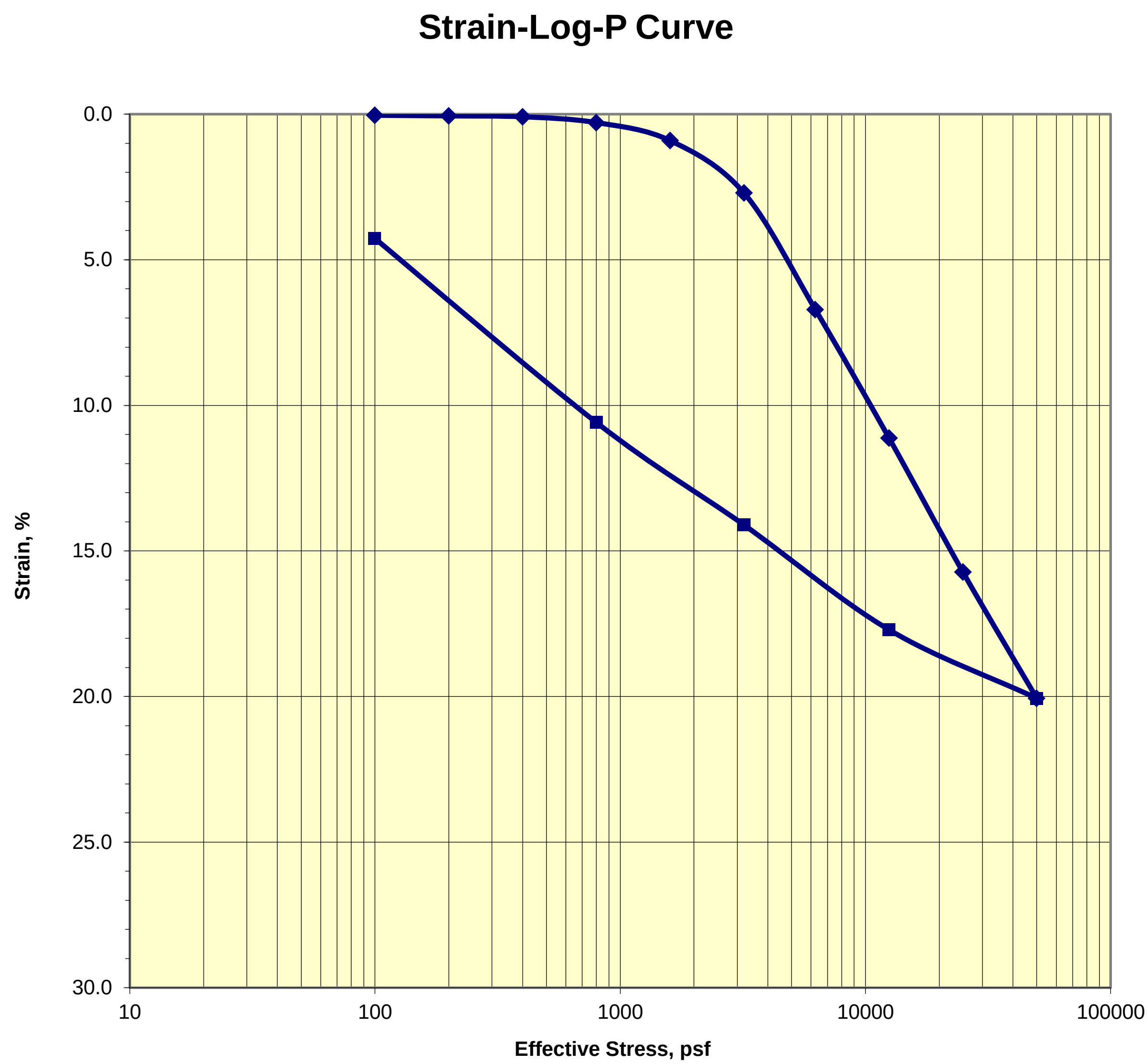
Figure B-4

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

Consolidation Test

ASTM D2435

Job No.:	652-023	**Boring:**	R-21-001	**Run By:**	MD
Client:	Signet Testing Labs	**Sample:**	3	**Reduced:**	PJ
Project:	60580130	**Depth, ft.:**	15(Tip-3")	**Checked:**	PJ/DC
Soil Type:	Gray CLAY w/ Sand			**Date:**	4/19/2021



Assumed Gs 2.75	**Initial**	**Final**
Moisture %:	31.7	30.2
Dry Density, pcf:	90.1	93.8
Void Ratio:	0.906	0.830
% Saturation:	96.1	100.0

Remarks:

Figure B-5

COOPER TESTING LABORATORY

Corrosivity Test Summary

CTL # 652-023 **Date:** 4/7/2021 **Tested By:** PJ **Checked:** PJ
Client: Signet Testing Labs **Project:** Caufield Lane Bridge, Petaluma, CA **Proj. No:** 60580130
Remarks:

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP	Moisture	
Boring	Sample, No.	Depth, ft.	As Rec.	Minimum	Saturated	mg/kg	mg/kg	%		(Redox)	At Test	Soil Visual Description
						Dry Wt.	Dry Wt.	Dry Wt.		mv	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
R-21-001	1	5	-	1591	-	56	138	0.0138	7.4	-	4.8	Olive Gray Silty GRAVEL w/ Sand

APPENDIX E –
Cultural Resources Database Search

AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612-1924
www.aecom.com

510 893 3600 tel
510 874 3268 fax

Date: June 24, 2020

To: City of Petaluma, Public Works & Utilities Department
202 N. McDowell Blvd
Petaluma, CA 94954

From: Karin G. Beck, M.A., RPA, RPH
AECOM
300 Lakeside Drive, Ste. 400
Oakland, CA 94928

Subject: **Preliminary Cultural Resources Assessment, Proposed Caulfield Bridge, Petaluma, Sonoma County, CA**

The City of Petaluma (city) is evaluating a new cross-town connector near the southern limits of the city that will extend Caulfield Lane south over the Petaluma River to connect with Petaluma Boulevard South at Crystal Lane (Attachment A: Figure 1). Caulfield Lane currently begins on the northeast side of Petaluma, crosses over United States (US) 101 just north of Lakeville Highway, crosses over Lakeville Street and terminates in a "T" intersection at Hopper Street immediately after crossing the Sonoma Marin Area Rail Transit (SMART) rail corridor. On the west side of US 101, Crystal Lane intersects Petaluma Boulevard South at a roundabout with a short segment of Crystal Lane extending north of the roundabout and then terminating on the south side of the Petaluma River. A Caltrans Maintenance Facility has driveway access to Crystal Lane in this location.

On the north side of Petaluma River between Hopper Street and the river, there is existing vacant riverfront land that has been graded for development, and the construction of a hotel is currently underway. On the south side of Petaluma River, Crystal Lane is the entrance to a residential development called Quarry Heights Subdivision on the south side of Petaluma Boulevard South. As mentioned above, a Caltrans Maintenance Facility is located west of the proposed bridge site, while a vacant lot is to the east.

The purpose of this memorandum is to identify any cultural resources in the proposed bridge site and road extension prior to design completion.

PROJECT LOCATION AND SETTING

The project site is located on either side of Petaluma River—a navigable waterway under the jurisdiction of the United State Coast Guard—just over a mile downstream from downtown Petaluma, in southwest Sonoma County, California. The project site is located on level terrain—from approximately 12 feet above mean sea level (amsl) to 26 feet amsl—within Section 34 of Township 5 North/Range 7 West, Mt. Diablo Base and Meridian, as depicted on the *Petaluma River, Calif*. US Geological Survey (USGS 1954, 1980) 7.5-minute topographic quadrangle. The Petaluma River Watershed is approximately 19 miles long, with the City of Petaluma near its center, and drains into the San Pablo Bay.

The north side of the project site is depicted as submerged marsh land until circa 1940s and the geology is mapped as Quaternary Alluvium (Q) and Quaternary Intertidal deposits (peaty-mud) (Qi) (Wagner and Bortugno 1982; USGS 1914,1942). The south side of the project site is mapped as Quaternary Alluvium (Q) and Jurassic Franciscan Complex (KJf) (Wagner and Bortugno 1982). Soils are mapped as alluvial land, sandy (AdA) on the north side and Yolo clay loam, 0 to 5 percent (YtA) on the south side (USDA 2020). The official description for Yolo series soils includes a paleosol (buried soil) at 41 to 58 inches below surface. The potential presence of this buried landform and proximity to the Petaluma River suggests in increased sensitivity for buried prehistoric archaeological resources within the southern portion of the project site. According to Caltrans' *Research Design and Treatment Plan for Native American Archaeological Resources in the San Francisco Bay-Delta Region* (Byrd et al. 2016), the project site has low to moderate sensitivity for surficial and buried prehistoric archaeological resources; and a high sensitivity for submerged resources.

PROJECT SITE

The project site encompasses the southern bank of the river to approximately 300 feet south to the crosswalk of the roundabout on Petaluma Boulevard South, with a width of approximately 85 feet; distance between the two banks of the river is approximately 190 feet. On the north side of the river, the project site extends from the river approximately 300 feet north, with the same width. There appears to be no historic-age resources in the vicinity of the project site that would warrant consideration of indirect project effects (e.g., visual or vibration impacts).

RECORDS SEARCH

A records search was conducted by the Northwest Information Center (NWIC) of the California Historical Resources Information System, at Sonoma State University, Rohnert Park, on June 8, 2020 (File No. 19-1998) (Attachment B). The NWIC, an affiliate of the State of California Office of Historic Preservation (OHP), is the official state repository of cultural resource records and studies for Sonoma County. Site records and previous studies were accessed for the APE and a 0.25-mile radius on the *Petaluma River, Calif*. USGS 7.5-minute topographic quadrangle. The following references were also reviewed:

- National Register of Historic Places
- California Register of Historical Resources
- Built Environment Resources Database, Petaluma, Sonoma County (OHP 2019)
- Historic Property Data File for Petaluma, Sonoma County (OHP April 2012)
- *Five Views: An Ethnic Historic Site Survey for California* (OHP 1988)
- California State Historical Landmarks (OHP 1996)
- California Inventory of Historic Resources (California Department of Parks and Recreation 1976)
- California Points of Historical Interest (OHP 1992)

The records search identified one resource (P-49-001044/CA-SON-1117H, Petaluma Rock Quarry) within the project site (Attachment B). There are four previously recorded resources identified within an 0.25-mile radius: C-1309 – Northwestern Pacific Railroad Bridge at McNear Crossing (Whatford 1994); P-49-002834/CA-SON-2322H – Northwestern Pacific Railroad; P-49-003288 – Bridge 20-0154 (US 101 over Petaluma River); and P-49-005165 – Haystack Landing Railroad Bridge. Nearly 100 percent of the project site has been previously studied by three prior studies: S-001082 (Origer 1978a), S-27681 (Chattan 2003a), and S-39520 (Tiley et al. 2003).

Petaluma Rock Quarry (P-49-001044/CA-SON-1117H). The Petaluma Rock Quarry was originally recorded in 1978 (Origer 1978b). This resource was originally contained to the south side of Petaluma Boulevard South on the large hill sometimes called Mae Hill or Mt. Pisgah, but was expanded to include north of Petaluma Boulevard South during a later study (Chattan 2003b). The resource has four loci of historic-period basalt quarrying activities and debris from a former brick plant and shop on the main hill, and then an old road and railroad grade near the river (near the current project site).

The vicinity of the current project site was used for loading barges and trucks but, by 2003, the land had been leveled and covered with gravel and sand (Chattan 2003b). No remnants of the quarry operations were identified during the 2003 study, except in the far eastern extent of this northern area, "a former roadway and the right-of-way of the old railroad spur could be seen" which were remnants of the original route of Petaluma Boulevard and the Northwestern Pacific Railroad spur (Chattan 2003b).

Chattan (2003a) evaluated the resource, including the area within the current project site, and determined that it does not appear eligible for the National Register of Historic Places (NRHP) or the California Register of Historical Resources (CRHR).

Previous USGS topographic maps depict spurs to several of the riverfront operations back in the 1940s (USGS 1942).

FIELD SURVEY

On May 26, 2020, AECOM archaeologist Karin G. Beck conducted a pedestrian survey of both sides of the river. Transects were spaced less than 5 meters apart. Ground visibility was poor on the north side of the project site, with 0-10% visibility due to shoulder-high weeds; and good (25–75%) visibility on the south side of the project site.

On the south side, the intersection of Petaluma Boulevard South and Crystal Lane was modified within the last 10 years into a roundabout. The current access into the project site is limited by a K-rail barrier at the northern end of the paved road. There are push piles of debris covered in ice plant nearest to the river, but no evidence of the previous roadway or railroad bed were observed. At the river's edge, there are several mooring piles encased in iron (**Photograph 1**) within the project site, and at the northeastern corner of the north side of the project site there is a row of 12-inch-wide boards (**Photograph 2**) that may have supported a pier or some type of landing; the majority of this feature is outside of the project site to the east. Several different types of drainage pipe exist, both parallel and perpendicular to the river. In the western corner, a large, twentieth century-era culvert exists at the water's edge. No other historic-era resources and no prehistoric cultural resources were identified during the pedestrian survey; however, stands of tule reeds (**Photograph 3**) were present on the south side of the project site, which obscured the bank in that area.

Photograph 1. Iron-encased mooring piling, camera facing south.

Photograph 2. Pier or remnant landing, camera facing west.

Photograph 3. Stand of tule reeds at the eastern corner of project site, south side of river, camera facing west.

SUMMARY AND RECOMMENDATIONS

Based on the background research and field analysis, one historic-era resource (Petaluma Rock Quarry) is identified within the southern portion of the project site; however, this resource was evaluated in 2003 and recommended ineligible for the NRHP/CRHR. As such, there are no known historical resources, unique archaeological resources, or historic properties that have the potential to be affected/impacted by the project. The southern side of the project site is highly sensitive for buried/submerged resources despite the fact that no prehistoric resources have yet been identified. Depending on the depth and location of proposed subsurface project impacts, and the permitting nexus of the project (e.g., federal permitting requiring compliance with Section 106 of the National Historic Preservation Act [NHPA]), pre-construction subsurface investigations to identify potential buried resources may be warranted. No Native American consultation was undertaken as part of this preliminary investigation. Such consultation may be required by the lead agency under state (Assembly Bill 52) and/or federal (Section 106) law, prior to project implementation.

REFERENCES

Byrd, Brian, Adrian Whitaker, and Patricia Mikkelsen. *Research Design and Treatment Plan for Native American Archaeological Resources in the San Francisco Bay-Delta Region*. Far Western Anthropological Research Group, Davis, California, and Caltrans District 4, Oakland, California.

Chattan, Cassandra, 2003a. A Cultural Resources Evaluation of the Dutra Quarry located at 1600 Petaluma Boulevard South, Petaluma, Sonoma County. Archaeological Resource Service, Petaluma, California.

______, 2003b. California Department of Parks and Recreation form 523 for P-49-001044/CA-SON-1117H. Archaeological Resource Service, Petaluma, California.

Origer, Thomas M., 1978a. An Archaeological Survey of the Petaluma Golf and Country Club, Petaluma, Sonoma County, California. The Anthropology Laboratory, Sonoma State College. On file: Northwest Information Center, Rohnert Park, California.

______, 1978b. Archaeological Site Record for for P-49-001044/CA-SON-1117H. The Anthropology Laboratory, Sonoma State College. On file: Northwest Information Center, Rohnert Park, California.

USDA [United States Department of Agriculture], 2020. Soil Series Descriptions. Natural Resources Conservation Services. Available: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053587. Accessed May 23, 2020.

USGS [United States Geological Survey], 1914. *Petaluma, California*. Topographic quadrangle map 1:62,500. Available: https://ngmdb.usgs.gov/topoview/viewer/#. Accessed May 23, 2020.

______, 1942. *Petaluma, California.* Topographic quadrangle map 1:62,500. Available: https://ngmdb.usgs.gov/topoview/viewer/#. Accessed May 23, 2020.

Wagner, D.L., and E.J. Bortugno, 1982. Geologica Map of the Santa Rosa Quadrangle, 1:250,000. Available: https://www.conservation.ca.gov/cgs/Documents/Publications/Regional-Geologic-Maps/RGM_002A/RGM_002A_SantaRosa_1982_Sheet1of5.pdf. Accessed May 23, 2020.

ATTACHMENTS

A – Figures

B – Northwest Information Center (NWIC) Records Search Results


Caufield Lane Bridge
Project Site
Lakeville Hwy
116
101
Caufield Ln
Payran St
Wilson St
East Ct
Lindberg Ln
Wood Ln
Palmetto Way
Catalpa Way
Anna Way
Crinella Dr
Wieling Way
Sartori Dr
Casa Grande Rd
St Anthony Ln
St Francis Dr
San Rafael Dr
Santa Clara Ln
Perry Ln
Eastside Rd
Marina Ave
Technology Ln
Fisher Dr
Cader Ln
S McDowell Blvd
5th St
6th St
K St
J St
Mission Dr
Jade St
Jacquelyn Ln
McNear Ave
Phillips Ave
Country Club Dr
Kastania Rd
Landing Way
Google Earth
© 2020 Google
3000 ft
N

CALIFORNIA HISTORICAL RESOURCES INFORMATION SYSTEM

ALAMEDA
COLUSA
CONTRA COSTA
DEL NORTE
HUMBOLDT
LAKE
MARIN
MENDOCINO
MONTEREY
NAPA
SAN BENITO
SAN FRANCISCO
SAN MATEO
SANTA CLATA
SANTA CRUZ
SOLANO
SONOMA
YOLO

Northwest Information Center
Sonoma State University
150 Professional Center Drive, Suite E
Rohnert Park, California 94928-3609
Tel: 707.588.8455
nwic@sonoma.edu
http://www.sonoma.edu/nwic

6/8/2020 NWIC File No.: 19-1998

Karin G. Beck
AECOM
300 Lakeside Drive, Suite 400
Oakland, CA 94612

re: Movable Bridge at Caulfield Lane

The Northwest Information Center received your record search request for the project area referenced above, located on the Petaluma River USGS 7.5' quad. The following reflects the results of the records search for the project area and a 0.25 mile radius:

Resources within project area:	P-49-001044.
Resources within 0.25 mile radius:	C-1309; P-49-002834, 003288, & 005165.
Reports within project area:	S-27681 & 39520. (See 'Other Reports' database list.)
Reports within 0.25 mile radius:	S-966, 1599, 2280, 13217, 26724, 30904, 31737, 33061, 33446, 47935, & 51005.

Resource Database Printout (list):	☒ enclosed	☐ not requested	☐ nothing listed
Resource Database Printout (details):	☐ enclosed	☒ not requested	☐ nothing listed
Resource Digital Database Records:	☐ enclosed	☒ not requested	☐ nothing listed
Report Database Printout (list):	☒ enclosed	☐ not requested	☐ nothing listed
Report Database Printout (details):	☐ enclosed	☒ not requested	☐ nothing listed
Report Digital Database Records:	☐ enclosed	☒ not requested	☐ nothing listed
Resource Record Copies:	☒ enclosed	☐ not requested	☐ nothing listed
Report Copies:	☒ enclosed	☐ not requested	☐ nothing listed
OHP Built Environment Resources Directory:	☐ enclosed	☒ not requested	☐ nothing listed
Archaeological Determinations of Eligibility:	☐ enclosed	☐ not requested	☒ nothing listed
CA Inventory of Historic Resources (1976):	☐ enclosed	☒ not requested	☐ nothing listed
Caltrans Bridge Survey:	☐ enclosed	☒ not requested	☐ nothing listed
Ethnographic Information:	☐ enclosed	☒ not requested	☐ nothing listed
Historical Literature:	☐ enclosed	☒ not requested	☐ nothing listed
Historical Maps:	☐ enclosed	☒ not requested	☐ nothing listed
Local Inventories:	☐ enclosed	☒ not requested	☐ nothing listed
GLO and/or Rancho Plat Maps:	☐ enclosed	☒ not requested	☐ nothing listed

Shipwreck Inventory: ☐ enclosed ☒ not requested ☐ nothing listed

*Notes:
** Current versions of these resources are available on-line:
Caltrans Bridge Survey: http://www.dot.ca.gov/hq/structur/strmaint/historic.htm
Soil Survey: http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=CA
Shipwreck Inventory: http://www.slc.ca.gov/Info/Shipwrecks.html

Please forward a copy of any resulting reports from this project to the office as soon as possible. Due to the sensitive nature of archaeological site location data, we ask that you do not include resource location maps and resource location descriptions in your report if the report is for public distribution. If you have any questions regarding the results presented herein, please contact the office at the phone number listed above.

The provision of CHRIS Data via this records search response does not in any way constitute public disclosure of records otherwise exempt from disclosure under the California Public Records Act or any other law, including, but not limited to, records related to archeological site information maintained by or on behalf of, or in the possession of, the State of California, Department of Parks and Recreation, State Historic Preservation Officer, Office of Historic Preservation, or the State Historical Resources Commission.

Due to processing delays and other factors, not all of the historical resource reports and resource records that have been submitted to the Office of Historic Preservation are available via this records search. Additional information may be available through the federal, state, and local agencies that produced or paid for historical resource management work in the search area. Additionally, Native American tribes have historical resource information not in the CHRIS Inventory, and you should contact the California Native American Heritage Commission for information on local/regional tribal contacts.

Should you require any additional information for the above referenced project, reference the record search number listed above when making inquiries. Requests made after initial invoicing will result in the preparation of a separate invoice.

Thank you for using the California Historical Resources Information System (CHRIS).

Sincerely,

Lisa C. Hagel
Researcher

INFO CENTER & IN-HOUSE RECORDS SEARCH

Project Name: Caufield Lane Bridge Project (60580130, Task 2.1)

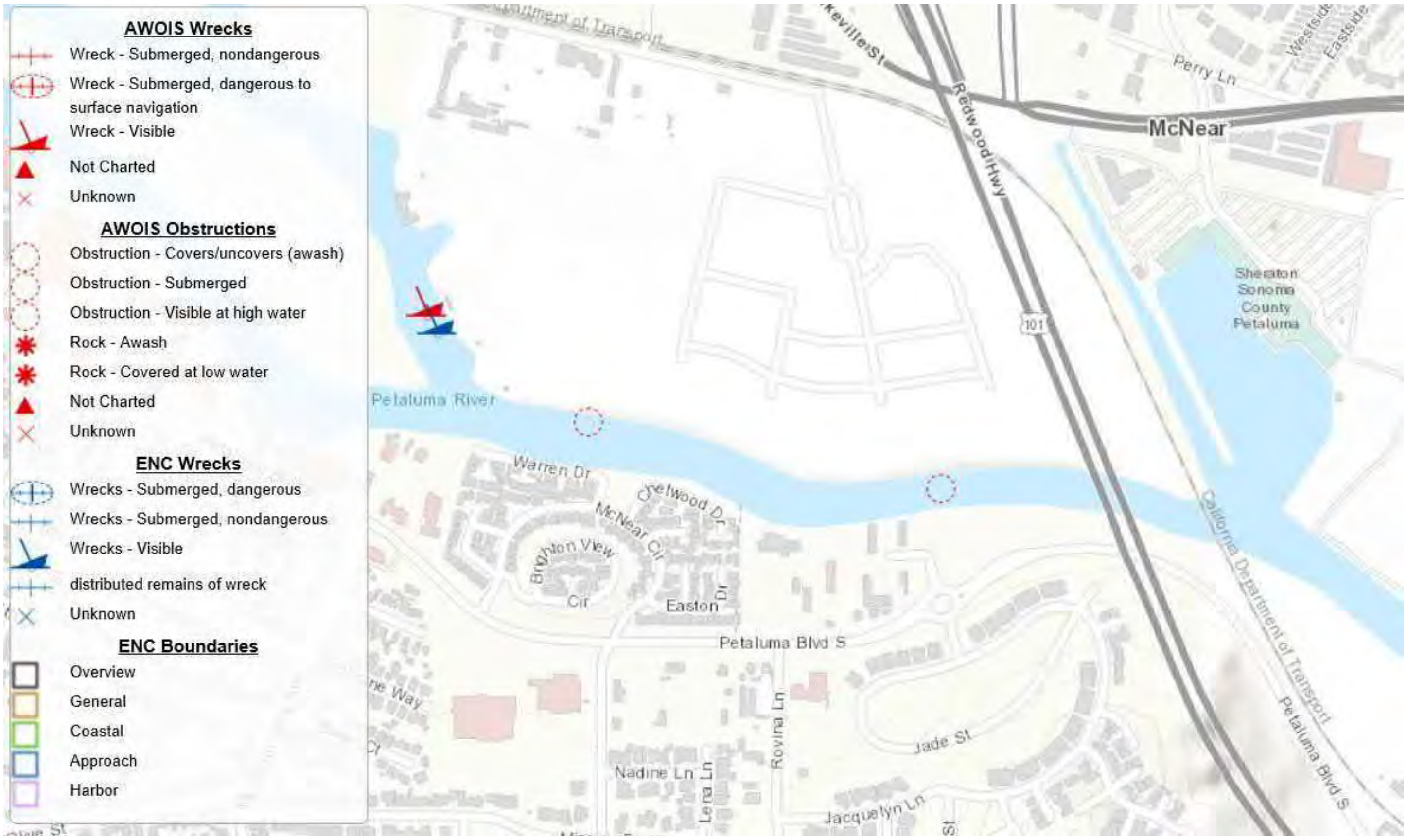
IC File No. 19-1998 (June 11, 2020 by NWIC staff for AECOM archaeologist Karin G. Beck)**Compliance:** (CEQA/Section 106)

Address/Location: between Petaluma Blvd South and Petaluma River
USGS Quad(s): *Petaluma River, Calif.* (Sonoma County)

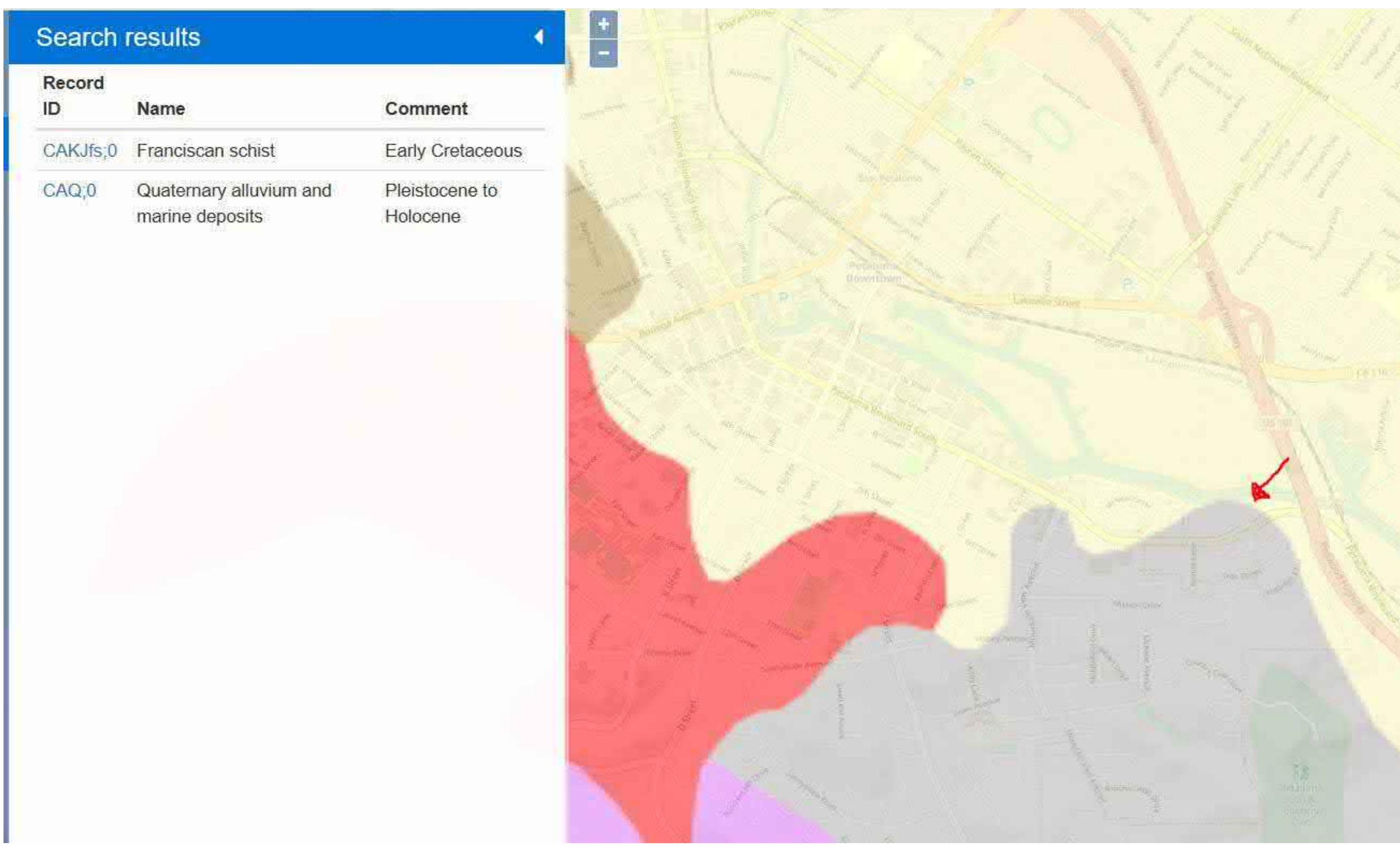
Cultural Resources within/adjacent to the study area	P-49-001044_CA-SON-1117H (Petaluma Rock Quarry/ Claasen Basalt Quarry – est. 1864)
Studies within/adjacent the study area	27681 (Chattan 2003) 39520 (Tiley, Simons, Bethard, Psota, Markwyn, and Meyer 2003)
Cultural Resources within 0.5-mile	
Studies within 0.5-mile	
OHP Historic Property Directory [April 5, 2012] **OHP Archaeological Determinations of Eligibility**	Make Copies of entire OHP for [Petaluma] Within APE: None
OHP Built Environment Res. Directory (BERD) [Dec. 2019] https://ohp.parks.ca.gov/?page_id=30338	[Caufield Ln] Within APE: None
Caltrans Bridge Survey (Updated 2019) http://www.dot.ca.gov/hq/structur/strmaint/historic.htm	[5/20/20] None
State Lands Commission Shipwreck Database http://shipwrecks.slc.ca.gov/ **NOAA Wrecks and Obstructions Database** https://wrecks.nauticalcharts.noaa.gov/viewer/ (Coast Survey's Automated Wreck and Obstruction Information System [AWOIS])	[5/20/20] **SLC** – Unknown **NOAA** – Obstruction nearby, but appears not to be within the project area, to the east (downstream) – See map below
CA Inventory of Historical Resources (1976) http://ohp.parks.ca.gov/listedresources/	[5/20/20] None
CA Historical Landmarks http://ohp.parks.ca.gov/default.asp?page_id=21387	[5/20/20] None
Five Views – An Ethnic Historic Site Survey for CA http://www.nps.gov/parkhistory/online_books/5views/5views.htm	[5/20/20] None
GLO (Township 5 North/Range 7 West, Section 34) http://www.glorecords.blm.gov/search/default.aspx	[5/20/20] N/A
Historical Maps/Aerial Photographs **NETR:** https://www.historicaerials.com/viewer **TopoView:** https://ngmdb.usgs.gov/topoview/viewer/#6/37.431/-119.323 **UCSB:** http://mil.library.ucsb.edu/ap_indexes/FrameFinder/ **USGS:** http://historicalmaps.arcgis.com/usgs/ **Rare Maps:** https://www.raremaps.com/	**1954, PR 1980 (USGS) Petaluma River** – one building to the east on south side of river **1965 (UCSB)** aerial of Petaluma River [Flight CAS_65_130, Frame 66-255] – previously mentioned building
Volume 8 - California	Coast Miwok [Kelly, pp. 414-425]
Historical Atlas of CA (Beck & Haase 1974)	p.30 Rincon de San Francisquito Rancho 1,471 acres
Historic Spots in CA (Kyle et al. 2002)	p.XX Petaluma, Sonoma County.
CA Place Names (Gudde 1998)	p.XX Petaluma.
Geology: https://mrdata.usgs.gov/geology/state/map-us.html#home or https://mrdata.usgs.gov/geology/state/ Horton, John D., 2017, The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States: U.S. Geological Survey data series DS 1052, U.S. Geological Survey, Denver, CO.	**Geology – Geologic Map of California, Santa Rosa Sheet** (Koenig 1967) North bank: Quaternary alluvium and marine deposits [Pleistocene to Holocene] South bank: Franciscan schist [Early Cretaceous] NB: Qal – Alluvium

	SB: Pvb (Pliocene era pyroclastic rocks) or KJf (Franciscan Formation
Soils	**USDA-NCSS SSURGO & STATSGO (2020)** North bank: **AdA** – Alluvial land, sandy (0-152cm – flood plain). Parent material: alluvium South bank: **YtA** – Yolo clay loam, 0-5% (0-165cm – alluvial fan/backslope). Parent material: alluvium from volcanic and sedimentary rock
Caltrans' Sensitivity Maps (Byrd et al. 2016)	Buried: Lowest Surface: North bank – lowest; South bank - moderate Submerged: high [see below]
Other	NAHC/NA: NONE @ THIS TIME Nearest H2O: Petaluma River Last dredged: 2003 (Press Demo 10 Feb 2020); USACOE supposed to dredge every 3 years (USACOE doc – see below)

UCSB (1965). Aerial photo of project area on Caufield Lane



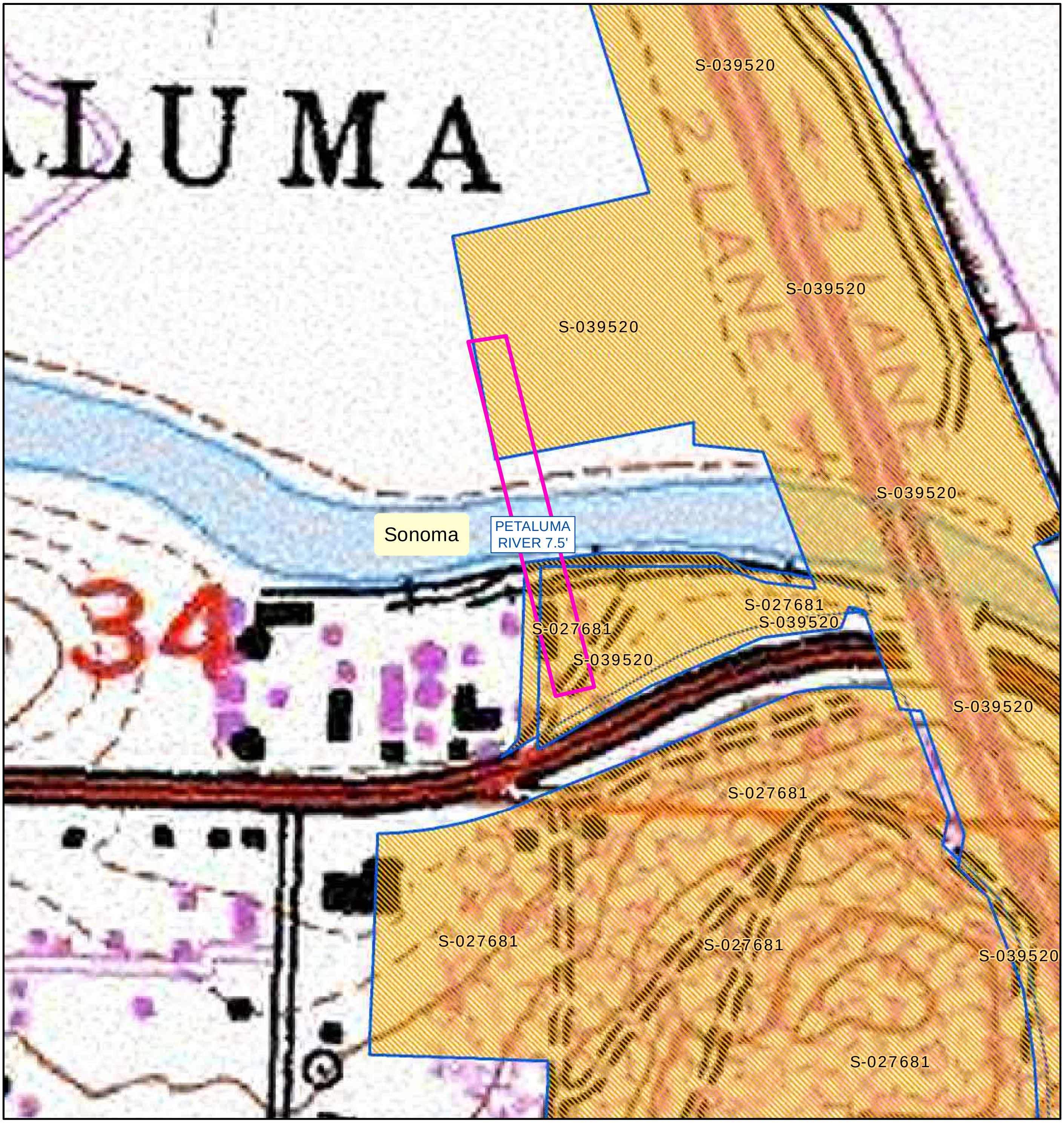
NOAA (2020). Obstruction appears immediately downstream (east) of bridge area, but appears outside project area.



USGS (2020). Geology of project area.

Byrd et al. (2016). Submerged sensitivity of project area is HIGH.

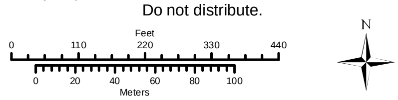
Movable Bridge at Caufield Lane
Report Map



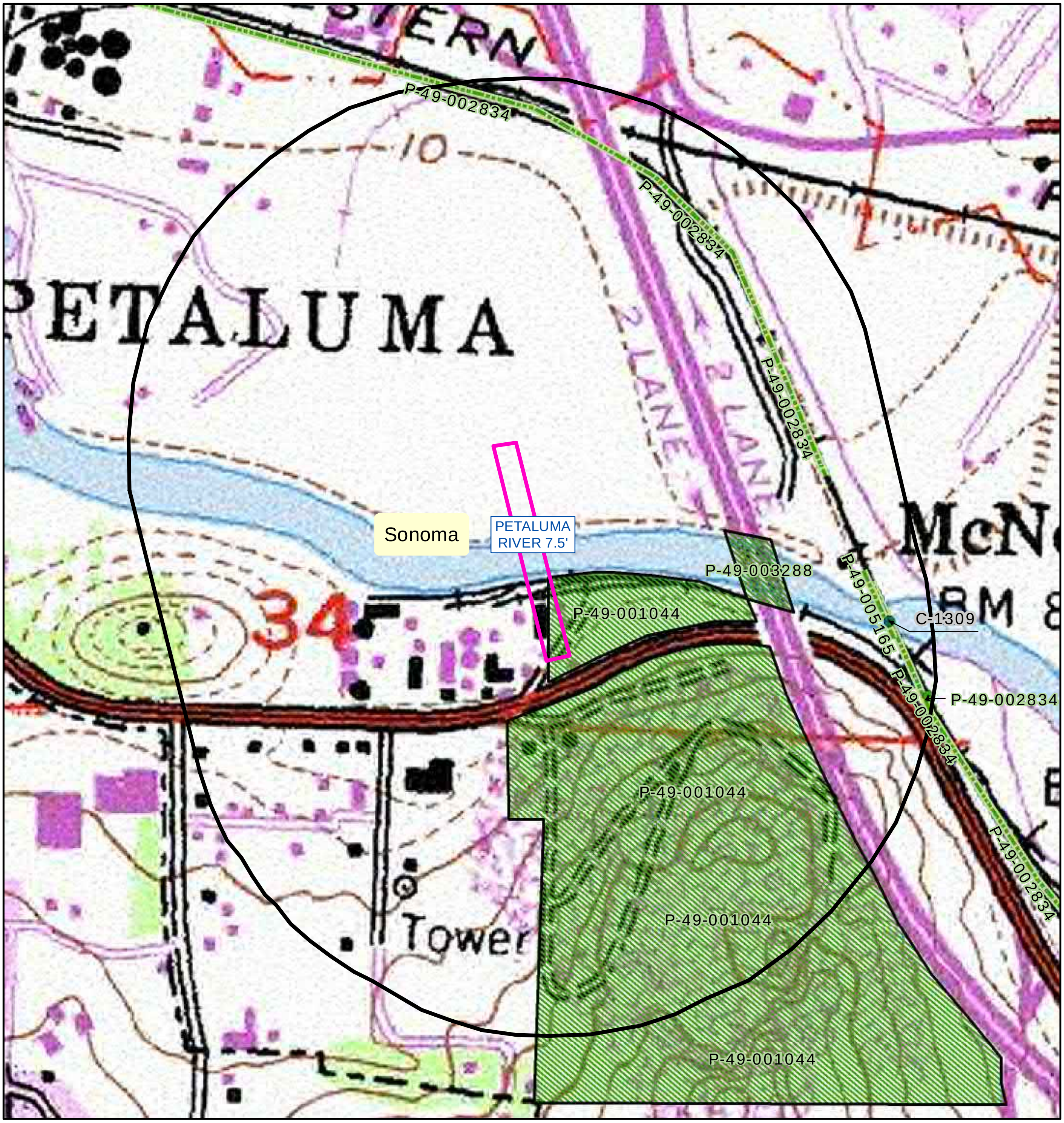
Northwest Information Center

File #19-1998, 8 June 2020, L. Hagel

May depict confidential cultural resource locations.
Do not distribute.



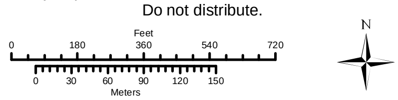
Movable Bridge at Caufield Lane
Resource Map



Northwest Information Center

File #19-1998, 8 June 2020, L. Hagel

May depict confidential cultural resource locations.
Do not distribute.



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DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Supplemental: ☐

Primary #: P-49-001044
HRI #:
Trinomial: CA-Son-1117H
NRHP Status Code:

Other Listings: ARS 03-067-01

Page: 1 **Review Code:** **Reviewer:** **Date:**

Resource Name or #: ARS 03-067-01

P1. Other Identifier: Petaluma Quarry, Mae Hill, Classen Quarry, Lauritzen Quarry, Cronin Quarry, Petaluma Rock Quarry, Dutra Quarry

P2. Location: ☐ Not for Publication ☐ Unrestricted (UTM:534010/4230500)

a. County: Sonoma and (P2b and P2c or P2d. Attach a Location Map as necessary.)

b. USGS Quad: Petaluma River 7.5' **Date:** 1996 **T** 4N **R** 7W 1/4 of 1/4 of Section: 3 **B.M.**

c. Address: 1600 Petaluma Boulevard South **City:** Petaluma **Zip:** 94952

d. UTM: Zone: 10 , 533800 **mE** / 4230700 **mN** (UTM:533540mE/4231040mN;533540/4230500)

e. Other Locational Data: Bordered by HWY 101 on the east and the Petaluma River on the North. Petaluma Boulevard South bisects the property in the northern portion.
Land Grant:

P3. Description: The site consists of a hill that has been quarried for over a century, three areas of associated debris, and the route of an old railroad spur. Two or three separate quarries operated on this hill sometimes called Mae Hill or Mt. Pisgah. The western portion of the hill was purchased by the Classen Family in 1858 and began operations as the Petaluma Rock Company in 1864. The Classen Quarry appears to have been dormant in the early 1900s but in 1925 Jens Classen a descendent of the original purchaser, leased the property to Hein Construction Company. Hein later incorporated into Hein Brothers Basalt Rock Company. The property continued to be leased to Hein Brothers, and ownership passed to the Classen's daughter May Lauritzen. When May Lauritzen passed away in 1948, her heirs sold the property to Mark Hein of Hein Brothers Basalt Company. The north and east portions of the hill were purchased by J. Cadden in the mid to late 1800s, who later sold the property to P. Cronin (1897). Cronin operated what was called both Cronin Quarry and sometimes Petaluma Rock Quarry and later leased the property to E.B.& A.L. Stone of San Francisco to operate in the 1910s. It appears that at some later point in time, Hein Brothers took over the operations of the Cronin Quarry as well. Proximity to the river and railroad made the location of these quarries ideal for shipping the product throughout the bay area. Hein Brothers improved their operation over the years adding a concrete plant in 1942 and asphalt in 1945. In the late 1940s Mark Hein purchased several properties and consolidated the P. Cronin Quarry (11.82 acres), 500 feet of water frontage from the G.P. McNear Company and the Lauritzen property to create the large parcel that exists today. In the late 1970s Quarry Products, Inc. (QPI), purchased and operated the quarry and arranged to quarry a large hill on the Country Club property to the south. QPI continued to produce basalt, agglomerate and breccia. In the mid 1980s the property was bought by American Rock, and later passed to Dutra Materials, the current operator. (see continuation sheet)

P3b. Resource Attributes - Historic: AH9. Quarry / associated debris and railroad spur, also possible original route of HWY 101

P3c. Resource Attributes - Prehistoric:

P4. Resources Present: ☐ Building ☐ Structure ☐ Object ☑ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc)

P5. Photograph or Drawing:

P5b. Description of Photo:
View of current quarry operation fom southwester portion of the property (looking northeast).

P6. Date Constructed/Age:
Historic

P7. Owner and Address:
Dutra Materials, 1600 Petaluma Boulevard South, Petaluma CA 94952

P8. Recorded by:
Cassandra Chattan, Archaeological Resource Service, 122 American Alley Suite A, Petaluma CA 94952

P9. Date Recorded:
30-Oct-03

P10. Type of Survey:
Reconnaissance

Describe Survey:
Evaluation of 43 acres, active quarry site

P11. Report Citation: Chattan, Cassandra. 2003, A Cultural Resources Evaluation of the Dutra Quarry located at 1600 Petaluma Boulevard South, Petaluma, Sonoma County. ARS 03-067. (see continuation sheet).

Attachments: ☐ None ☑ Location Map ☑ Sketch Map ☑ Continuation Sheet ☐ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Stone Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Isolate Record ☐ Other:

S-27681 b

NOV 20 2003

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DEPARTMENT OF PARKS AND RECREATION

Primary # P-49-001044
HRI #
Trinomial CA-Son-1117H

CONTINUATION RECORD

Resource Name or # ARS 03-067-01

Recorded by: Cassandra Chattan ☑ Continuation ☐ Update

Page: 2

(P3 continued) -Thomas Origer performed an evaluation in 1978 on the property to the south and recorded four separate loci associated with quarrying activities. Locus 2 extended onto the current subject parcel. Origer also noted the quarry on our subject parcel was originally called the Petaluma Rock Quarry established in 1864, and that the property to the south (his study area) was the Classen Quarry. The four loci representing past quarrying activities were assigned the archaeological site numerical designation of CA-Son-1117H (Origer 1978b).

In the late 1800s and early 1900s, Sonoma County was known for its production of cut stone. These stones were used in the construction of buildings in Petaluma, Santa Rosa and San Francisco as well as cobblestones to pave the streets of these cities (Turner 1951 in Tharp 1978). Quarries existed all around Petaluma, Penngrove and Santa Rosa and basalt paving blocks were at one time one of Sonoma Counties most profitable industries (Tuomey 1926; Tharp 1978).

An article from the Petaluma Journal from 1857 notes the presence of a basalt ledge of rocks located three quarters of a mile south of the town of Petaluma. The article noted that the ledge was "composed of regular prismatic columns, inclined toward the center of the hill. The columns generally have five sides" (Petaluma Journal 1857 in Tuomey 1926). The article goes on in very prosaic language about the geologic formation and notes how locals found it "a work of art." At that time, the stone was already being quarried by locals for building blocks.

In 1915, a bulletin put out by the State Mining Bureau noted the history of the Petaluma Rock Quarry, also known as the Cronin Quarry. The quarry was noted as "at tidewater on Petaluma Creek (at one time called Rudesill's landing), and at McNear's spur on the Northwestern Pacific. The rock is a basalt with, fine white feldspar phenocrysts" (Bradley 1915:189). The quarry began operations in 1864 providing paving blocks, and in 1890 switched to producing crushed rock. A description of the quarrying process in 1913 was added;

"in the quarry face the material is shoveled to cars and trammed to the screen which takes out the clay; then by gravity tram (in balance) to crushers. From this point a belt conveyor carries it to the revolving screen, four sizes being made" (Bradley 1915: 189).

A brick making plant was also located on the property for a while, but no reference to this facility was found in the historic literature.

The Mines and Minerals of Sonoma County published in 1950 noted the following about the quarry;

"The Hein Brothers Quarry was opened in August 1925 in a basalt flow 100 feet thick which caps a small hill. The flow, which is scoriaceous near the top and bottom, grades inward to a vesicular black porphyry. The central part is a fine-grained tough basalt. The quarry has a face about 510 feet high. Thirty-foot holes are drilled into the toe of the face, and when these are blasted the upper part of the face caves. Two trucks which are loaded by a steam shovel carry the broken rock to the primary crusher which is just below the level of the quarry floor. The crushing and screening plant, which is flexible enough to meet the specifications of any order, is located on the hillside between the quarry and the highway. Equipment includes two trammels to remove fines from the primary crusher product, secondary cone crushers, crushing rolls, and double-decked vibrating screens. Belt conveyors and a bucket elevator are used. The company also has at Haystack Landing a ready-mixed concrete plant and an asphalt mixing plant" (Honke and VerPlank 1950: 111).

Some historic debris was observed along the western property boundary. Several piles of debris consisting of concrete fragments, pieces of stone including basalt and granite, and bricks and some metal were deposited near several trees near the western property boundary approximately 500 feet north of the southern property boundary. These clusters of debris appeared to have been moved to these areas by a dozer or other piece of large equipment, and do not appear to have a subsurface component. Portions of a frame of an old conveyor belt are located in this area as well.

Approximately, one hundred feet north of these debris piles, is the location of the former brick plant, and a maintenance shop for the Hein Brothers operation. All that remains here is portion of two concrete pads, portions of a concrete wall, portions of vehicles, tires, and metal debris and chunks of concrete. The concrete appears to be from the 1940s and the surrounding debris from a later period. This deposit is not a significant feature.

In the northern section of the property, across Petaluma Boulevard South, the land has been leveled and covered with gravel and sand. This area has been used for loading barges and trucks. A few conveyor belts and sifting bins are located at the water's edge and are still in use. No debris or foundations were seen. In the far eastern portion of this area, a former roadway and the right-of-way of the old railroad spur could be seen. McNear Spur once extended from the Northwestern Pacific Railroad to the east and across the northern edge of the subject property, but the rails have been removed. Inspection of this area revealed a portion of this right-of-way and an area paved with asphalt. A faint white line could be seen in the center of part of the road section. The operations manager told us that this area had been the original route of Petaluma Boulevard. This was before the boulevard was smoothed out and widened at its current location. Inspection of older maps and aerial photographs (1913, 1953, 1961, 1971, 1980) showed that the street was originally located much closer to the river.

(P11. Continued) REFERENCES CONSULTED

n.a. "Old Hein Brothers Quarry to get Facelift" Press Democrat July 28, 1977 p. 3.

n.a. "M.Hein of Hein Bros. Basalt Co. Buys Lauritzen Estate Including Mae Hill Quarry" Argus Courier Jan 9, 1948.

Bradley, Walter. 1915, Mines and Mineral Resources of the Counties of Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo. California State Mining Bureau, San Francisco.

Honke, Martin Jr. and William Ver Planck, Jr. 1950, California Journal of Mines and Geology. Volume 46 no(1): 83-141. San Francisco, Division of Mines.

Origer, Thomas. 1978a, An Archaeological Survey of the Petaluma of and Country Club, Petaluma, Sonoma County, California. On file at the CHRIS as S-01082.1978b, Site record for the Petaluma Rock Quarry and Claasen Rock Quarry on file at CHRIS as CA-Son-1117H.

Petaluma Historical Museum. n.d. "Quarries"clipping file.

Tharp, Elizabeth. 1978, A Report on the Stone Quarries in Sonoma County, California. On file at the CHRIS.

Thormahlen, David. 1979, Quarry Products, Inc. in Geology of Hardrock Quarries in Sonoma County. Rolfe Erickson, compiler. Unpublished manuscript on file at the Sonoma State Library as QE90. G46.

Tuomey, Honoria. 1926, History of Sonoma County, California, Volume 1. San Francisco, S.J. Clarke Publishing Co.

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Primary #: P-49-001044
HRI #:
Trinomial: CA-Son-1117H

SKETCH MAP

Page: 3 **Resource Name or #:** ARS 03-067-01
Drawn by: Cassandra Chattan from Orthophoto **Sketch Date:** 16-Oct-03

6

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DEPARTMENT OF PARKS AND RECREATION

LOCATION MAP

Primary #: P-49-001044
HRI #:
Trinomial: CA-Son-1117H

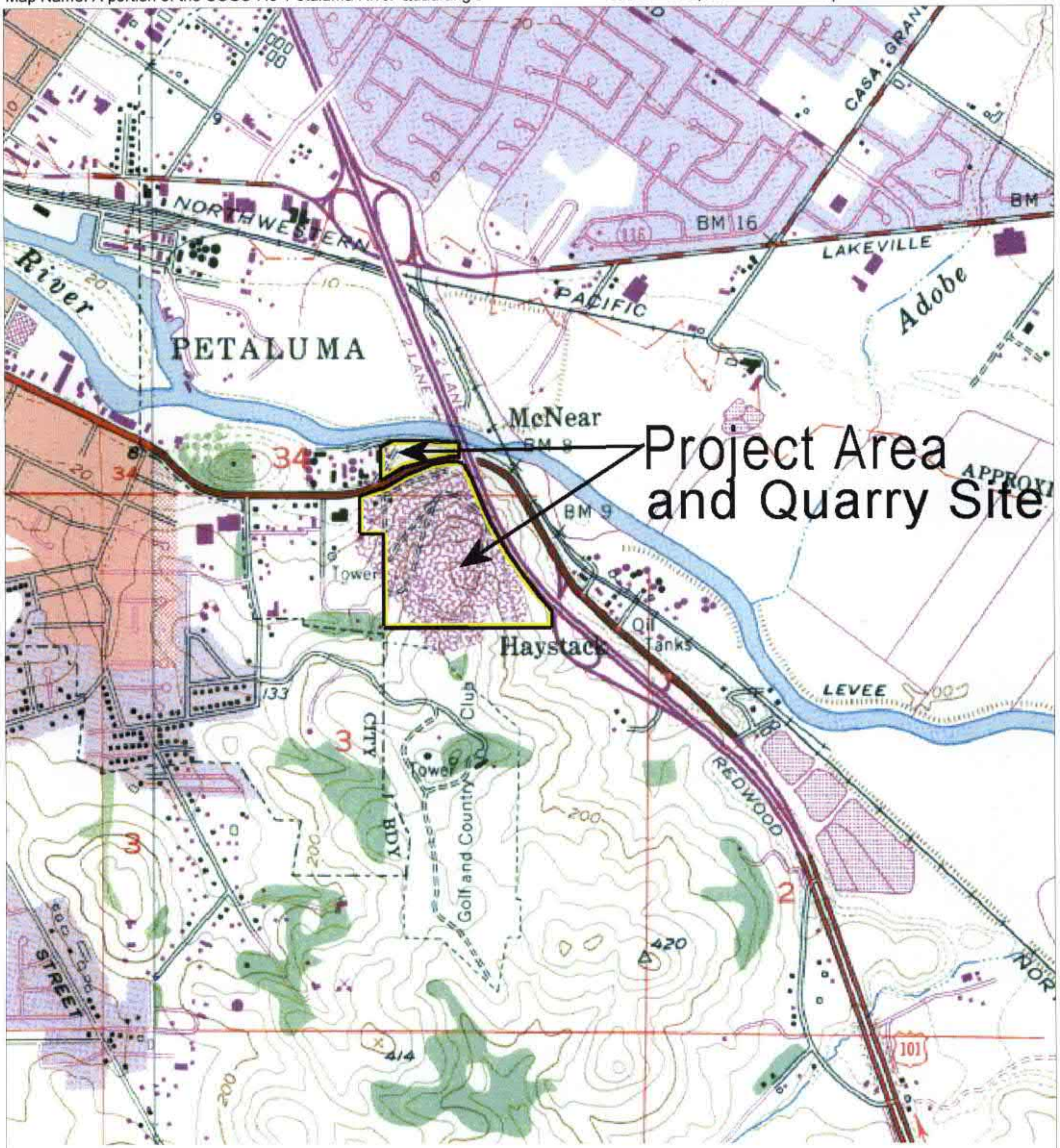
Page:

Resource Name or #: ARS 03-067-01

Map Name: A portion of the USGS 7.5' Petaluma River Quadrangle

Scale: 1:24,000

Map Date:



b

Lab Copy

P-49-001044

ARCHAEOLOGICAL SITE RECORD

THE ANTHROPOLOGY LABORATORY
SONOMA STATE COLLEGE

1. Site Trinomial	2. USGS Quad.Map	3. USGS MAP NO.#
CA-SON-1117H	7.5' Petaluma River	484A

4. Other Site Designation	5. County	6. Landgrant
Petaluma Rock Quarry and Claasen Basalt Quarry	Sonoma	

7. Twp. Range

T_N /R_W __ ¼ of W ½ of E ½ Sec. 3

8. UTM Grid Location — Zone

m.E	m.N	Zone	
533900	4230160	10	Locus 1
533660	4230400	10	Locus 2
533600	4230380	10	Locus 3
533700	4230080	10	Locus 4

9. Contour Elevation
280'- 400'msl

10. Location

northern ½ of the present site of the Petaluma Golf and Country Club

11. Site Description

four loci of basalt quarrying activities with basalt flakes, dump piles, and quarry holes.

12. Dimensions	13. Est. Area	14. Est. Depth/State method used	15. Height
each locus ca. 10m²		N/A	N/A

16. Environmental setting of site and immediate surrounding area (describe vegetation: overstory, understory; terrain: relief, geological features; nearest water: distance, direction, type, flow; exposure to sun; fauna; etc.

Terrain generally steep with much recent modification as golf course. Was a grassland/scattered oak type environment. No creeks or springs to provide water to prehistoric population of general area. Some rock outcrops possibly useful for bedrock mortars or cupules; however, none were observed (cupules or BRMs)

17. Soil of Site	18. Surrounding Soil	19. Burials
N/A	N/A	N/A

20. Features (housepits, material concentrations, associated features/petroglyphs)

Basalt quarry holes, waste flakes, and dump piles

21. Artifacts (were any collected?) — Accession Number______

N/A

22. Modifications (natural: erosion, fire, landslide, etc.; cultural: cultivation, logging, roads, buildings, etc.)

area now a golf course

23. Possibility of destruction — 24. Previous destruction (pothunting?)

Loci 1, 2, and 3 should remain intact. Loci 4 may be destroyed.

25. Previous Professional Excavation or references — SSC AIR # S-______

S-2589

1978 Rev. (see reverse)

a

26. Photos (indicate slides, b&w, color) yes, of Locus 1

On file at: SSC Anthro Lab

27. Owners and/or tenants Petaluma Golf and Country Club

Address

28. Recorded by T. Origer

29. Date 6-13-78

30. Additional Information/Comments

Area to be developed into condominiums etc.

31. SKETCH MAP (Indicate scale) Legend: Spring ; Intermittent stream ; Perennial stream ; Road ; Fence ; Stone wall ; Bedrock outcrop ; Bedrock mortar ; Tree ; House ; Petroglyph/Pictograph ; Cupules ; Auger test ; Structural foundation ; House pit .

none, see USGS quad copy for locations

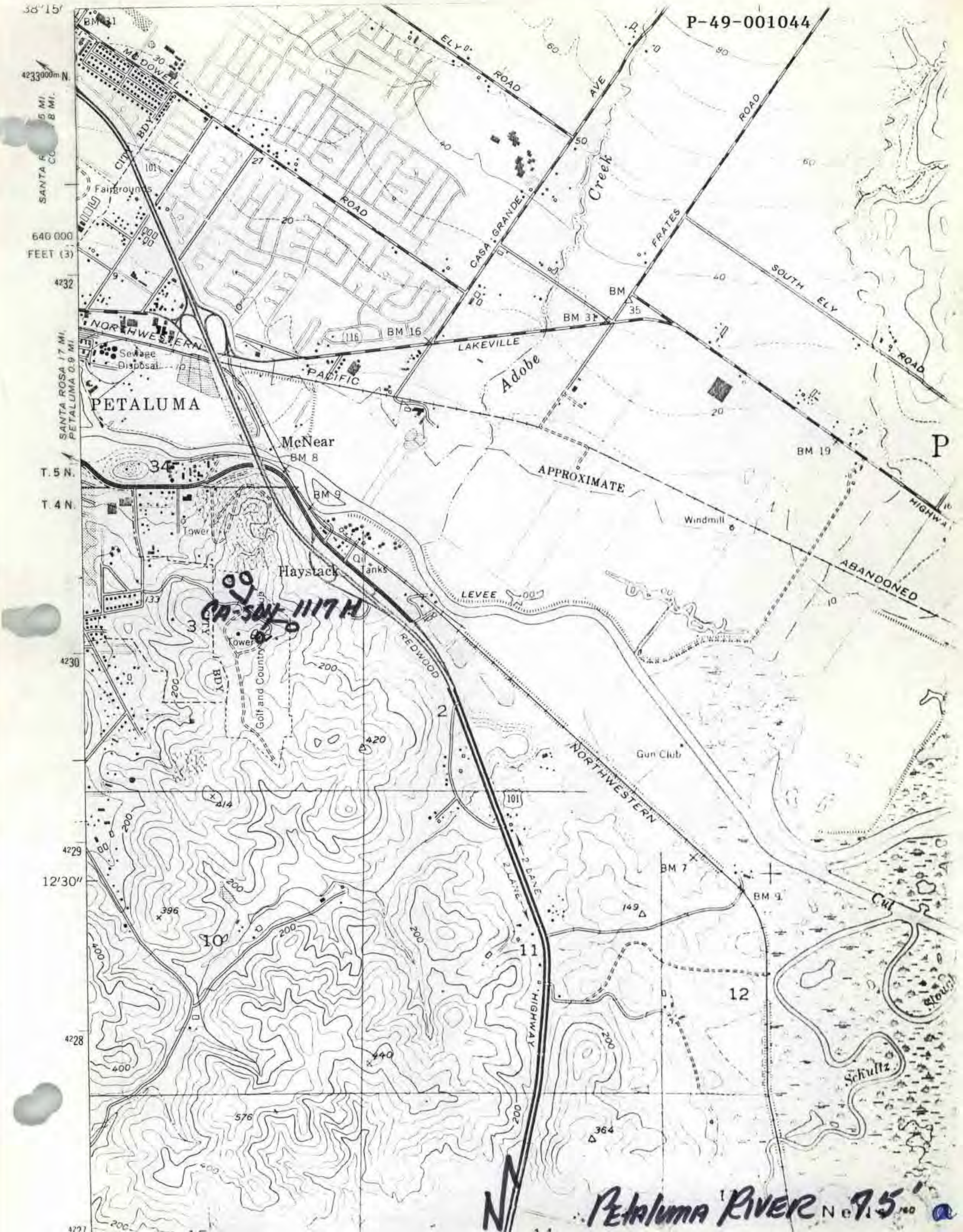
scale:

Indicate North (True or Magnetic)

a

MAP 1. Project Location

P-49-001044



38°15'
4233000m N.
SANTA ROSA
640 000 FEET (3)
4232
SANTA ROSA 17 MI.
PETALUMA 0.9 MI.
T. 5 N.
T. 4 N.
4230
4229
12'30"
4228
4227
BM 31
McDOWELL
CITY BDY
101
Fairgrounds
ELY ROAD
AVE
CASA GRANDE
ROAD
Creek
Adobe
FRATES ROAD
SOUTH ELY ROAD
BM 35
BM 31
116
BM 16
LAKEVILLE
NORTHWESTERN
PACIFIC
Sewage Disposal
PETALUMA
McNear
BM 8
BM 9
34
APPROXIMATE
ABANDONED
HIGHWAY
BM 19
P
Windmill
Tower
Haystack
Oil Tanks
LEVEE
CA-SON-1117H
3
Tower
CITY BDY
Golf and Country
REDWOOD
2
420
414
Gun Club
NORTHWESTERN
101
BM 7
BM 9
2 LANE
149
396
10
11
HIGHWAY
12
Cut
Slough
Schultz
440
576
364
Petaluma River

APPENDIX F –
Environmental Clearance Strategy

AECOM Imagine it. Delivered.

AECOM
2020 L Street, Suite 400
Sacramento, CA 95811
aecom.com

Project name:
Caulfield Moveable Bridge Project

Project ref:
AECOM Project Number 60580130

From:
Emma Rawnsley,
Senior Environmental Planner

Date:
June 24, 2020

To: City of Petaluma, Public Works & Utilities Department
202 N. McDowell Blvd
Petaluma, CA 94954

CC: Tom Barnard, AECOM Project Manager

Memorandum

Subject: Environmental Clearance Strategy - Caulfield Bridge

Introduction and Project Understanding

The City of Petaluma is proposing construction of a moveable bascule-style bridge across the Petaluma River, approximately 700 feet upstream (west) of the US Route 101 bridge (Figure 1). The proposed bridge would extend Caulfield Lane South across the river to connect with Petaluma Boulevard South at Crystal Lane. The purpose of this memorandum is to identify permitting requirements for the proposed bridge, and to identify an appropriate approach to preparing environmental clearance documentation for the project in accordance with CEQA and/or NEPA.

Figure 1: Project Site Location

The Petaluma River at the proposed bridge site is a navigable waterway under the jurisdiction of the United States Coast Guard (USCG) under Section 9 of the Rivers and Harbors Act. A preliminary clearance determination from the USCG has been obtained for the project, which outlines the required horizontal and vertical clearances required for a bridge in this location.

This memorandum has been prepared based on project information provided to AECOM as of June 2020, which includes:

- USCG Preliminary Public Notice 11-150 dated May 6, 2019 and associated project exhibits; and
- Site Constraints Exhibit, Sheets 1 and 2, prepared by Steven J. Lanfranchi & Associates, Inc. dated August 31, 2018.

Environmental Impact Review

California Environmental Quality Act (CEQA) Compliance

CEQA requires that California state and local agencies analyze the environmental impacts of a proposed project prior to approving the project or issuing any discretionary permit for a project. For this project, the City of Petaluma would be the CEQA Lead Agency. Other local or state permitting agencies would rely on the CEQA documentation prepared by the City to meet their role as responsible agencies under CEQA.

Based on the limited project information available to date, it is anticipated that the appropriate level of CEQA documentation would be an Initial Study (IS), as it is anticipated that all potentially significant environmental impacts of the project could be reduced to a less than significant level with the incorporation of mitigation measures, allowing the City to adopt a Mitigated Negative Declaration (MND) under CEQA.

However, if the Initial Study determines that significant impacts could not be reduced to a less than significant level through mitigation, then an Environmental Impact Report would be required. While such significant and unavoidable impacts are not anticipated to result from this project, the City may want to consider preparation of an EIR, particularly if the project is likely to be the focus of intense public interest and/or the City believes that project opponents may be able to raise a fair argument supported by substantial evidence that the project could cause a significant environmental impact (a legal standard). This is true even if there is also substantial evidence to the contrary. In addition, recent case law shows that the Courts provide additional deference to the Lead Agency if an EIR is prepared, whereas the burden of proof for project opponents is much lower for an IS/MND.

National Environmental Policy Act (NEPA) Compliance

Prior to approving discretionary permits for a project, federal agencies must comply with the requirements of NEPA. Although the federal lead agency typically prepares the appropriate NEPA document for a federal action, the CEQA lead agency may choose to prepare a joint CEQA/NEPA document, in order to facilitate review of the project by federal agencies under NEPA. USCG is anticipated to be the federal lead agency under NEPA, unless the project requires an individual Section 404 permit from USACE (i.e., if the project would not qualify for NWP 15, as discussed above).

For this project, it is anticipated that the appropriate level of NEPA documentation would be an Environmental Assessment, as it is anticipated that all potentially significant environmental impacts of the project could be reduced to a less than significant level with the incorporation of mitigation measures, which would allow the federal lead agency under NEPA to issue a Finding of No Significant Impact.

The majority of environmental impacts analyzed under NEPA are similar to those evaluated under CEQA; however, there are certain additional requirements, such as sections containing the following:

- Purpose and Need of the proposed action;
- Analysis of alternatives for the proposed action, including a no-action alternative, at the same level of detail for all alternatives;

- Analysis of environmental justice issues, under Executive Order 12898;
- Analysis of floodplain management and protection of wetlands issues in accordance with Executive Orders 11988 and 11990; and
- Analysis supporting a consistency determination under the Coastal Zone Management Act (if applicable[1]).

If a joint CEQA/NEPA document is to be prepared for the project, it should include both state and federal significance criteria and added analysis of these topics. To support each Lead Agency determination, a joint document should clearly delineate whether its conclusions are made with respect to CEQA or NEPA criteria, or both. Early consultation with federal permitting agencies is recommended to identify the federal lead agency and ensure their specific NEPA implementation guidelines are followed.

Permit Acquisition

The following permits or public agency approvals are anticipated to be required for the project:

- **U.S. Coast Guard (USCG):** A Bridge Permit from the USCG will be required under Section 9 of the Rivers and Harbors Appropriation Act and the General Bridge Act, because Petaluma River is considered a navigable water of the United States. Although a preliminary determination from the USCG has already been obtained for the project (USCG 2019), which requires 90 feet of horizontal clearance in both open and closed bridge position, and 10 feet of vertical clearance above mean high water in the closed position, the preliminary clearance does not constitute an approval or final agency determination. A Coast Guard Bridge permit application is required, in accordance with the USCG's Bridge Permit Application Guide. Note: Issuance of a Coast Guard bridge permit is considered to be a federal action subject to NEPA.
- **U.S. Army Corps of Engineers (USACE):** Activities associated with construction of the bridge will affect wetland and non-wetland waters of the U.S. as defined under Clean Water Act (CWA) Section 404 (AECOM 2020a). As a result, the project will require one or more permits from USACE pursuant to Section 404 CWA and Section 10 of the River & Harbors Act. The project may qualify for USACE's Nationwide Permit (NWP) 15, which applies to USCG-approved bridges, but does not apply to causeways or approach fills for bridges. Assuming that any approach fill material for the proposed bridge is outside of USACE's jurisdiction, and all other terms, general conditions and regional conditions applicable to NWP 15 are met, the project may be able to obtain authorization under NWP 15. If the project does not qualify under NWP 15, the project would require an Individual Permit under Section 404 CWA. Note: Issuance of a USACE permit is considered a federal action and subject to NEPA. For all NWPs, the USACE has already undertaken NEPA review at a programmatic level, therefore project-specific NEPA documentation would not be required to issue a NWP 15.
- **San Francisco Bay Regional Water Quality Control Board (RWQCB):** CWA Section 401 requires Water Quality Certification from the RWQCB for discharges to the Petaluma River associated with construction. Because the SWRCB has not provided general certification for USACE's NWP 15, a project-specific Section 401 certification would be required. A CWA Section 402 Permit under the National Pollutant Discharge Elimination System (NPDES) from the SWRCB would be required for construction-related stormwater discharges if 1 acre of land would be disturbed during construction. However, because the project site would less than 1 acre, the requirements from the statewide NPDES Construction Permit are not applicable. It is assumed that post-construction stormwater discharges from the completed bridge and roadway approaches would be directed to the municipal stormwater system, and would meet the conditions of the City's MS4 permit, in which case an individual permit for operational stormwater discharges would not be required.
- **National Marine Fisheries Service (NMFS):** The Petaluma River is considered Designated Critical Habitat for steelhead - Central California Coast ESU and has the potential to support Chinook salmon. The potential therefore exists for the project to impact fish species listed as threatened or endangered under the federal

[1] Preliminary review indicates that the project site is not within a coastal zone, including Bay Conservation Development Commission (BCDC) jurisdiction, and would therefore not subject to the Coastal Zone Management Act. BCDC jurisdiction extends from the San Francisco Bay up the Petaluma River as far as it's confluence with Adobe Creek, approximately 4,000 feet downstream of the project site.

Endangered Species Act (ESA), requiring consultation under Section 7 of the ESA. A Biological Assessment would be required in order to obtain a Biological Opinion from NMFS supporting a USACE or USCG decision to issue their permits. The presence of special-status plant species or habitat suitable for special-status terrestrial animals was not identified in a June 2020 site survey (AECOM 2020b), therefore consultation and/or a biological opinion from the US Fish and Wildlife Service (USFWS) is not expected to be necessary for this project.

- **California Department of Fish and Wildlife (CDFW):** Section 1602 California Fish and Game Code requires that the CDFW be notified prior to any project that would divert or obstruct the natural flow, change the bed, channel or bank, or use or deposit any material from or into any river, stream or lake. However, the definition of a stream under the Code does not include tidal sloughs or other tidally influenced areas, therefore, the Channel, as a tidal water, does not fall under the jurisdiction of Section 1602 (AECOM 2020a).
- **California State Lands Commission:** A State Lands Commission submerged lands lease would be required as navigable waters are considered sovereign state-owned lands.
- **Tribal Consultation:** No known historical resources, unique archaeological resources, or historic properties with the potential to be affected by the project were identified during a June 2020 pedestrian survey of the project site, however the southern side of the river is highly sensitive for buried/submerged resources (AECOM, 2020c). Depending on the depth and location of proposed subsurface project impacts, pre-construction subsurface investigations to identify potential buried resources may be warranted. Consultation with Native American tribes may be required under state Assembly Bill (AB) 52 and Section 106 of the National Historic Preservation Act.

It is recommended that pre-application meetings be held with permitting agencies as early in the process as feasible to review project design features and discuss best management practices to minimize or avoid impacts and typical mitigation measures.

References

AECOM, 2020a. Draft Jurisdictional Delineation for the Caulfield Bridge and Extension Project, City of Petaluma, Sonoma County. June.

AECOM, 2020b. Preliminary Biological Resources Memorandum for the Caulfield Bridge and Extension Project, City of Petaluma, Sonoma County (in preparation).

AECOM, 2020c. Preliminary Cultural Resources Assessment, Proposed Caulfield Bridge, Petaluma, Sonoma County, CA. Prepared for City of Petaluma Public Works and Utilities Department. June 24.

United States Coast Guard (USCG), 2019. Preliminary Clearance Determination, July 15.

APPENDIX G –
Draft Jurisdictional Delineation

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Draft Jurisdictional Delineation for the Caulfield Bridge and Extension Project

City of Petaluma, Sonoma County

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List of Acronyms and Abbreviations

°F	degrees Fahrenheit
BCDC	San Francisco Bay Conservation and Development Commission
BSA	Biological Study Area
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
CWA	Clean Water Act
EPA	United States Environmental Protection Agency
FAC	Facultative (plant species)
FACU	Facultative Upland (plant species)
FACW	Facultative Wetland (plant species)
GPS	Global Positioning System
HTL	High Tide Line
HUC	Hydrologic Unit Code
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MSL	Mean Sea Level
MTL	Mean Tide Level
NAVD88	North American Vertical Datum of 1988
NL	Not Listed (plant species)
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
NWPR	Navigable Waters Protection Rule
OBL	Obligate Wetland Plant Species
OWUS	Other Waters of the United States
Project	Caulfield Bridge Project
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board
TNW	Traditional Navigable Water
UP	Upland Data Point
UPL	Obligate Upland (plant species)
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code

USCG	United States Coast Guard
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WDR	Waste discharge requirements
WETS	NRCS Climate Analysis for Wetlands
WL	Wetland Data Point
WOTUS	Waters of the U.S.
WUS	Wetland Waters of the United States

1 Introduction

This report was prepared by AECOM for the City of Petaluma to identify and delineate jurisdictional wetlands (WUS) and other (non-wetland) waters of the United Stated (U.S.) (OWUS) within the Biological Study Area (BSA), as defined in Section 1.2, for the Caulfield Bridge and Extension Project (Project). The delineation was conducted in accordance with the guidelines defined in the United States Army Corps of Engineers (USACE) Wetlands Delineation Manual (Environmental Laboratory 1987), the USACE Arid West Manual (USACE 2008), relevant USACE regulatory guidance letters, and USACE district-specific minimum reporting requirements. Surveys were conducted on May 26, 2020. The project will include construction of a moveable span bridge (drawbridge) along with piers, that house operating equipment, on the banks of the Petaluma River in order to extend Caulfield Lane to Petaluma Boulevard South. The new 118-foot drawbridge will eventually connect Petaluma Boulevard South with the new Riverfront development under construction at the end of Hopper Street.

1.1 Project Description

The City of Petaluma is proposing construction of a moveable bascule style bridge across the Petaluma River, that would extend Caulfield Lane South across the river to connect with Petaluma Boulevard South at Crystal Lane. Just downstream (east) of the proposed bridge site is the US 101 bridge across the Petaluma River. Further east, there is an existing movable bridge, the Haystack Landing Rail Drawbridge, for the Sonoma Marin Area Rail Transit rail corridor where the rail tracks cross Petaluma River. The Petaluma River is a navigable waterway and under the jurisdiction of the United States Coast Guard (USCG) at the proposed bridge site. A preliminary clearance determination from the USCG has been obtained for the project, which outlines the required horizontal and vertical clearances required for a bridge in this location.

The project area is within a Federal Emergency Management Agency 100-year floodplain. Any encroachment within the 100-year floodplain by any bridge improvements including the roadway approaches would need to satisfy the City’s net-zero fill policy. Mitigation measures may be needed if there is an encroachment such as terracing of the Petaluma River upstream and/or downstream of the river crossing.

While the proposed bridge crossing of the Petaluma River provides a cross-town connector for motorists, it also provides a new link for pedestrians and bicyclists. There will be opportunities to evaluate whether separated pedestrian and bicycle facilities can be provided on the new bridge and roadway approaches (e.g. sidewalks and bike lanes) or if shared use facilities that combine pedestrians and bicyclists onto a multi-use trail on one side of the bridge and roadway approaches are feasible. The City of Petaluma Bicycle and Pedestrian Plan, adopted in May of 2008 as an appendix to the City’s General Plan 2025, proposes future on street Class II bike lanes across the vacant riverfront land that would connect with existing Class II bike lanes on Caulfield Lane (up to Hopper Street) and on Petaluma Boulevard South.

1.2 Study Area Setting

The geographic area where the wetland and waters delineation was conducted (the BSA) is in Sonoma County, California (Figure 1) (approximate location: 38.228754°, -122.618321°). The project site is approximately 650 feet west of the U.S. Highway 101 along the Petaluma River. Primary access to the north side of the project site is from Hopper Street and Caulfield Lane, and to the south side off of

Petaluma Boulevard South at Crystal Lane. The project site is relatively flat and is mostly undeveloped, with some paved areas on the south side. A mixed-use development project is under construction to the north of the BSA on Caulfield Lane. On the north side of the Petaluma River between Hopper Street and the river, there is existing vacant riverfront land. The 1.97-acre BSA is within the Petaluma River 7.5-minute United States Geological Survey (USGS) quadrangle, Section 34, Township 5 North, Range 7 West. The BSA includes portions of Assessor Parcel Numbers: 019-210-008, 019-210-010, 019-210-038, 136-690-009, 136-690-012 (USGS 2012).

The BSA includes all habitat within and surrounding the project that could be impacted by project activities and extends approximately 50 feet beyond the proposed project footprint to incorporate the proposed bridge and staging areas (Figure 2). The entire BSA was surveyed for wetlands and non-wetland waters (other waters) of the U.S. under jurisdiction of the USACE.

Before the start of field investigation, a desktop analysis of the BSA was performed using appropriate reference materials and maps. The remainder of this section provides information related to climate, topography, hydrology, growing season and precipitation analysis, soils and vegetation in the BSA.

1.2.1 Climate and Topography

The BSA has a Mediterranean type climate characterized by hot, dry summers and cool, wet winters with some fog and wind (Petaluma Watershed Enhancement Plan 1999). Climate summary data recorded from 1893 to 2019 for the city of Petaluma show that annual average precipitation is 24.89 inches with about 95% of the rainfall falling between the months of October and April (Western Regional Climate Center 2020). The mean maximum and minimum temperatures are 70.4- and 44.9-degrees Fahrenheit (°F) respectively. The hottest months range from May through October and the coolest months include November to April. The topography of the Petaluma River valley within which the BSA lies is relatively flat. Elevations in the BSA range from 12 feet above mean sea level (MSL) at the Petaluma River to 25 feet above MSL at the upland banks along the river.

1.2.2 Hydrology

The BSA is in the 134-square mile San Pablo Bay Estuaries Hydrologic Unit Code (HUC) 12 Sub-Watershed (USGS HUC 180500020801), which is within the larger 229-square mile San Pablo Bay HUC 10 watershed (USGS HUC 1805000208) (USGS 2020) (Figure 3).

The Petaluma River is a brackish tidal slough which connects to San Francisco Bay and supports along its edges brackish tidal marshes, or tidal wetlands. The headwaters of the Petaluma River are located southwest of the town of Cotati. From there the river flows southward through the City of Petaluma, where the river becomes navigable, and then continues its flow another 11 miles through the Petaluma Marsh before it empties out into the northwest corner of San Pablo Bay.

Petaluma Marsh, located two miles downstream of the Project site, is the largest remaining intact tidal marsh within San Pablo Bay. The tidal marsh is buffered on either end by diked farmed and grazed baylands and bracketed on either side by rural upland slopes (San Francisco Bay and Development Commission [BCDC] 1997; BCDC 2020). Historically, the Petaluma River was a narrow, shallow, relatively straight and short single-thread channel with large pools (Baumgarten et. al. 2018). The river had a high degree of seasonal flow variability characterized by low flows during the dry summer months and seasonal flooding along the mainstem and on the alluvial plane to the east during the wet winter months (Baumgarten et. al. 2018). In order to make the river more conducive to maritime navigation, it was straightened and dredged starting around the late 19th Century (Baumgarten et. al. 2018). The Petaluma River is designated as a traditional navigable water (TNW).

Freshwater hydrological sources for the Petaluma River include precipitation and runoff from the surrounding lands and larger Petaluma Watershed area. A large culvert is located on the southwest side of the BSA. This culvert similarly drains stormwater from the surrounding area (see Appendix C: photo F).

1.2.3 Growing Season and Precipitation Analysis

Precipitation and growing season analyses are necessary components in establishing baseline hydrology conditions for the BSA. They are also important in determining the validity or interpretation of hydrology field indicators during years with above- or below-normal rainfall. Therefore, establishing whether the hydrological conditions during the field survey were within a normal range is an important criterion of the wetland delineation.

To meet this criterion, current conditions are compared with long-term data maintained by the United States Department of Agriculture (USDA), National Water and Climate Center. The center publishes the ranges of weather data for more than 8,000 National Weather Service weather stations (Natural Resources Conservation Service [NRCS] 2020a). The data pertinent to wetland hydrology, called the NRCS Climate Analysis for Wetlands, or WETS for short, are standardized tables that provide a monthly summary and probability analysis of temperature and precipitation specifically for wetland determinations (Table 1-1 and Table 1-2; see also Appendix A).

The BSA consists of the tidal Petaluma River and riparian marshes that receive saline water from San Francisco Bay with some freshwater inputs from upstream. Therefore, the wetlands and other waters in the BSA are predominately tidally dependent, not precipitation dependent, and would not be as affected by drought conditions as non-tidal wetlands would be.

The objective of the WETS tables (in Appendix A) is to define the normal ranges for growing seasons and for monthly precipitation, so that the climatic characteristics for a geographic area may be assessed over a representative period.

Growing Season Analysis

The growing season is defined as the period when soil temperatures 12 inches below ground surface are greater than 41°F. Lacking field data, the growing season dates may be approximated by the median dates (50 percent probability of occurrence) of 28°F air temperatures in spring and fall, as described in the WETS tables (USACE 2005; 2008).

Table 1-1 provides a growing season analysis for the closest available weather station near the BSA, which is at the Petaluma Municipal Airport (approximately 2 miles to the northeast) (NRCS 2020a). To meet the USACE criteria for positive wetland hydrology, the required minimum number of days during the growing season of continuous surface saturation and/or inundation to the surface is 17 days (or 5 percent of the growing season, which is 338 days according to the WETS station). Observations of inundation and/or surface saturation during the early spring would be a strong positive indicator that the wetland hydrology criteria have been met, assuming that climate conditions were normal. At the Petaluma Airport station, the growing season is nearly year-round with most of the rainfall occurring in the fall, winter and spring months (Table 1-1)

Table 1-1. Growing Season Analysis

Station and Period of Record	Location Relative to Project	Elevation (feet)	Average Annual Rainfall (inches)	Rainfall November through April	>28°F Growing Season	Number of Days
Petaluma Airport (1893-2020)	2.25 miles northeast	20	25.62	90%	January 17–December 21	338

Source: USDA Field Office Climate Data (NRCS 2020a). Reviewed data between 1990-2020.

°F = degrees Fahrenheit

Precipitation Analysis

Indicators of hydrology may not be reliable during years with above- or below-normal rainfall. Using a method for assessing antecedent precipitation conditions at a site that was developed by the NRCS and defined by Sprecher and Warne as “the NRCS Method,” current annual rainfall for the BSA was analyzed to determine whether conditions were normal, drier than normal, or wetter than normal during the field inspections (NRCS 1997; Sprecher and Warne 2000). Normality is defined as the range of rainfall within the 30th to 70th percentiles.

Table 1-2 compares the WETS normal precipitation ranges with the actual observed rainfall for the 3 months before the field investigations near the Petaluma Airport station (the closest station to provide recent data). Using weighted averages and thresholds developed in the NRCS Method, the data show that rainfall conditions prior to the field survey were dry to normal, with the driest February (no precipitation) being recorded since record keeping began. The BSA is in a region of California that is currently designated as being in “moderate to severe drought” conditions by several drought monitors, including the Palmer Drought Severity Index (National Integrated Drought Information System 2020; USDA 2020).

However, as discussed in Section 1.2.3, the wetlands and waters within the BSA are tidally influenced and are less dependent on precipitation than freshwater systems. Therefore, these areas should be considered to be in normal condition for the 2020 survey period.

Table 1-2: NRCS Precipitation Analysis for the Petaluma Airport Station for 2020

Month	Total (Observed)	Precipitation Average	30th Percentile	70th Percentile	Condition [1]	Condition Weight Factor [2]	Month Weight Factor	Product
February	0	5.01	2.14	5.96	Dry	1	1	1
March	2.15	3.38	1.24	4.08	Normal	2	2	4
April	1.07	1.66	0.81	2.03	Normal	2	3	6
							Sum [3]	**11**

Notes: Precipitation average between 2000 and 2020. Data presented in inches.

1. If Total (Observed) is between 30th percentile and 70th percentile values, Condition = Normal; if Total (Observed) is less than 30th percentile, Condition = Dry; if Total (Observed) is more than 70th percentile, Condition = Wet.
2. Dry = 1; Normal = 2; Wet = 3
3. A sum of 6 to 9 is drier than normal; 10 to 14 is normal; 15 to 18 is wetter than normal.

Source: USDA Field Office Climate Data (NRCS 2020a).

1.2.4 Soils

The National Technical Committee for Hydric Soils defines hydric soils as having formed under conditions of saturation, flooding, or ponding during the growing season that persisted long enough that anaerobic conditions could develop in the upper portion of the soil (Federal Register 1994). Hydric soils constitute one of the three parameters required for a location to qualify as a wetland under USACE jurisdiction.

The NRCS soil survey identified two soil map units (conglomeration of soil series) within the BSA (see Appendix B: NRCS Custom Soil Resource Report) (NRCS 2020b): Alluvial land, sandy (AdA) and Yolo, clay loam, 0-5 percent slopes, MLRA 14 (YtA). Approximately, 26% of the BSA is composed of AdA soils while 48% of the BSA contains YtA soils. The remaining 26% is comprised of open water. AdA soils are found predominantly on floodplains. They are extremely well-drained soils comprised of alluvium (i.e. gravelly sand) and range from coarse sand to sand in texture. AdA soils are listed as a hydric soil on the NRCS Official List of U.S. Hydric Soils (NCRS 2014). YtA soils are found within alluvial fans and are comprised of alluvium derived from volcanic and sedimentary rock. YtA soil profile is comprised of clay loam and loam and are considered well-drained soils. YtA soils are not are listed as a hydric soil on the NRCS Official List of U.S. Hydric Soils (NCRS 2014).

1.2.5 Vegetation Communities

Vegetation communities are assemblages of plant species defined by species composition and relative abundance that occur together in the same area. The natural communities presented in this report are based on the classification presented in *A Manual of California Vegetation* (Sawyer et al. 2009) and were mapped within the BSA. Botanical nomenclature follows the second edition of *The Jepson Manual* (Baldwin et al. 2012). Most of the upland types are composed of landscaped, escaped, or other non-native plants, and the wetland types associated with estuarine and brackish marsh habitats are generally dominated by native salt marsh species. Photographs of vegetation communities identified in the BSA are shown in Appendix C. Vegetation communities and other landcover types are shown on Figure 4. A list of plant species identified in the project area are provided in Appendix D.

1.2.5.1 Ruderal

Ruderal habitats are characterized by non-native, predominantly herbaceous weedy species, with some annual grasslands. These vegetation communities occur in highly disturbed areas. Ruderal habitats were observed along the upland regions of the southern and northern banks of the Petaluma River. On the south side of the BSA, ruderal vegetation was observed in the upland areas interspersed between the ice plant mats and coyote brush scrub vegetation communities. Along the north bank, ruderal habitats occur further upland (north) of the mustard and other forb vegetation communities. Species such as ripgut grass (*Bromus diandrus),* fennel (*Foeniculum vulgare*), wild oats (*Avena* spp.), Jersey cudweed (*Pseudognaphalium luteoalbum*), annual beard grass (*Polypogon monspeliensis*), stinkwort (*Dittrichia graveolens*) and thistle species such as yellow star-thistle(*Centaurea solstitialis*) and Italian thistle (*Carduus pycnocephalus*) are common in the ruderal areas.

1.2.5.2 Upland Mustards and Forbs

This ruderal vegetation community is dominated by mustards and hence warranted a listing as a separate vegetation community type. The upland mustards and forbs vegetation community is found on the north side of the BSA, directly upslope from (north of) the salt marsh bulrush marshes. This area consists of a dense stand of black mustard (*Brassica nigra*) with other species such as Italian thistle, Scarlet pimpernel (*Lysimachia arvensis*) and wild oats.

1.2.5.3 Coyote Brush Scrub

Coyote brush scrub vegetation communities are dominated or co-dominated by dense stands of the native coyote brush (*Baccharis pilularis*). Coyote brush scrub was observed in a large patch on the southwestern side of the BSA. Understory species are sparse, and are similar to those found in the ruderal habitats.

1.2.5.4 Ice Plant Mats

The non-native ice plant (*Carpobrotus edulis)* is a low growing succulent, forming dense mats that often cover large areas (Cal-IPC, 2020). Ice-plant mats were observed in the uplands south of the Petaluma River, adjacent to the paved areas. Non-native grasses such as wild oats are subdominant in this vegetation type.

1.2.5.5 Salt Marsh Bulrush Marshes

Salt marsh bulrush marshes occur above the intertidal mudflats, in the lower to mid marsh regions, and just below upland communities not subject to tidal action. These coastal brackish marshes are found at the interior edges of coastal bays and estuaries and may be adjacent to salt marsh. Along the Petaluma River this community is dominated by Alkali bulrush (*Bolboschoenus maritimus*), California bulrush (*Schoenoplectus californicus*), pickleweed (*Sarcocornia pacifica*), marsh gumplant (*Grindelia stricta*), brass buttons (*Cotula coronopifolia*), and saltgrass (*Distichlis spicata*). These marshes occur in narrow bands and patches along the south and north banks of the Petaluma River (Figure 4). This community grows on the higher edges of the river, sometimes through riprap where soils are saturated during high tides.

1.3 Regulatory Setting

1.3.1 Federal Regulation

The regulatory setting is framed by current enabling legislation and case law. Under Section 404 of the Clean Water Act (CWA), the USACE regulates the discharge of dredged and fill materials into “waters of the United States” (WOTUS). Jurisdictional waters of the U.S. include “intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds, and wetlands adjacent to any water of the U.S.” (33 Code of Federal Regulations [CFR] § 328). Certain waters of the U.S. are considered “special aquatic sites” because they are generally recognized as having particular ecological value. Such sites include sanctuaries and refuges, mudflats, wetlands, vegetated shallows, and riffle and pool complexes. Special aquatic sites are defined by the United States Environmental Protection Agency (EPA) and may be afforded additional consideration in a project’s permit process.

Projects that place fill in jurisdictional wetlands and non-wetland waters of the United States require either an individual or a nationwide permit from the USACE. Nationwide permits are issued by the USACE for specific types of activities that have minimal individual or cumulative adverse environmental impacts. Individual permits are required for large and/or complex projects or projects that exceed the impact threshold for nationwide permits.

The USACE also has jurisdiction over “navigable waters” under Section 10 of the Rivers and Harbors Act. Section 10 of this act applies to tidal areas below mean high water (MHW) and includes tidal areas currently subject to tidal influence as well as historic tidal areas behind levees that both historically and presently reside at or below MHW. “Navigable waters of the U.S.,” as defined in 33 CFR Part 329, are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce (33 CFR § 322.2). The act prohibits any unauthorized action that obstructs the "navigable capacity of any waters of the U.S." These actions can include building of structures, excavation, fill, and alterations and modifications to navigable waters (33 United States Code [USC] 403). A determination of navigability, once made, applies laterally over the entire surface of the water body and is not extinguished by later actions or events that impede or destroy navigable capacity. The upper limit of navigable water is at the point along its length where the character of the river changes from navigable to non-navigable, such as at a major fall or rapids. Because the upper limit of navigability of waterways under Section 10 jurisdiction is sometimes difficult to discern, determinations of navigability under Section 10 are often made by the USACE and kept on file, independent of submitted permit applications or delineations.

1.3.1.1 Jurisdictional Changes

The first WOTUS Rule that was consistent between USACE and USEPA was developed in 1993. There were minor changes to the rule in attempts to clarify, but how the Rule was applied remained relatively consistent until after the Rapanos v. United States case at the U.S. Supreme Court (USACE and EPA 2007). There was no majority decision in the case, but there was a plurality decision (Justice Scalia plurality) and a concurring decision (Justice Kennedy). This second decision was viewed as more consistent with other court decisions and provided a stronger basis for regulatory rulemaking and guidance. The Kennedy decision became the basis for future guidance. The case, as it applies to the various rules, created a "significant nexus" test for whether a wetland or stream was jurisdictional, spoke to adjacency of wetlands and streams, and incorporated limited subsurface connections as a part of maintaining jurisdictional review. The agencies issued 2008 Guidance which explained the applicability of the Rapanos decision to the 1993 Rule (USACE and EPA 2008). This combined rule and guidance is often referred to as the "Pre-2015 Rule".

In early 2015, the EPA issued a report titled "Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence" (EPA 2015). The report summarized the known connections that occur between streams, wetlands, and groundwater. A new 2015 Rule defining waters of the U.S. (80 CFR 37053) was subsequently issued, with the intent to provide greater clarity. Many felt the 2015 Rule strengthened or extended jurisdictional authority into some ephemeral streams, as well as potentially extended jurisdictional authority based solely on groundwater connections "uphill" from a wetland without specificity on where the line would need to be drawn. This called into question as to how the significant nexus requirement from the Kennedy decision was being applied.

As a result, two significant court challenges were made to the 2015 Rule. A North Dakota federal court rendered an injunction to the rule in favor of 13 states, and in another slightly later case, the remaining 37 states, territories, and protectorates obtained an injunction on the rule. In early 2018, the 37-state injunction was lifted, but the 13-state injunction remained, resulting in a mixed bag of 2015 Rule applicability that remained until the "2019 Rule" repealed the 2015 Rule in December 2019 (40 CFR 136). The 2019 Rule has been superseded by the Navigable Waters Protection Rule (NWPR) discussed below.

1.3.1.2 The Navigable Waters Protection Rule

On April 21, 2020, the EPA and the USACE published the NWPR defining the scope of waters federally regulated under the CWA (85 FR 22250). This final rule repeals and replaces the 2015 Rule defining WOTUS. The final rule became effective on June 22, 2020; however, lawsuits have already been filed by several states and environmental groups contesting the new definition. Courts may reject or block the rule in which case jurisdictional determinations would be based on the 2008 guidance issued by the Corps following the Rapanos Supreme Court decision.

In adopting the new approach, the Agencies explicitly eliminate the case-specific application of their previous interpretation of Justice Kennedy's significant nexus test in what was called their "Rapanos Guidance". The new rule regulates traditional navigable waters and the core tributary systems that provide perennial or intermittent flow into them. The four clear categories of waters are federally regulated:

- The territorial seas and traditional navigable waters
- Perennial and intermittent tributaries to those waters
- Certain lakes, ponds, and impoundments
- Wetlands adjacent to jurisdictional waters

Among the NWPR's most significant changes from the 2015 WOTUS Rule's definition of federally regulated waters of the United States are the exclusions of ephemeral streams and wetlands that are not adjacent to another non-wetland jurisdictional water. Another notable element is the Agencies' confirmation that groundwater is not subject to regulation under the CWA and, consequently, that surface water features connected only via groundwater likewise are not jurisdictional.

1.3.1.3 Exemptions

The final Rule also details 12 categories of exclusions, features that are not "waters of the United States," such as features that only contain water in direct response to rainfall (e.g., ephemeral features); groundwater; many ditches; prior converted cropland; and waste treatment systems.

1.4 State and Local Regulation

1.4.1 Waters of the State under the Regional Water Quality Control Boards

The EPA has deferred water quality certification authority to the Regional Water Quality Control Board (RWQCB) under Section 401 of the Clean Water Act. Water quality certification or waiver is required for all nationwide or individual permits issued by the USACE under Section 404 of the Clean Water Act. Issuance of water quality certification (or waiver) is considered a discretionary action, requiring review under the California Environmental Quality Act (CEQA). The RWQCB would be expected to consider impacts on all Waters of the U.S. and Wetlands identified in this report during the CEQA review process. The RWQCB is also authorized under Section 13263(a) of the Porter-Cologne Act to regulate discharges to waters of the State, including isolated wetlands, through the issuance of waste discharge requirements (WDRs). In Section 13050(e), the act defines waters of the state to mean any surface water or groundwater, including saline waters, within the boundaries of the state of California. This definition includes all wetlands, including isolated wetlands, and drainage features such as dry and ephemeral/seasonal streambeds and channels outside USACE jurisdiction. The State Water Resources Control Board (SWRCB) has issued guidance for regulation of discharges to non-federal, isolated waters and wetlands. Water Quality Order No. 2004- 0004-DWQ specifies general WDRs for dredged or fill discharges to waters deemed by the USACE to be outside of federal jurisdiction under Section 404 of the CWA.

In California, in response to the NWPR, the SWRCB has adopted a State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (Procedures), implemented May 28, 2020. The SWRCB adopted the Procedures to address several important issues, including to strengthen protection of waters of the state that are no longer protected under the CWA due to U.S. Supreme Court decisions, since the Water Boards have historically relied on CWA protections in dredged or fill discharge permitting practices, as well as to alleviate inconsistencies across the Water Boards in requirements for discharges of dredged or fill material into waters of the state, including wetlands. The State policy will assert jurisdiction over some wetlands and waters that have been excluded in the NWPR. The RWQCB will have much of the “handle” or responsibility for permitting projects affecting aquatic resources to the State.

2 Methods

Before the field investigations, a desktop analysis of the BSA was performed using appropriate reference materials and maps. Satellite images of the BSA were examined to identify potential wetland or water features to investigate during the field surveys. Imagery was taken from Esri using ArcGIS, dated 2019 and Google Earth (Google Earth 2020). This chapter provides details on these analytical methods.

2.1 Reference Materials

Reference materials were assembled to inform the methods and data interpretation used in the delineation. The primary reference materials were:

- *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979)
- *Corps of Engineers Wetlands Delineation Manual*, online edition (Environmental Laboratory 1987)
- *Regional Supplement to the USACE Wetland Delineation Manual: Arid West Region* (USACE 2008)
- *The Jepson Manual*, second edition (Baldwin et al. 2012)
- National Wetlands Inventory (NWI) (USFWS 2009)
- *A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (Lichvar and McColley 2008)
- *The National Wetland Plant List: 2018 Wetland Ratings* (USACE 2018)

2.2 Field Surveys

AECOM biologists conducted field surveys for potentially jurisdictional wetlands and other waters of the U.S. in the BSA on May 26, 2020. The NWI was reviewed for potential wetlands occurring in the BSA (Figure 5) (USFWS 2009). Determining regulatory agency jurisdiction in tidal areas is dependent on determining the location of corresponding tidal elevations within the BSA. The high tide line (HTL) was delineated using a combination of field surveys and desktop survey elevations using data from the National Oceanic and Atmospheric Administration (NOAA) Petaluma River Upper Drawbridge gage (Station ID Number 9415584) located 0.25 mile east of the BSA for the 1983 to 2001 tidal epoch (tidal datum analysis period between January 1, 1983, and December 21, 2001) correlated to correspond with North American Vertical Datum of 1988 (NAVD88), as well as tidal charts for 2020 (NOAA 2020). In the field the HTL was identified by shoreline indicators, which included drift lines or wrack lines and watermarks observable on culverts and other structures lining the river channel and, in some cases, the upper limit of the tidal marsh plant community in areas with wetland vegetation. For mapping purposes, the HTL was determined using the highest tide levels recorded during King Tide events of 2020.

Other tidal heights, such as MHW, mean low water (MLW), or MSL were determined from the published tidal data from the Petaluma River Upper Drawbridge gage. The mean high water (MHW) was used to delineate the current Section 10 waters of the U.S.

Areas suspected of being wetlands were delineated in accordance with the routine on-site methodology described in the USACE Wetland Delineation Manual and Arid West Supplement (Environmental

Laboratory 1987; USACE 2008). This method uses a three-parameter approach to determine if an area is a jurisdictional wetland. The three parameters are soil, vegetation, and hydrology. Under normal circumstances (undisturbed conditions), a potential jurisdictional wetland must have positive wetland indicators of hydric soils, wetland hydrology, and a dominance of hydrophytic vegetation. Positive wetland indicators include field indicators and published data such as United States Department of Agriculture NRCS lists of hydric soils (NRCS 2014).

Representative photographs, provided in Appendix C, were taken to document important observations. Plants observed during the investigation were identified to the species and recorded. The plant species observed within the BSA are reported in Appendix D with their wetland indicator status (USACE 2018)

The boundaries of potentially jurisdictional features, where accessible, were mapped in the field using a Trimble TDC150 GNSS Global Positioning System (GPS) receiver. All GPS data were differentially corrected to achieve a sub-meter horizontal accuracy. Mapped jurisdictional feature boundaries were digitized and projected onto current 1:1,200 (1 inch equals 100 feet) aerial photograph maps.

2.3 Limitations That May Limit Results

One limitation to this survey was the lack of access to certain parts of the BSA. For safety reasons, AECOM biologists could not access the north shore wetland areas due to a very steep and vertically high slope. As a result, wetlands WUS-1 and WUS-2 (Figure 6) on the north bank were mapped from the opposite south shore bank and using aerial imagery when necessary.

3 Findings

Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act, wetlands and waters of the U.S. were delineated within the BSA. Tidal elevations were used to help identify the HTL and MHW within the BSA. Based on NAVD88 (where the NAVD88 datum is set at 0 feet at San Francisco), the tidal elevations at the upper drawbridge, which are considered accurate for the BSA because of proximity, are:

- HTL = 7.7 feet
- MHHW (mean higher high water) = 6.35 feet
- MHW = 5.88 feet
- MTL (mean tide level) = 3.28 feet
- MSL = 3.42 feet
- MLW = 0.67 feet
- MLLW (mean lower low water) = - 0.31 feet

Numbers above are set relative to NAVD88. Control station is San Francisco, and above data is from Petaluma River Upper Drawbridge tide gage.

3.1 Section 404 Wetlands and Waters of the United States

The potentially jurisdictional waters of the U.S. within the BSA are shown on Figure 6. A summary of these features, locations, and Cowardin classifications is presented in Table 3-1 and described below. Representative photographs of the features are included in Appendix C.

Table 3-1: Potentially Jurisdictional Wetlands and Waters of the U.S. in the BSA

Feature Type	Feature ID	Cowardin Classification	Latitude	Longitude	Square Feet	Acres
Wetlands						
Brackish Marsh	WUS-1	Estuarine Intertidal Emergent Wetland	38.228978	-122.618518	709	0.02
Brackish Marsh	WUS-2	Estuarine Intertidal Emergent Wetland	38.229017	-122.618288	216	<0.01
Brackish Marsh	WUS-3	Estuarine Intertidal Emergent Wetland	38.228472	-122.618505	69	<0.01
Brackish Marsh	WUS-4	Estuarine Intertidal Emergent Wetland	38.228511	-122.618257	775	0.02
				Wetlands Total	**1,769**	**0.04**
Other Waters						
Petaluma River	OWUS-1	Tidal slough	38.228738	-122.618437	28,368	0.65
				Total*	**30,137**	**0.69**

*The totals of the columns may not add up due to rounding.

Section 404 jurisdiction includes all open water areas of the tidal slough and adjacent shorelines to the HTL. In other areas, HTL was delineated based on field indicators (as discussed in Section 2.2). Potentially jurisdictional wetlands were found in tidal marsh communities up to or just above the HTL. No non-tidal wetlands or waters were found within the BSA.

3.1.1 Brackish Marsh

Brackish marshes are intertidal emergent wetlands dominated by grasses, forbs, and shrubs that are tolerant to salinities from slight to moderate (0.5- to 18- parts per thousand salt).The structure and composition of the coastal brackish marsh is similar to a coastal salt marsh and supports some plants in common with salt marsh, , but generally has lower salt concentration than salt marsh because of freshwater input, and salinity may vary considerably with tide or season. Patches of narrow fringe brackish marsh wetlands are found along the north and south shorelines of the Petaluma River (WUS 1-4: Figure 6 and Appendix C: photos A-F, H). These features are fully exposed at low tides once or twice a day. Brackish marshes support a combination of species found in freshwater and saline marshes and seasonal wetlands, specifically those species that have some amount of “cross-tolerance”. This includes species that grow in freshwater marshes but can tolerate some salinity and some of the dominant “middle-marsh” salt marsh species such as pickleweed, Alkali bulrush, California bulrush and saltgrass. All three criteria, including hydric vegetation, wetland hydrology indicators, and hydric soils were met. The vegetation delineating the upland areas included black mustard, fennel, and a number of non-native grasses and forbs.

3.1.2 Petaluma River

The Petaluma River flows through the center of the BSA (Open Waters, OWUS-1: Figure 6). Historically, tidal wetlands occupied about 16,000 acres along the lower Petaluma River. The tidal wetlands were composed of a range of estuarine habitat types including tidal marsh, intertidal flats, subtidal channels, and marsh ponds/pannes (Baumgarten et. al. 2018). The Petaluma River entered the estuary near present-day Payran Street in Petaluma, and followed a sinuous course for 17 miles to its mouth at San Pablo Bay, influenced both by tidal flux and by freshwater input from the Petaluma River, San Antonio Creek, and other tributaries. A potentially non-jurisdictional culvert, likely draining stormwater from the surrounding streets, is located on the south shore. The slough is navigable in this region and also has wildlife value. The existing shoreline on the project site is characterized by unprotected natural shoreline with some debris (broken concrete, and random pieces of rock) lining the edges; and beach-fronted, unprotected slopes. The shoreline shows areas of erosion and areas of vegetation and habitat growth within the intertidal zone. The slough was delineated using HTL field indicators in combination with Geographic Information System analysis.

3.2 Potential Section 10 Waters of the U.S.

Jurisdiction for Section 10 includes all navigable areas up to the plane of MHW, which has been calculated to be 5.88 feet (NAVD88) (Figure 7). There is overlap between the Section 404 waters and the Section 10 waters.

The Section 10 waters of the U.S. include any potentially jurisdictional features that are below the MHW line of San Francisco Bay (Figure 7). The features listed in Table 3-1 fall below the MHW line and are therefore classified as Section 10 waters. In the BSA, there are 0.69 acres (30,137 square feet) of Section 10 waters.

3.3 Non-jurisdictional Stormwater Feature

A basin located on the north side of the Petaluma River exhibited some wetland parameters and appeared as a depressional seasonal swale. A soil test pit was dug to assess for hydric soils. This feature appears to drain adjacent uplands only, carrying stormwater runoff from the area under development to the north. Some hydric vegetation was present, but no hydric soils and no definitive wetland hydrology was present. This slight depressional area is behind a created berm, that may be a historic levee, and so the feature pools water during heavy rain and extreme flooding events (see Appendix C: photos I and J). Due to the lack of wetland criteria, it was concluded that this feature did not fit the description of a jurisdictional wetland and was therefore not considered a wetland for this report.

3.4 Summary of Findings

A total of 0.69 acres of potential waters of the U.S. were identified within the BSA, of which 0.04 acres are potential jurisdictional wetlands and 0.65 acres are potential jurisdictional other waters of the U.S. These features also qualify as Waters of the State under Section 401.

Activities associated with the construction of the bridge will affect wetland and non-wetland waters of the U.S. as defined under Section 404 of the CWA. As a result, the project will require one or more permits from the USACE pursuant to Section 404 of the CWA and Section 10 of the Rivers and Harbors Act and a Water Quality Certification from the San Francisco Bay RWQCB pursuant to Section 401 of the CWA.

The definition of “stream” under the California Fish and Game Code does not include tidal sloughs or other tidally influenced areas. Therefore, The Channel, as a tidal water, does not fall under the jurisdiction of California Fish and Game Code Section 1602.

4 Report Preparers

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Saana Deichsel, Senior Ecologist

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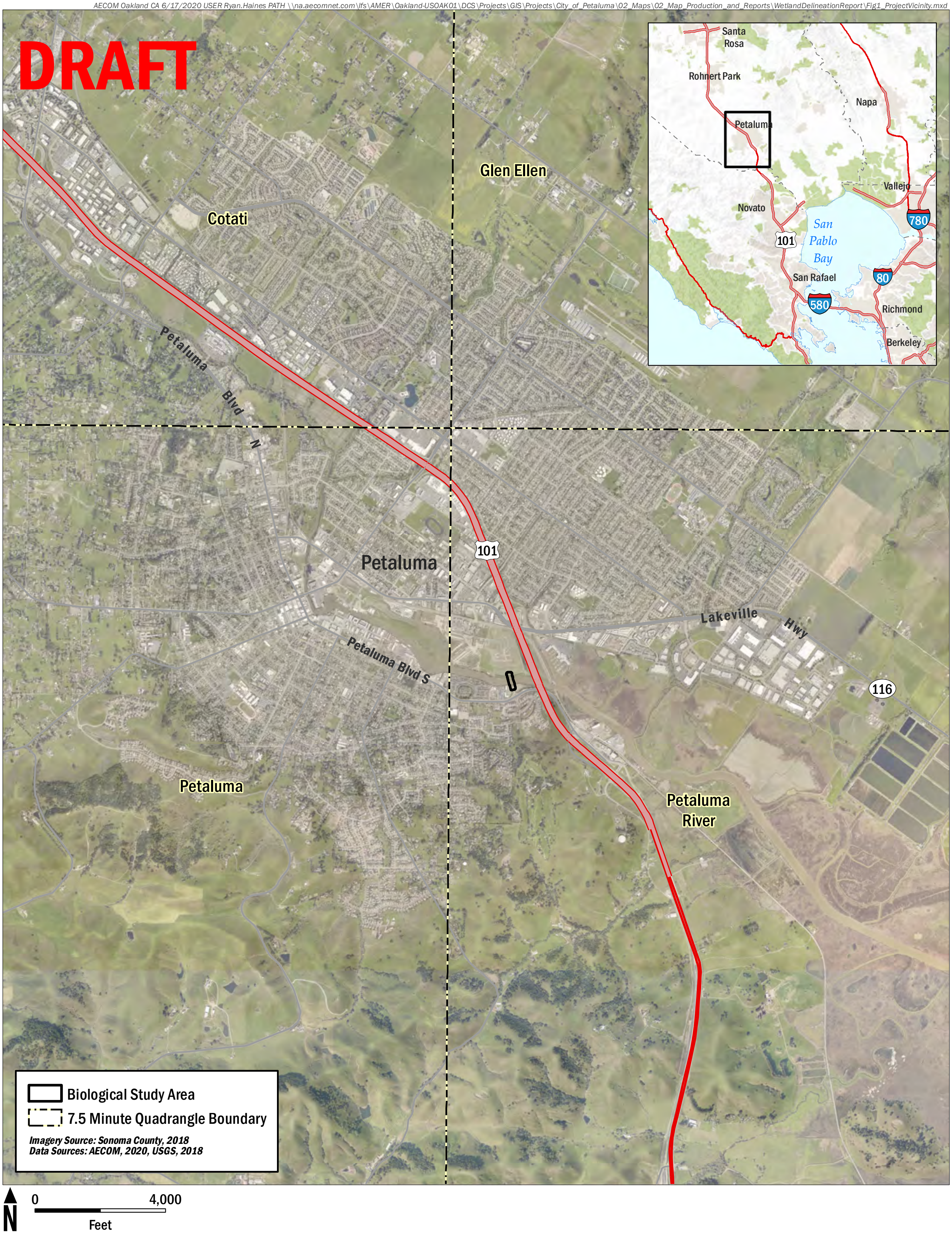
FIGURES

AECOM Oakland CA 6/17/2020 USER Ryan.Haines PATH \\na.aecomnet.com\lfs\AMER\Oakland-USOAK01\DCS\Projects\GIS\Projects\City_of_Petaluma\02_Maps\02_Map_Production_and_Reports\WetlandDelineationReport\Fig1_ProjectVicinity.mxd



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City of Petaluma

Caufiled Bridge & Extension Project

FIGURE 1

Project Vicinity

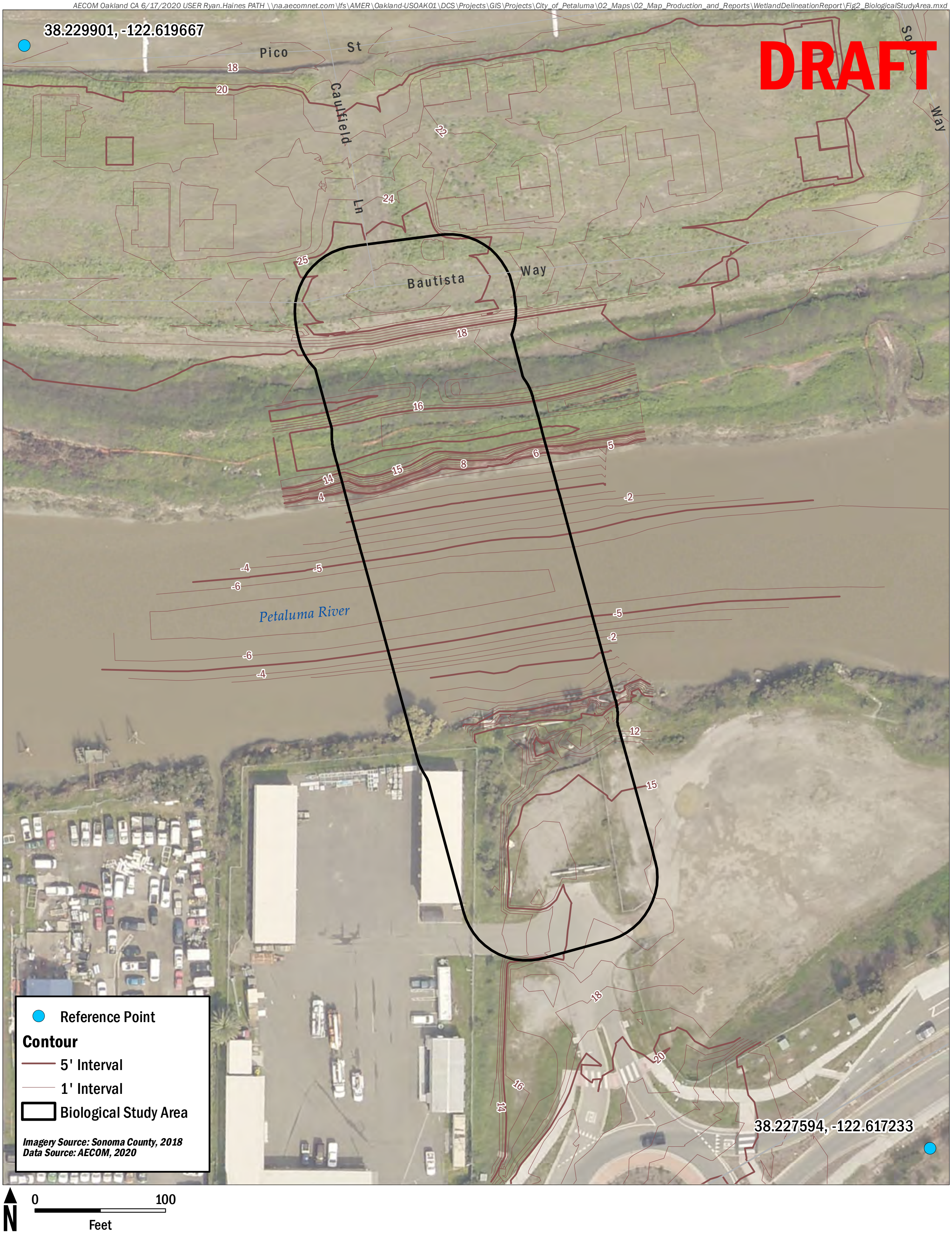

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FIGURE 2

Biological Study Area

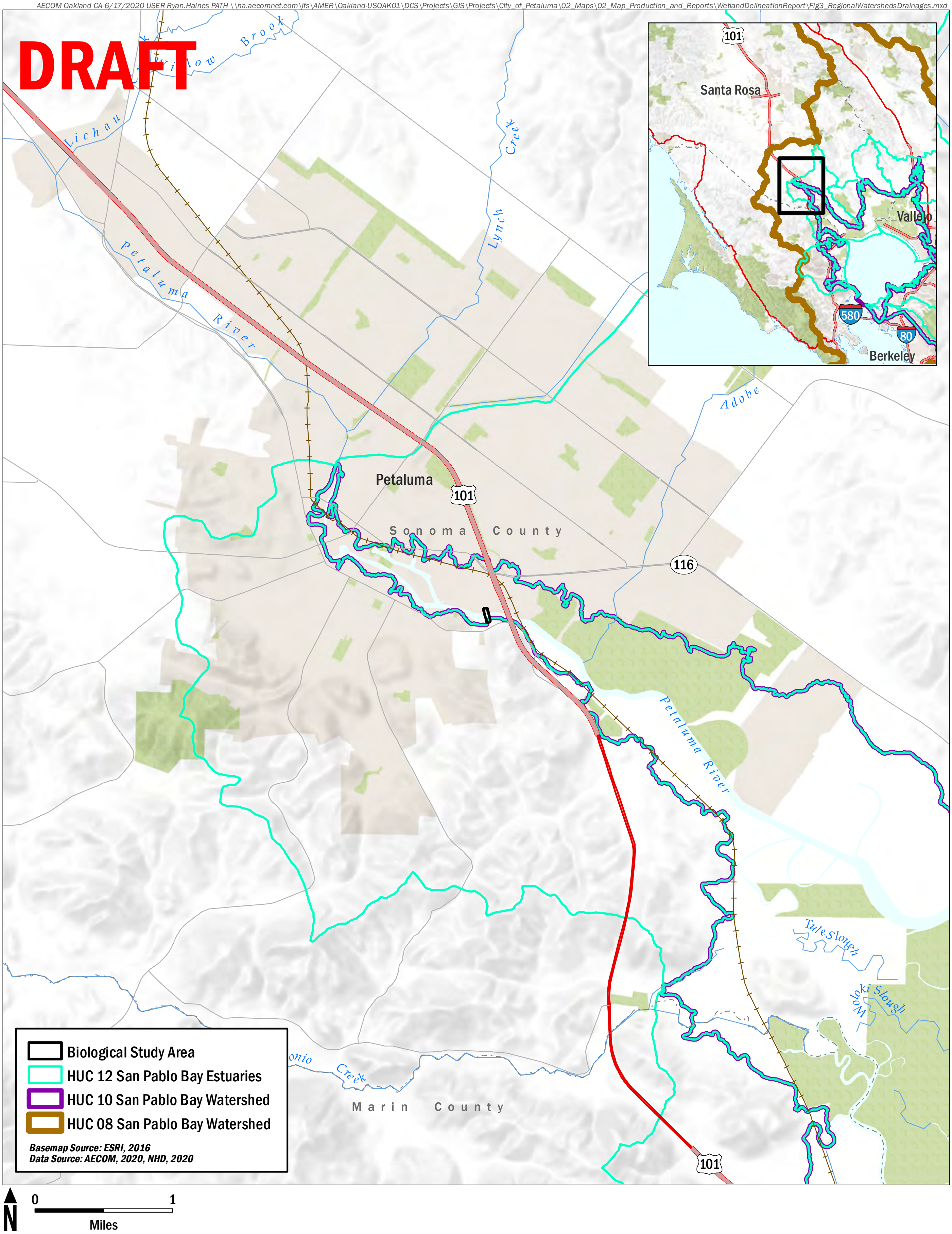

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FIGURE 3

Regional Watersheds & Drainages

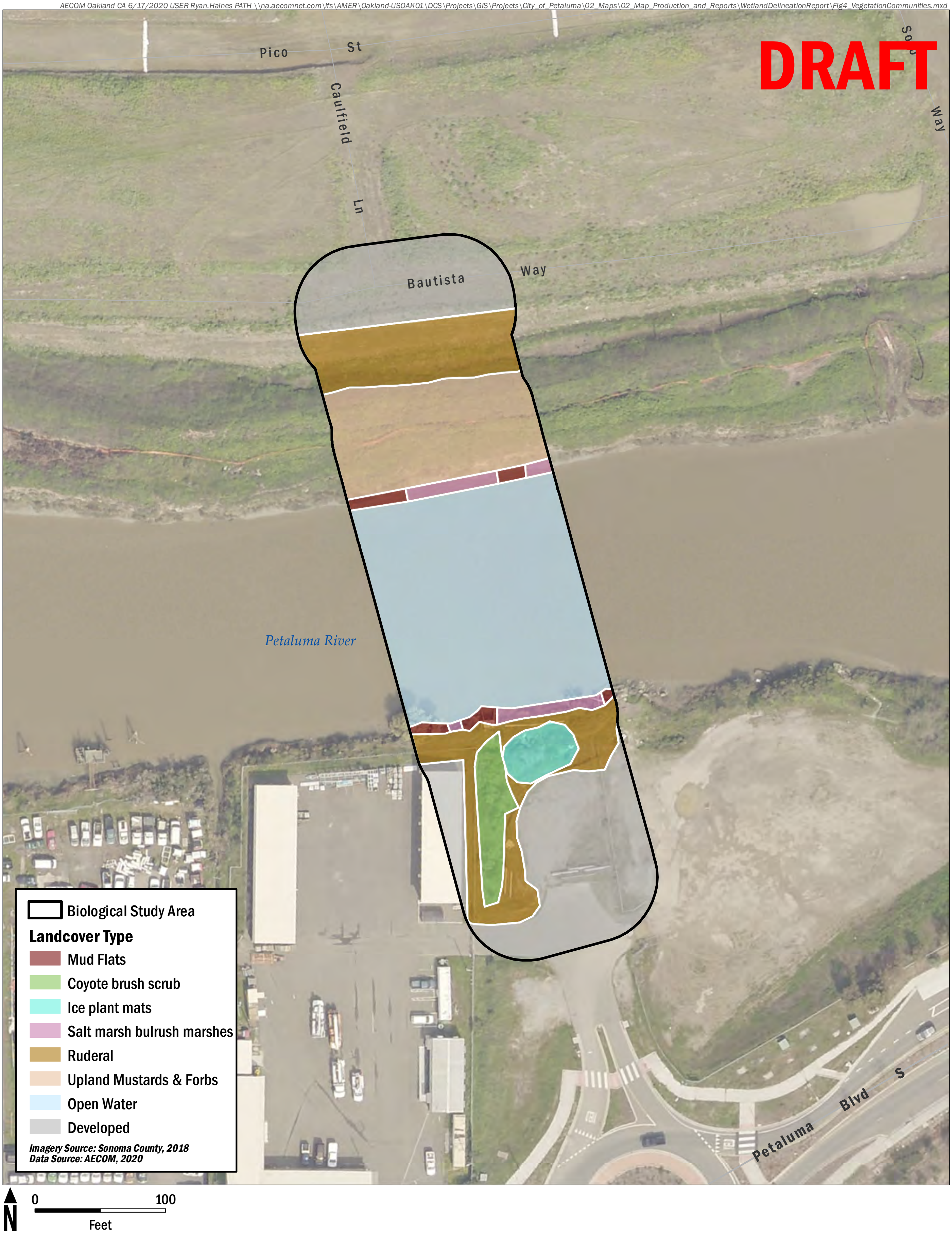

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FIGURE 4

Vegetation Communities

U.S. Fish and Wildlife Service
National Wetlands Inventory

Caulfield Bridge and Extension Project

May 19, 2020

Wetlands

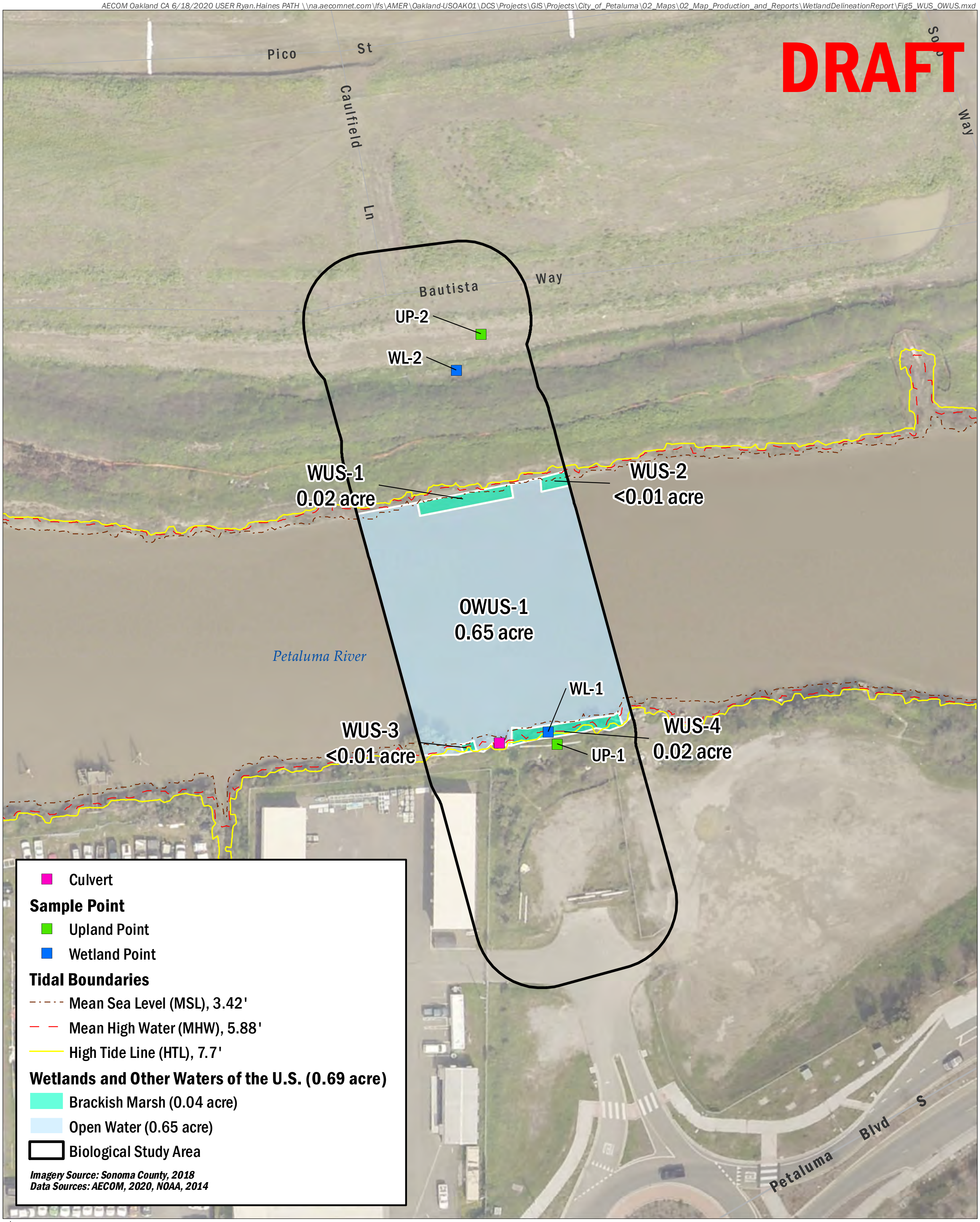
- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

Figure 5: NWI Wetlands

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

AECOM Oakland CA 6/18/2020 USER Ryan.Haines PATH \\na.aecomnet.com\lfs\AMER\Oakland-USOAK01\DCS\Projects\GIS\Projects\City_of_Petaluma\02_Maps\02_Map_Production_and_Reports\WetlandDelineationReport\Fig5_WUS_OWUS.mxd



N
0 100
Feet

AECOM
City of Petaluma
Caufiled Bridge & Extension Project

Delineated by AECOM on 05/26/2020
Coordinate System: NAD 1983 State Plane California Zone II, U.S. Feet
Projection: Lambert Conformal Conic
Horizonatal Datuam: NAD 1983
Vertical Datuam: NAVD 88, U.S. Feet

FIGURE 6
Wetlands and Other Waters of the U.S.

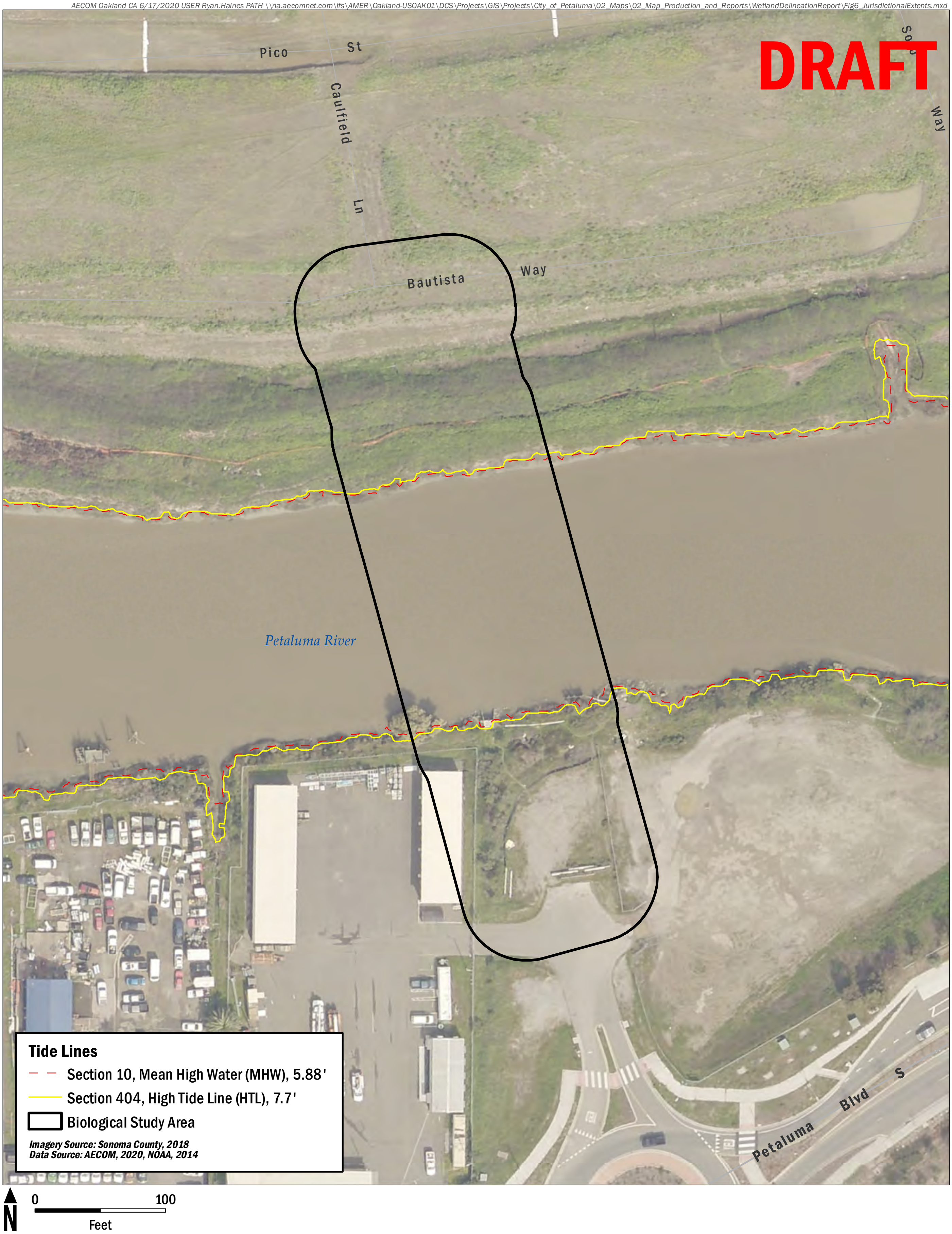


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FIGURE 7

Jurisdictional Extents of Wetlands & Waters

Appendix A
WETS Tables

WETS Table

WETS Station: PETALUMA AIRPORT, CA								
Requested years: 1990 - 2020								
Month	Avg Max Temp	Avg Min Temp	Avg Mean Temp	Avg Precip	30% chance precip less than	30% chance precip more than	Avg number days precip 0.10 or more	Avg Snowfall
Jan	57.9	38.9	48.4	4.78	1.81	5.78	8	0.0
Feb	61.6	40.4	51.0	5.01	2.14	5.96	8	0.0
Mar	65.0	42.2	53.6	3.38	1.24	4.08	7	0.0
Apr	68.0	44.0	56.0	1.66	0.81	2.03	4	0.0
May	72.1	47.7	59.9	1.00	0.33	1.07	2	0.0
Jun	78.5	50.7	64.6	0.23	0.00	0.13	1	0.0
Jul	81.3	52.8	67.0	0.01	0.00	0.00	0	0.0
Aug	81.4	53.1	67.2	0.04	0.00	0.00	0	0.0
Sep	81.8	51.6	66.7	0.09	0.00	0.09	0	0.0
Oct	76.1	47.7	61.9	1.26	0.49	1.38	2	-
Nov	65.6	42.4	54.0	2.86	1.54	3.49	5	-
Dec	57.9	38.7	48.3	5.30	1.91	6.39	9	-
Annual:					19.97	30.82		
Average	70.6	45.9	58.2	-	-	-	-	-
Total	-	-	-	25.62			46	-

GROWING SEASON DATES			
Years with missing data:	24 deg = 8	28 deg = 8	32 deg = 7
Years with no occurrence:	24 deg = 20	28 deg = 4	32 deg = 0
Data years used:	24 deg = 23	28 deg = 23	32 deg = 24
Probability	24 F or higher	28 F or higher	32 F or higher
50 percent *	No occurrence	1/17 to 12/21: 338 days	2/24 to 11/29: 278 days
70 percent *	No occurrence	1/2 to 1/5: 368 days	2/14 to 12/10: 299 days
* Percent chance of the growing season occurring between the Beginning and Ending dates.			

STATS TABLE - total precipitation (inches)													
Yr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annl
1893		2.34	6.41	1.24	0.65	0.00	0.00		M0.12	0.19	3.75	3.54	18.24
1894	M8.61	M2.92	0.85	0.69	0.69	0.69			1.61	1.72		10.15	27.93
1895	9.89	M2.47	2.55	0.61	0.81		0.08		0.36	0.15			16.92
1896													
1897													
1898													
1899													
1900													
1901													
1902													
1903													
1904													

1905													
1906													
1907													
1908													
1909													
1910													
1911													
1912													
1913		0.70	1.95	1.01	0.69	0.01	0.11	T	T	0.00	6.68	9.17	20.32
1914	15.77	5.97	1.02	1.04	0.37	0.14	0.00		0.02	1.07	0.48	7.49	33.37
1915	8.77	11.70	3.14	0.45	3.19		M0.02			0.06	0.83	6.26	34.42
1916	16.59	3.31	1.92	0.02	M0.15	0.08	0.12	0.22	0.73	0.46	1.14	6.03	30.77
1917	2.12	5.46	1.16	0.63	0.09	0.00			0.10		0.59	1.91	12.06
1918	1.43	4.76	2.79	0.64	0.00	0.11		0.00	2.85	0.63	4.15	2.32	19.68
1919	3.78	7.60	2.13	0.19	T	0.00			0.25	0.37	0.31	4.35	18.98
1920	0.24	1.00	3.00	1.71		0.44	0.06		0.10	2.59	4.79	8.03	21.96
1921	8.47	0.97	1.60	0.35	M2.93	0.02			0.25	0.85	1.64	6.51	23.59
1922	1.94	4.90	2.15	M0.24	0.34	0.12		0.00		2.28	3.43	10.06	25.46
1923	M2.48	1.27		4.56	0.05	0.06	MT	0.17	1.00	0.22	0.76	1.10	11.67
1924	3.40	3.29	1.72	0.23	0.14		0.00		0.00	3.57	1.70	M5.98	20.03
1925	1.66	11.17	2.89	M4.17	4.60	M0.06	0.03	0.16	0.38	0.55	3.65	1.28	30.60
1926	6.14	7.15	0.36	6.62	0.50	0.00	0.00	0.01	0.10	1.94	9.73	1.93	34.48
1927									MT	1.84	3.84	3.53	9.21
1928	2.35	2.71	5.23	1.82	0.17	0.00	0.00	0.00	0.03	0.07	4.02	4.75	21.15
1929	1.39	M2.08	M1.32	1.08	T	1.57	0.00	0.00		M0.06	0.00	M5.74	13.24
1930	M4.61	M2.62	3.35	1.30	0.20	0.00	0.00	0.00	0.48	0.97	1.29	0.38	15.20
1931	6.85	1.28	1.98	0.63	0.77	0.97	0.00	0.00	T	1.00	M1.53	11.26	26.27
1932	2.78	2.32	0.76	0.89	2.06	T	0.00	0.00	T	T	1.24	3.58	13.63
1933	6.25	1.39	3.16	0.15	1.40	0.00	0.00	0.00	T	M1.91	0.00	7.22	21.48
1934	0.75	4.49	0.38	0.74	1.75	0.48	0.00	T	0.30	M1.50	M3.81	3.90	18.10
1935	7.07	2.09	5.70	3.22	0.00	0.00	0.00	0.09	0.30	0.69	1.57	2.76	23.49
1936	6.85	9.68	1.17	1.30	0.22	0.71	T	T	0.00	0.35	0.02	2.79	23.09
1937	4.94	7.57	7.18	1.00	T	M0.85	T	0.00	0.00	1.19	3.61	4.35	30.69
1938	4.43	9.38	8.58	1.93	T	0.00	0.00	0.00	0.51	1.02	1.28	2.50	29.63
1939	3.40	2.07	2.23	0.15	0.48	T	0.00	0.00	0.08	0.19	0.18	1.50	10.28
1940	9.98	10.19	5.46	2.14	1.22	0.04	0.00	0.00	0.08	1.30	1.91	11.86	44.18
1941	9.58	8.50	5.91	5.43	0.90	0.30	0.00	T	T	1.48	2.18	6.72	41.00
1942	6.09	6.47	M3.61	4.50	1.12	0.00	0.00	0.00	0.	0.	4.71	M4.	31.

									08	99		19	76
1943	7.48	2.22	3.77	1.47	0.07	0.07	0.00	0.00	0.00	0.43	M0.43	2.46	18.40
1944	M4.72	7.03	2.10	2.12	1.20	0.24	0.00	0.02	T	1.59	5.01	4.66	28.69
1945	2.75	4.02	4.12	0.03	0.62	0.00	T	0.00	0.05	2.84	4.15	10.96	29.54
1946	2.15	2.59	2.09	0.29	0.08	0.00	0.04	0.00	0.04	0.23	3.52	2.97	14.00
1947	0.76	2.63	M4.03	0.69	0.29	M1.26	0.00	0.00	0.00	3.37	1.20	M0.45	14.68
1948	1.82	2.03	3.75	5.11	0.50	0.07	0.00	0.00	0.03	0.51	0.87	4.67	19.36
1949	1.50	2.54	7.16	0.00	0.24	0.00	M0.00	M0.10	T	0.12	1.18	2.77	15.61
1950	9.18	3.90	1.86	1.20	0.39	0.00	0.00	0.00	0.00	2.78	5.93	7.41	32.65
1951	4.03	3.38	1.30	0.74	0.86	0.00	0.00	0.00	0.00	1.36	3.17	6.99	21.83
1952	10.46	2.66	4.61	0.70	0.10	0.26	0.00	0.00	0.00	0.15	2.48	11.66	33.08
1953	4.68	0.08	1.87	3.04	0.66	0.35	0.00	0.20	0.00	0.28	3.58	0.60	15.34
1954	5.11	2.97	5.25	1.55	0.09	0.36	0.01	0.39	T	0.22	4.05	4.91	24.91
1955	4.06	0.95	0.37	3.34	0.00	0.00	0.00	0.00	0.55	0.18	2.22	15.48	27.15
1956	9.85	4.65	0.33	2.23	0.61	0.00	T	T	0.08	1.41	0.09	0.35	19.60
1957	3.52	5.46	2.34	1.50	2.16	T	0.00	0.00	0.99	4.87	0.88	3.08	24.80
1958	5.57	11.23	5.21	5.72	0.46	0.32	T	0.00	0.04	0.09	0.18	1.13	29.95
1959	6.35	6.26	0.59	0.35	0.08	0.00	0.06	T	1.85	0.04	T	1.31	16.89
1960	5.88	4.76	2.24	1.01	0.66	0.00	0.00	0.00	0.02	0.40	3.91	2.75	21.63
1961	4.37	1.99	3.25	1.15	0.37	0.07	0.00	0.02	0.63	0.07	3.29	4.11	19.32
1962	1.30	9.15	3.32	0.43	0.00	0.00	0.00	0.03	0.08	7.29	0.61	3.32	25.53
1963	4.97	3.04	4.58	4.58	0.46	0.00	0.00	0.00	0.05	1.52	5.60	0.92	25.72
1964	4.63	0.26	1.81	0.08	0.21	0.84	0.05	T	0.00	2.42	5.42	5.81	21.53
1965	5.19	0.66	1.53	3.57	0.00	T	0.00	0.41	0.00	0.20	5.93	3.70	21.19
1966	5.00	3.10	0.55	0.46	0.12	0.18	0.00	0.11	0.05	0.00	6.42	5.47	21.46
1967	12.78	0.49	4.47	4.96	0.07	2.02	0.00	0.00	0.03	0.82	2.35	3.15	31.14
1968	6.58	3.70	3.43	0.32	0.58	0.00	0.00	0.62	0.03	1.84	3.20	5.72	26.02
1969	7.72	7.57	1.63	2.52	0.00	0.01	0.00	0.00	T	1.65	0.88		21.98
1970	13.34	2.34	2.48	0.17	0.00	0.48	0.00	0.00	0.00	0.96	9.11	6.40	35.28
1971	1.87	0.31	3.38	0.85	0.33	0.00	0.00	0.00	0.15	0.21	2.37	5.48	14.95
1972	1.67	2.40	0.38	1.08	T	0.15	0.01	T	0.92	4.46	5.26	4.50	20.83
1973	11.27	8.55	2.81	0.08	0.02	T	0.00	0.00	0.27	1.25	9.70	4.65	38.60
1974	5.30	1.83	4.72	2.30	0.00	0.02	0.95	0.00	0.00	0.91	0.89	3.40	20.32
1975	1.97	7.17	6.41	1.13	T	0.11	0.12	0.03	T	4.64	0.68	0.79	23.05
1976	0.32	1.95	0.97	1.51	0.00	0.01	0.00	0.62	0.	0.	1.54	0.89	8.98

									57	60			
1977	1.80	1.26	2.00	0.06	0.82	0.00	0.00	0.00	0.73	0.41	4.70	4.16	15.94
1978	12.58	4.62	4.24	3.68	0.09	0.00	0.00	0.00	0.46	0.00	1.51	0.73	27.91
1979	10.45	5.61	1.73	1.17	0.38	0.00	0.00	0.00	0.09	3.40	M3.02	5.60	31.45
1980	5.89	10.26	M1.38	1.08	0.24	0.05	0.19	0.00	T	0.34	0.32	M3.30	23.05
1981	5.93	M1.37	4.24	0.07	0.38	0.00	0.20	0.00	0.00	2.19	M5.29	M8.11	27.78
1982	M9.48	3.44	5.58	3.28	0.00	0.01	0.00	0.00	0.64	2.91	6.72	2.74	34.80
1983		9.11	15.04	4.59	0.28	0.00	0.00	0.48	0.42	0.61	8.75	9.43	48.71
1984	0.41	1.92	1.43	1.33	0.19	0.26	T	0.13	0.15	2.25	7.43	1.64	17.14
1985	1.20	2.41	4.07	0.54	T	0.01	0.06	0.00	0.08	0.98	3.68	3.48	16.51
1986	4.58	15.26	7.07	1.15	0.44	0.00	T	0.00	1.67	0.24	0.26	2.33	33.00
1987	4.40	4.53	3.29	0.08	0.04	0.00	0.00	0.00	0.00	1.42	3.04	6.39	23.19
1988	5.43	0.55	0.08	M1.24	0.67	0.73	0.00	0.00	0.00	0.09	3.25	2.81	14.85
1989	1.39	0.99	6.14	1.08	0.15	0.01	0.00	0.00	1.77	1.69	1.77	0.00	14.99
1990	5.06	3.48	0.99	0.31	2.34	0.00	0.00		0.12				12.30
1991	0.36	4.33	8.67	0.46	0.20	0.60	M0.00	0.08					14.70
1992	2.14	M7.29	M5.11	M1.27	0.00	M1.12	0.00	T	0.04	M2.81	0.50	M7.89	28.17
1993	8.62	5.27	M2.10	M0.84	1.40	0.80	T	0.00	T	1.63	2.94	2.46	26.06
1994	2.38	4.45	0.29	1.51	1.21	0.04	0.00	0.00	0.00	1.20	7.21	3.22	21.51
1995	16.31	1.00	11.98	1.35	1.89	0.43	T	0.00	0.00	0.00	0.28	9.10	42.34
1996	5.58	8.04	2.54	3.40	2.37	T	T	0.00	0.10	1.01	2.73	10.82	36.59
1997	8.65	0.48	0.60	M0.30	0.38	M0.05	0.00	1.04	0.20	0.94	7.69	2.40	22.73
1998	9.49	19.59	2.55	2.95	3.74	0.01	0.00	0.00	0.04	0.85	5.47	1.24	45.93
1999	3.82	10.00	3.54	2.04	0.10		0.00	0.00	0.03	0.74	3.12	0.74	24.13
2000	4.95	10.25		1.65	1.21	0.16	0.00	0.01	0.20	2.00	1.35	0.71	22.49
2001	4.53		1.52	1.22	0.00	0.01	0.00	0.01	M0.10	0.59	5.39	8.64	22.01
2002	3.49	2.23	1.97	0.56	0.93	0.00	0.00	0.00	0.00	0.00	3.21	12.30	24.69
2003	2.12	1.49	0.76	3.34	1.22	T	T	0.00	0.03	0.27	1.76	7.27	18.26
2004	2.45	6.41	0.74	0.41	0.08	0.00	0.00	0.00	0.25	4.67	2.33	9.28	26.62
2005	4.64	4.35	4.35	1.54	3.03	0.86	0.00	0.01	0.00	0.62	1.61	13.12	34.13
2006	4.37	4.28	8.08	4.99	0.32	0.00	0.00	0.00	0.00	0.67	2.98	4.68	30.37
2007	0.79	5.31	0.20	1.36	0.23	0.00	0.10	0.00	0.10	1.82	0.69	3.67	14.27
2008	9.68	2.93	0.32	0.08	0.16	M0.00	0.00	0.00	0.04	0.54	2.11	2.15	18.01
2009	0.75	7.71	2.13	0.54	1.70	0.07	0.00	0.00	0.17	3.16	0.61	M2.01	18.85
2010	9.15	3.73	2.72	4.05	1.49	T	0.00	0.00	0.	M2.	2.53	8.35	34.

									00	46			48
2011	1.43	3.89	M9.88	0.55	1.60	2.32	0.00	0.00	0.00	2.06	1.62	0.10	23.45
2012	4.61	1.26	6.34	1.56	0.01	0.03	0.00	T	0.00	1.30	6.13	7.01	28.25
2013	0.60	0.44	0.80	1.15	0.21	0.56	0.00	0.00	0.61	0.00	0.87	0.38	5.62
2014	0.12	9.60	2.90	1.61	M0.00	0.00	0.02	0.05	0.42	0.59	3.25	15.60	34.16
2015	0.03	2.86	0.08	1.27	0.37	0.26	0.06	0.00	0.04	0.06	1.96	4.99	11.98
2016	6.96	0.88	6.63	1.05	0.31	0.00	0.00	0.00	0.00	5.56	3.09	3.92	28.40
2017	11.85	9.93	2.67	2.76	0.00	0.23	0.00	0.00	0.02	0.00	3.67	0.08	31.21
2018	4.80	0.15	5.24	4.55	0.35	0.00	0.00	0.00	0.00	1.34	4.19	2.42	23.04
2019	5.75	10.96	5.33	0.61	2.81	0.00	0.00	M0.00	0.05	0.02	M0.76	6.56	32.85
2020	2.55	0.00	2.15	1.07	M1.41	M0.00							7.18
Notes: Data missing in any month have an "M" flag. A "T" indicates a trace of precipitation.													
Data missing for all days in a month or year is blank.													
Creation date: 2016-07-22													

Appendix B
NRCS Custom Soil Resource Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Sonoma County, California

Caulfield Bridge Project

May 19, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


122° 37' 9" W
122° 37' 2" W
38° 13' 46" N
38° 13' 39" N
533330
533350
533370
533390
533410
533430
533450
533470
533490
4231360
4231340
4231320
4231300
4231280
4231260
4231240
4231220
4231200
4231180
4231160
4231140
AdA
W
Petaluma River
YtA
Petaluma
Soil Map may not be valid at this scale.
Map Scale: 1:1,130 if printed on A portrait (8.5" x 11") sheet.
Meters
0 15 30 60 90
Feet
0 50 100 200 300
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Sonoma County, California
Survey Area Data: Version 13, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 16, 2019—Apr 9, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AdA	Alluvial land, sandy	0.7	26.6%
W	Water	0.6	25.7%
YtA	Yolo clay loam, 0 to 5 percent slopes, MLRA 14	1.2	47.7%
Totals for Area of Interest		**2.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Sonoma County, California

AdA—Alluvial land, sandy

Map Unit Setting

National map unit symbol: hf9s
Elevation: 200 to 800 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 59 to 61 degrees F
Frost-free period: 200 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Alluvial land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Alluvial Land

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 10 inches: gravelly sand
H2 - 10 to 60 inches: stratified very gravelly coarse sand to sand

Properties and qualities

Slope: 0 to 5 percent
Natural drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Frequency of flooding: Occasional
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydric soil rating: Yes

Minor Components

Unnamed

Percent of map unit: 15 percent
Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

YtA—Yolo clay loam, 0 to 5 percent slopes, MLRA 14

Map Unit Setting

National map unit symbol: 2w89x
Elevation: 0 to 360 feet
Mean annual precipitation: 28 to 41 inches
Mean annual air temperature: 58 to 60 degrees F
Frost-free period: 240 to 260 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Yolo and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yolo

Setting

Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from volcanic and sedimentary rock

Typical profile

A - 0 to 8 inches: clay loam
C - 8 to 60 inches: loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline (0.3 to 0.5 mmhos/cm)
Available water storage in profile: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability classification (nonirrigated): 3c
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Pleasanton

Percent of map unit: 5 percent
Hydric soil rating: No

Zamora

Percent of map unit: 5 percent
Hydric soil rating: No

Pajaro

Percent of map unit: 5 percent
Hydric soil rating: No

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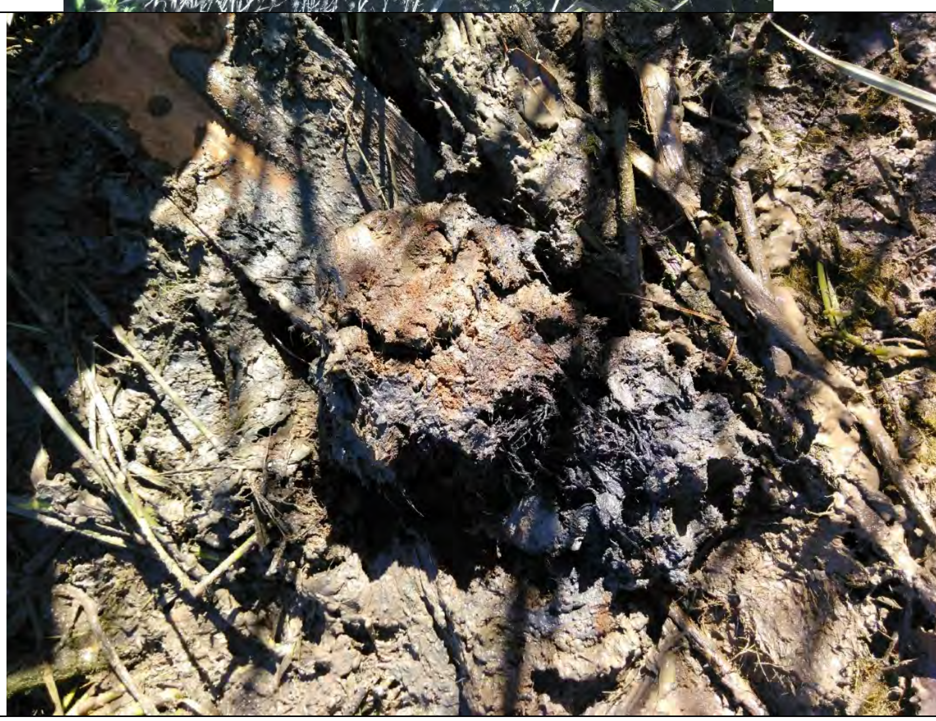
Appendix C Photographs

Photograph A. Delineation sample plot WL-1 at WUS-4 taken along the south bank of the Petaluma River, north aspect. 5/26/20.	
Photograph B. View of soil at delineation sample plot WL-1, within WUS-4. 5/26/20.	

Photograph C. View of open water, mudflats, and brackish marsh wetland at sample plot WL-1 within WUS-4, north aspect. 5/26/20.	
Photograph D. View of open water, brackish marsh wetlands WUS-3 and WUS-4, and adjacent ruderal uplands, directly east of delineation sample plot WL-1, west aspect. 5/26/20.	

Photograph E. View of open water and wetlands directly east of delineation sample plot WL-1 within WUS-4 bordered on the right side by flat upland area dominated by ruderal species, east aspect. 5/26/20.	
Photograph F. View of potentially non-jurisdictional stormwater culvert adjacent to WUS-3 on south bank of Petaluma River, west aspect. 5/26/20.	

Photograph G. View of the Coyote brush scrub habitat in the upland area, south of the Petaluma River, southwest aspect. 5/26/20.	
Photograph H. View of open water and WUS-2 along the north bank of the Petaluma River, north aspect. 5/26/20.	

Photograph I. View of non-jurisdictional depressional swale with California annual grasslands on north shore of BSA with upland levee bordering the right side of the swale, west aspect. 5/26/20.	
Photograph J. Delineation sample plot WL-2 taken within the upland depressional swale on the north shore of BSA east aspect. 5/26/20.	

Photograph K. View of dense ruderal vegetation comprised primarily of mustard, fennel and other forb species on the upland north shore of BSA, east aspect. 5/26/20.	
Photograph L. View of the parking lot and ruderal habitat on the south shore of BSA, north aspect. 5/26/20.	

Appendix D
Plants Observed in the BSA

Table -1: Plants Observed in the BSA

Common Name	Scientific Name	Nativity	Wetland Indicator Status
blackwood acacia	*Acacia melanoxylon*	Non-native	NL
yarrow	*Achillea millefolium*	Native	FACU
California dandelion	*Agoseris agoseris*	Native	NL
fat hen	*Atriplex prostrata*	Non-native	FACW
wild oats	*Avena* spp.	Non-native	NL
coyote brush	*Baccharis pilularis*	Native	NL
Mediterranean lineseed	*Bellardia trixago*	Non-native	NL
saltmarsh bulrush	*Bolboschoenus maritimus*	Native	OBL
black mustard	*Brassica nigra*	Non-native	NL
ripgut brome	*Bromus diandrus*	Non-native	NL
iceplant	*Carpobrotus edulis*	Non-native	FACU
Italian thistle	*Carduus pycnocephalus*	Non-native	FACU
yellow star thistle	*Centaurea solstitialis*	Non-native	NL
common tarweed	*Centromadia pungens*	Native	FAC
spotted spurge	*Chamaesyce maculata*	Non-native	NL
chicory	*Chicorium intybus*	Non-native	NL
bull thistle	*Cirsium vulgare*	Non-native	NL
poison hemlock	*Conium maculatum*	Non-native	FACW
horseweed	*Conyza canadensis*	Non-native	NL
brass buttons	*Cotula coronopifolia*	Non-native	OBL
swamp grass	*Crypsis schoenoides*	Non-native	FACW
Bermuda grass	*Cynodon dactylon*	Non-native	FACU
hairy crabgrass	*Digitaria sanguinalis*	Non-native	FACU
saltgrass	*Distichlis spicata*	Native	FAC
stinkwort	*Dittrichia graveolens*	Non-native	NL
beardless wild rye	*Elymus triticoides*	Native	NL
shortfruit stork's bill	*Erodium* brachycarpum	Non-native	NL
Italian rye grass	*Festuca perennis*	Non-native	FAC
rattail sixweeks grass	*Festuca myuros*	Non-native	NL
fennel	*Foeniculum vulgare*	Non-native	NL
marsh gumplant	*Grindelia stricta*	Native	FACW
crete weed	*Hedypnois cretica*	Non-native	NL
bristly ox-tongue	*Helminthotheca echiodes*	Non-native	NL
toyon	*Heteromeles arbutifolia*	Native (Planted)	NL
meadow barley	*Hordeum brachyantherum*	Native	FACW
seaside barley	*Hordeum marinum*	Non-native	FAC
toad rush	*Juncus bufonius*	Native	FACW
sharp leaved fluellin	*Kickxia elatine*	Non-native	UPL
prickly lettuce	*Lactuca serriola*	Non-native	FACU
sweet pea	*Lathyrus latifolius*	Non-native	NL

Common Name	Scientific Name	Nativity	Wetland Indicator Status
hawkbit	*Leontodon saxatilis*	Non-native	FACU
perennial pepperweed	*Lepidium latifolium*	Non-native	FAC
birds foot trefoil	*Lotus corniculatus*	Non-native	FAC
scarlet pimpernel	*Lysimachia arvensis*	Non-native	FAC
hyssop loosestrife	*Lythrum hyssopifolia*	Non-native	OBL
dwarf mallow	*Malva neglecta*	Non-native	NL
bushmallow	*Malacothamnus sp.*	Native	NL
bur clover	*Medicago polymorpha*	Non-native	FACU
sour clover	*Melilotus indica*	Non-native	NL
harding grass	*Phalaris aquatica*	Non-native	NL
cut leaf plantain	*Plantago coronopus*	Non-native	NL
narrowleaf plantain	*Plantago lanceolata*	Non-native	FAC
prostrate knotweed	*Polygonum aviculare*	Non-native	FAC
annual beard grass	*Polypogon monspeliensis*	Non-native	FACW
Jersey cudweed	*Pseudognaphalium luteoalbum*	Non-native	FAC
wild radish	*Raphanus* sp.	Non-native	NL
curly dock	*Rumex crispus*	Non-native	FAC
pickleweed	*Salicornia pacifica*	Native	OBL
California bulrush	*Schoenoplectus californicus*	Native	OBL
common dandelion	*Taraxacum officinale*	Non-native	FACU
clover	*Trifolium* sp.	Non-native	NL
vetch	*Vicia villosa*	Non-native	NL

Notes:
Species observed by AECOM employees during site visit conducted 5/26/20.
Sources: Calflora 2020; USACE 2018.
Wetland indicator status is defined using the following terms:

- Obligate (OBL): Plants that almost always occur in wetlands under natural conditions (estimated probability >99 percent), but that rarely occur in non-wetlands
- Facultative Wetland (FACW): Plants that occur usually (estimated probability >67 percent to 99 percent) in wetlands, but also occur in non-wetlands
- Facultative (FAC): Plants with a similar likelihood (estimated probability 33 percent to 67 percent) of occurring in both wetlands and non-wetlands
- Facultative Upland (FACU): Plants that occur sometimes (estimated probability 1 percent to <33 percent) in wetlands, but occur more often in non-wetlands
- Obligate Upland (UPL): Plants that occur rarely (estimated probability <1 percent) in wetlands, but occur almost always in non-wetlands
- Not Listed (NL): Plant species for which insufficient information was available to determine an indicator status; these species are treated as upland species because they do not occur on the wetland plant list.

Appendix E
Arid West Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Caulfield Bridge Project City/County: Petaluma, Sonoma Sampling Date: 5/26/2020

Applicant/Owner: City of Petaluma State: CA Sampling Point: WL-1

Investigator(s): Saana Deichsel, Kerstin Kalchmayr Section, Township, Range: S34 T5N R7W

Landform (hillslope, terrace, etc.): River Local relief (concave, convex, none): None Slope (%): 10

Subregion (LRR): C - Mediterranean California Lat: 38.22850986 Long: -122.61831267 Datum:

Soil Map Unit Name: Yolo Clay Loam, 0-5% slopes NWI classification: EZUSN

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☑ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ☑ No ☐

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☑	No ☐
Hydric Soil Present?	Yes ☑	No ☐
Wetland Hydrology Present?	Yes ☑	No ☐

Is the Sampled Area within a Wetland? Yes ☑ No ☐

Remarks: Fringe salt/brackish marsh wetland within the HTL of the Petaluma River, adjacent to open water and mud flats. Dominated by tules.

VEGETATION

Tree Stratum (Use scientific names.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
Total Cover:	%		
Sapling/Shrub Stratum			
1.			
2.			
3.			
4.			
5.			
Total Cover:	%		
Herb Stratum			
1. *Grindelia stricta*	25		FACW
2. *Salicornia pacifica*	20		OBL
3. *Bolboschoenus maritimus*	10		OBL
4. *Lepidium latifolium*	10		FAC
5. *Cotula coronopifolia*	<5		OBL
6. *Schoenoplectus californicus*	20		OBL
7. *Distichlis spicata*	<5		FAC
8.			
Total Cover:	85 %		
Woody Vine Stratum			
1.			
2.			
Total Cover:	%		

% Bare Ground in Herb Stratum 30 % % Cover of Biotic Crust %

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	0	(A)
Total Number of Dominant Species Across All Strata:	0	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	0 %	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	50	x 1 =	50
FACW species	25	x 2 =	50
FAC species	10	x 3 =	30
FACU species		x 4 =	0
UPL species		x 5 =	0
Column Totals:	85 (A)		130 (B)

Prevalence Index = B/A = 1.53

Hydrophytic Vegetation Indicators:

- ☐ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes ☑ No ☐

Remarks:

SOIL

Sampling Point: WL-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture[3]	Remarks
1-5	10 YR 4/2	80	5YR 4/6	20	D	M	clay	
8-16	Gley 2 2.5/10b	90	5YR 4/6	10	D	M	clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.
[3]Soil Textures: Clay, Silty Clay, Sandy Clay, Loam, Sandy Clay Loam, Sandy Loam, Clay Loam, Silty Clay Loam, Silt Loam, Silt, Loamy Sand, Sand.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- [ ] Histosol (A1)
- [ ] Histic Epipedon (A2)
- [ ] Black Histic (A3)
- [ ] Hydrogen Sulfide (A4)
- [ ] Stratified Layers (A5) (**LRR C**)
- [ ] 1 cm Muck (A9) (**LRR D**)
- [ ] Depleted Below Dark Surface (A11)
- [ ] Thick Dark Surface (A12)
- [ ] Sandy Mucky Mineral (S1)
- [ ] Sandy Gleyed Matrix (S4)
- [ ] Sandy Redox (S5)
- [ ] Stripped Matrix (S6)
- [ ] Loamy Mucky Mineral (F1)
- [x] Loamy Gleyed Matrix (F2)
- [x] Depleted Matrix (F3)
- [ ] Redox Dark Surface (F6)
- [ ] Depleted Dark Surface (F7)
- [x] Redox Depressions (F8)
- [ ] Vernal Pools (F9)

Indicators for Problematic Hydric Soils[4]:

- [ ] 1 cm Muck (A9) (**LRR C**)
- [ ] 2 cm Muck (A10) (**LRR B**)
- [ ] Reduced Vertic (F18)
- [ ] Red Parent Material (TF2)
- [ ] Other (Explain in Remarks)

[4]Indicators of hydrophytic vegetation and wetland hydrology must be present.

Restrictive Layer (if present):

Type: None

Depth (inches):

Hydric Soil Present? Yes (●) No ( )

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [ ] Saturation (A3)
- [ ] Water Marks (B1) (**Nonriverine**)
- [ ] Sediment Deposits (B2) (**Nonriverine**)
- [ ] Drift Deposits (B3) (**Nonriverine**)
- [ ] Surface Soil Cracks (B6)
- [x] Inundation Visible on Aerial Imagery (B7)
- [x] Water-Stained Leaves (B9)
- [ ] Salt Crust (B11)
- [x] Biotic Crust (B12)
- [ ] Aquatic Invertebrates (B13)
- [ ] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Plowed Soils (C6)
- [ ] Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- [x] Water Marks (B1) (**Riverine**)
- [ ] Sediment Deposits (B2) (**Riverine**)
- [x] Drift Deposits (B3) (**Riverine**)
- [ ] Drainage Patterns (B10)
- [ ] Dry-Season Water Table (C2)
- [ ] Thin Muck Surface (C7)
- [ ] Crayfish Burrows (C8)
- [x] Saturation Visible on Aerial Imagery (C9)
- [ ] Shallow Aquitard (D3)
- [x] FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ( ) No (●) Depth (inches):

Water Table Present? Yes ( ) No (●) Depth (inches):

Saturation Present? (includes capillary fringe) Yes (●) No ( ) Depth (inches):

Wetland Hydrology Present? Yes (●) No ( )

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Point taken within fringe wetland band on south end of the river

WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Caulfield Bridge | City/County: Petaluma / Sonoma | Sampling Date: 5/26/20

Applicant/Owner: City of Petaluma | State: CA | Sampling Point: UP-1

Investigator(s): Saana Deichsel, Kerstin Kalchmayr | Section, Township, Range: S34, T5N, R7W

Landform (hillslope, terrace, etc.): Hillslope | Local relief (concave, convex, none): | Slope (%): 5

Subregion (LRR): C - Mediterranean California | Lat: 38.22848592 | Long: -122.618289816667 | Datum: NAD 83

Soil Map Unit Name: Yolo clay loam | NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes (●) No ( ) (If no, explain in Remarks.)

Are Vegetation ☐ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ( ) No (●)

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?	( )	(●)
Hydric Soil Present?	( )	(●)
Wetland Hydrology Present?	( )	(●)

Is the Sampled Area within a Wetland? Yes ( ) No (●)

Remarks: Floodplain on south bank.

VEGETATION

Tree Stratum (Use scientific names.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
Total Cover:	%		
Sapling/Shrub Stratum			
1.			
2.			
3.			
4.			
5.			
Total Cover:	%		
Herb Stratum			
1. *Carpobrotus edulis*	70		Not Listed
2. *Bromus diandrus*	1		Not Listed
3. *Avena spp.*	1		Not Listed
4. *Vicia Villosa*	2		Not Listed
5. *Erodium brachycarpum*	2		Not Listed
6. *Carduus pycnocephalus*	1		Not Listed
7. *Festuca perennis*	2		FAC
8. *Lactuca seriola*	1		FACU
Total Cover:	80 %		
Woody Vine Stratum			
1.			
2.			
Total Cover:	%		

% Bare Ground in Herb Stratum 20 % | % Cover of Biotic Crust %

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 0 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 % (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	0
FACW species		x 2 =	0
FAC species	2	x 3 =	6
FACU species	1	x 4 =	4
UPL species	77	x 5 =	385
Column Totals:	80 (A)		395 (B)

Prevalence Index = B/A = 4.94

Hydrophytic Vegetation Indicators:

- ☐ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes ( ) No (●)

Remarks:

SOIL

Sampling Point: UP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture[3]	Remarks
2	5YR 2.5/1	100	none				sandy loam	many small stones/road gravel

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.
[3]Soil Textures: Clay, Silty Clay, Sandy Clay, Loam, Sandy Clay Loam, Sandy Loam, Clay Loam, Silty Clay Loam, Silt Loam, Silt, Loamy Sand, Sand.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[4]:

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[4]Indicators of hydrophytic vegetation and wetland hydrology must be present.

Restrictive Layer (if present):

Type: road fill

Depth (inches): 2

Hydric Soil Present? Yes ○ No ●

Remarks: Fill area - hard to dig deep for soil sample

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Thin Muck Surface (C7)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ○ No ● Depth (inches):

Water Table Present? Yes ○ No ● Depth (inches):

Saturation Present? (includes capillary fringe) Yes ○ No ● Depth (inches):

Wetland Hydrology Present? Yes ○ No ●

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Caulfield Bridge	City/County: Petaluma / Sonoma		Sampling Date: 5/26/20
Applicant/Owner: City of Petaluma		State: CA	Sampling Point: WL-2
Investigator(s): Saana Deichsel, Kerstin Kalchmayr	Section, Township, Range: S34, T5N, R7W		
Landform (hillslope, terrace, etc.): Terrace	Local relief (concave, convex, none): Concave		Slope (%): 2
Subregion (LRR): C - Mediterranean California	Lat: 38.229248583	Long: -122.618557245	Datum: NAD 83
Soil Map Unit Name: Alluvial land, sandy		NWI classification: None	

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ○ No ● (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☒ or Hydrology ☒ significantly disturbed? Are "Normal Circumstances" present? Yes ● No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ●	No ○
Hydric Soil Present?	Yes ○	No ●
Wetland Hydrology Present?	Yes ○	No ●

Is the Sampled Area within a Wetland? Yes ○ No ●

Remarks: Between Petaluma River and active construction site of new development. Slight depressional basin/swale on terrace above the River. Possibly formed by scraping. Collects stormwater runoff from east and west and pools due to slight berm on the north. Ground appears to be covered in tackifier, may have been hydroseeded.

VEGETATION

Tree Stratum (Use scientific names.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
Total Cover:	%		
Sapling/Shrub Stratum			
1.			
2.			
3.			
4.			
5.			
Total Cover:	%		
Herb Stratum			
1. *Lythrum hyssopifolia*	5	No	OBL
2. *Polypogon monspeliensis*	15	No	FACW
3. *Juncus bufoniius*	10	No	FACW
4. *Carduus pycnocephalus*	10	No	FACU
5. *Polygonum aviculare*	5	No	FAC
6. *Centromadia pungens*	5	No	FAC
7. *Festuca perennis*	5	No	FAC
8. *Dittrichia graveolens*	10	No	Not Listed
Total Cover:	65 %		
Woody Vine Stratum			
1.			
2.			
Total Cover:	%		

% Bare Ground in Herb Stratum 35 % % Cover of Biotic Crust %

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	0	(A)
Total Number of Dominant Species Across All Strata:	0	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	0 %	(A/B)

Prevalence Index worksheet:

Total % Cover of:			Multiply by:	
OBL species	5	x 1 =	5	
FACW species	25	x 2 =	50	
FAC species	15	x 3 =	45	
FACU species	10	x 4 =	40	
UPL species	10	x 5 =	50	
Column Totals:	65	(A)	190	(B)

Prevalence Index = B/A = 2.92

Hydrophytic Vegetation Indicators:

- ☐ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes ● No ○

Remarks: Area may have been hydroseeded.

SOIL

Sampling Point: WL-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture[3]	Remarks
0-6	2.5 Y 3/2	98	5 YR 6/8	2		M	Sandy loam	Top layer of soil contains tackifier

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.
[3]Soil Textures: Clay, Silty Clay, Sandy Clay, Loam, Sandy Clay Loam, Sandy Loam, Clay Loam, Silty Clay Loam, Silt Loam, Silt, Loamy Sand, Sand.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[4]:

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[4]Indicators of hydrophytic vegetation and wetland hydrology must be present.

Restrictive Layer (if present):

Type: Fill

Depth (inches): 6

Hydric Soil Present? Yes ○ No ◉

Remarks: May be been scraped to create detention basin.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☒ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☒ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Thin Muck Surface (C7)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ○	No ◉	Depth (inches):
Water Table Present?	Yes ○	No ◉	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes ○	No ◉	Depth (inches):

Wetland Hydrology Present? Yes ○ No ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Cracks may be due to tackifier cracking as it dries. Cracks visible in soil in upland areas, as well. No other hydrology indicators present. May be part of historic floodplain.

WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Caulfield Bridge | City/County: Petaluma / Sonoma | Sampling Date: 5/26/20

Applicant/Owner: City of Petaluma | State: CA | Sampling Point: UP-2

Investigator(s): Saana Deichsel, Kerstin Kalchmayr | Section, Township, Range: S34, T5N, R7W

Landform (hillslope, terrace, etc.): Hillslope | Local relief (concave, convex, none): none | Slope (%): 7

Subregion (LRR): C - Mediterranean California | Lat: 38.22932333 | Long: -122.61849423 | Datum: NAD 83

Soil Map Unit Name: Alluvial land | NWI classification:

Are climatic / hydrologic conditions on the site typical for this time of year? Yes (●) No ( ) (If no, explain in Remarks.)

Are Vegetation ☐ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes (●) No ( )

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?	( )	(●)
Hydric Soil Present?	( )	(●)
Wetland Hydrology Present?	( )	(●)

Is the Sampled Area within a Wetland? Yes ( ) No (●)

Remarks: Constructed levee on floodplain, Recent hydroseeding, non-native fill

VEGETATION

Tree Stratum (Use scientific names.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
Total Cover:	%		
Sapling/Shrub Stratum			
1.			
2.			
3.			
4.			
5.			
Total Cover:	%		
Herb Stratum			
1. *Polypogon monspliensis*	20		FACW
2. *Brassica rapa*	40		FACU
3. *Festuca perennis*	5		FAC
4. *Hordeum brachyantherum*	5		FACW
5. *Leontodon saxatilis*	5		FACU
6. *Festuca myuros*	5		Not Listed
7. *Avena spp.*	5		Not Listed
8. *Centromadia pungens*	5		FAC
Total Cover:	90 %		
Woody Vine Stratum			
1.			
2.			
Total Cover:	%		

% Bare Ground in Herb Stratum 15 % | % Cover of Biotic Crust %

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 0 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 % (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 = 0
FACW species	25	x 2 = 50
FAC species	10	x 3 = 30
FACU species	45	x 4 = 180
UPL species	10	x 5 = 50
Column Totals:	90 (A)	310 (B)

Prevalence Index = B/A = 3.44

Hydrophytic Vegetation Indicators:

- ☐ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes ( ) No (●)

SOIL

Sampling Point: UP-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture[3]	Remarks
0-3	10 YR4/2	100						Sandy loam

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. [2]Location: PL=Pore Lining, RC=Root Channel, M=Matrix.
[3]Soil Textures: Clay, Silty Clay, Sandy Clay, Loam, Sandy Clay Loam, Sandy Loam, Clay Loam, Silty Clay Loam, Silt Loam, Silt, Loamy Sand, Sand.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[4]:

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[4]Indicators of hydrophytic vegetation and wetland hydrology must be present.

Restrictive Layer (if present):

Type: Fill to construct levee: small rocks/g

Depth (inches): 3

Hydric Soil Present? Yes ○ No ◉

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (any one indicator is sufficient)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Thin Muck Surface (C7)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ○ No ○ Depth (inches):

Water Table Present? Yes ○ No ○ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ○ No ○ Depth (inches):

Wetland Hydrology Present? Yes ○ No ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

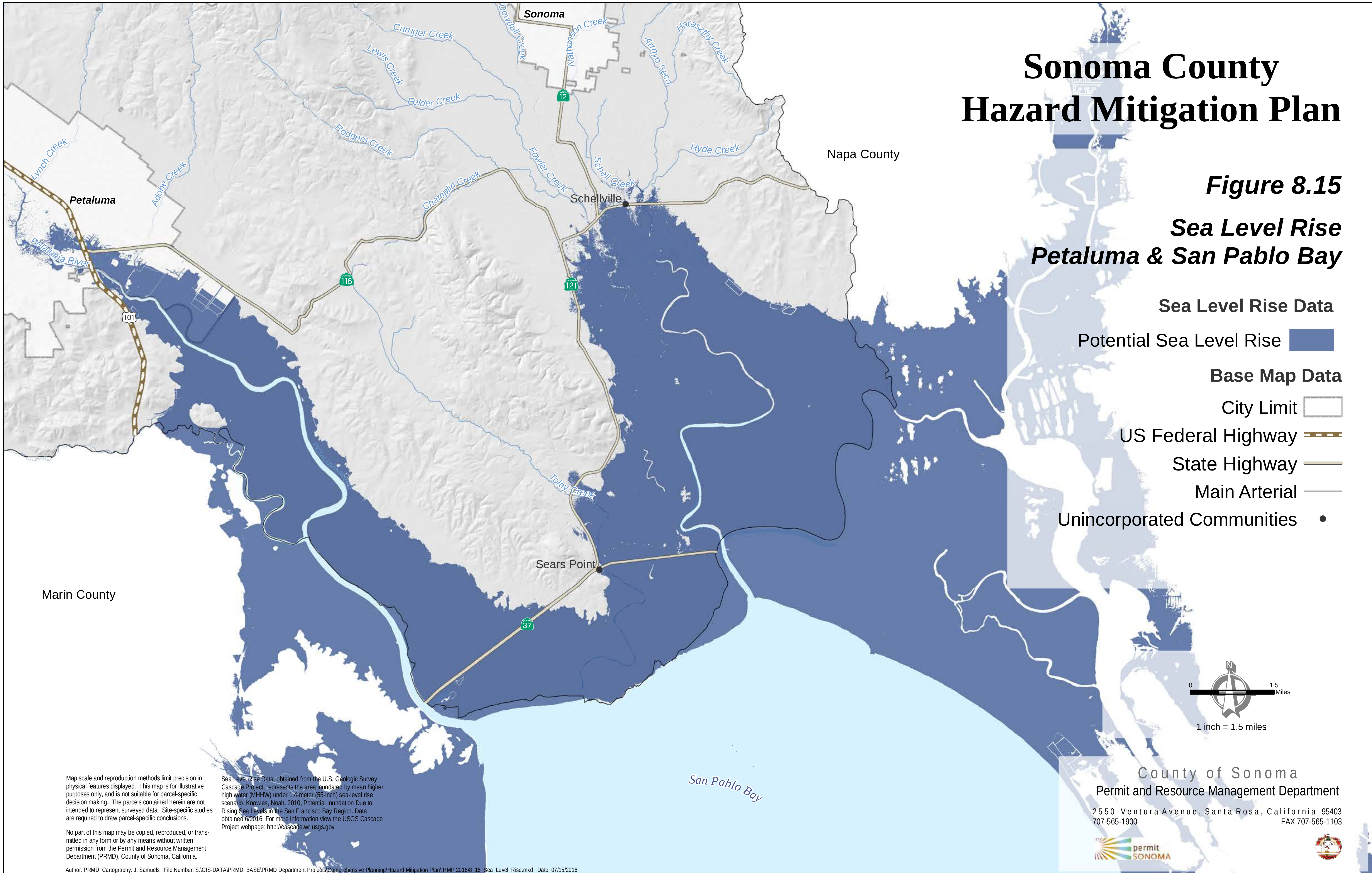
Remarks:

APPENDIX H –
Sea Level Rise Information

Sonoma County Hazard Mitigation Plan

Figure 8.15

Sea Level Rise Petaluma & San Pablo Bay



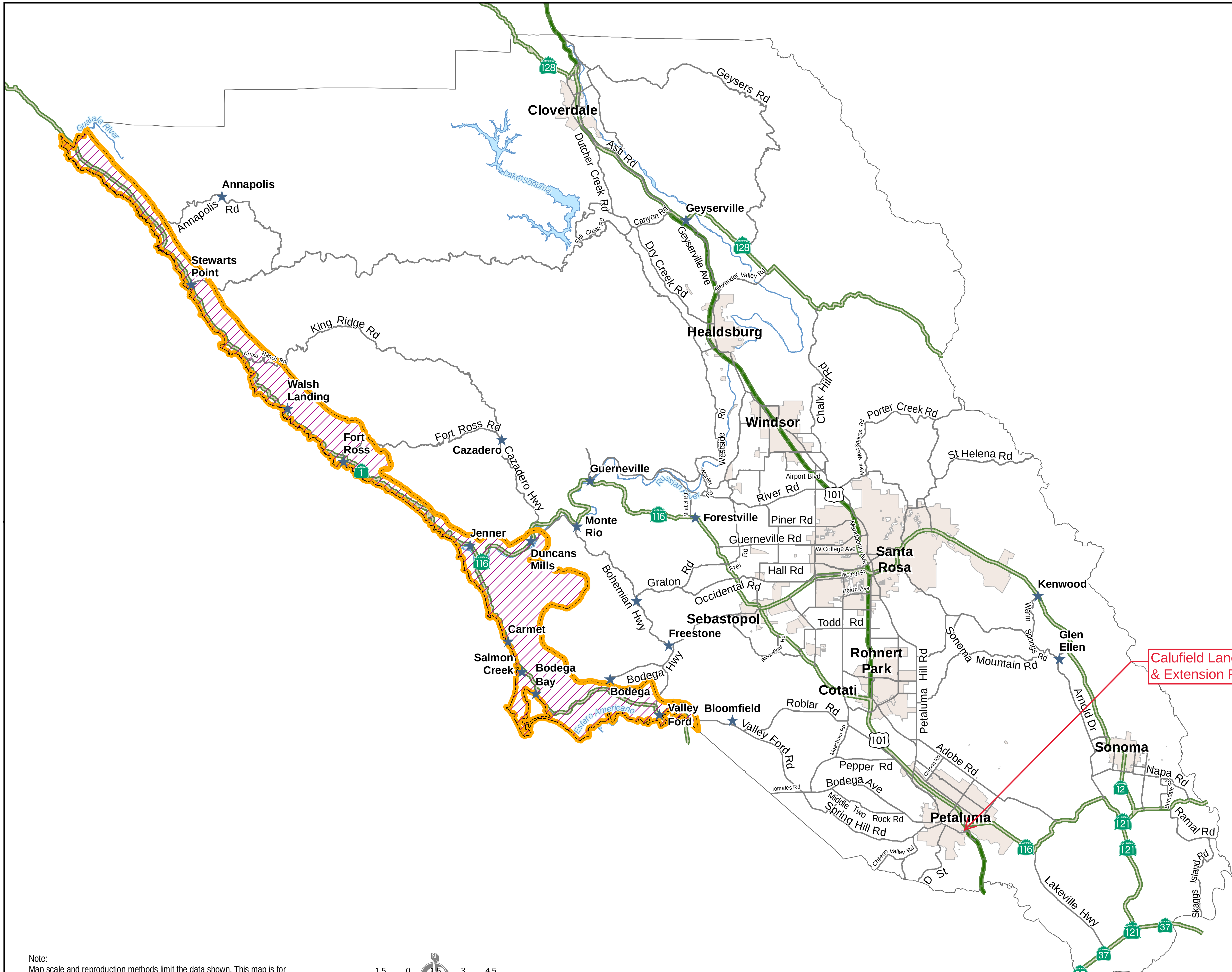
Map scale and reproduction methods limit precision in physical features displayed. This map is for illustrative purposes only, and is not suitable for parcel-specific decision making. The parcels contained herein are not intended to represent surveyed data. Site-specific studies are required to draw parcel-specific conclusions.

Sea Level Rise Data, obtained from the U.S. Geologic Survey Cascade Project, represents the area inundated by mean higher high water (MHHW) under 1.4-meter (55-inch) sea-level rise scenario. Knowles, Noah. 2010, Potential Inundation Due to Rising Sea Levels in the San Francisco Bay Region. Data obtained 6/2016. For more information view the USGS Cascade Project webpage: http://cascade.wr.usgs.gov

Author: PRMD Cartography: J. Samuels File Number: S:\GIS-DATA\PRMD_BASE\PRMD Department Projects\Comprehensive Planning\Hazard Mitigation Plan\ HMP 2016\8_15_Sea_Level_Rise.mxd Date: 07/15/2016

Local Coastal Plan
Coastal Zone Extent

Sonoma Coastal Zone Boundary
City Limits
Main Arterial
Community



Note:
Map scale and reproduction methods limit the data shown. This map is for illustrative purposes only, and does not reflect all Land Use policies. Refer to the official Land Use maps on file at the Permit and Resource Management Department.

1.5 0 1.5 3 4.5 Miles

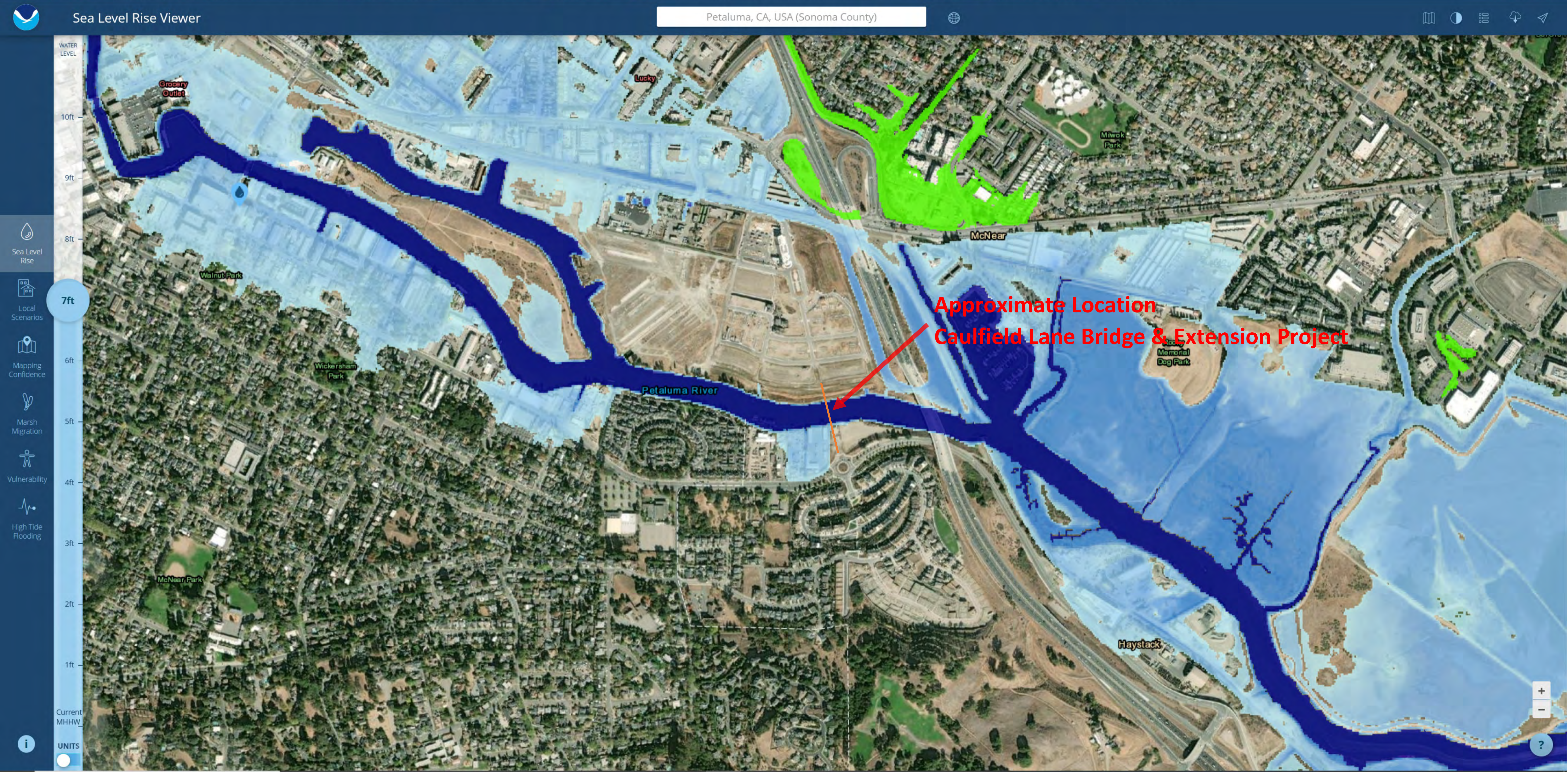
1 inch = 5.37 miles

Permit and Resource Management Department

2550 Ventura Avenue, Santa Rosa, California 95403
707-565-1900 FAX 707-565-1103

Coastal Plan

Author: PRMD Cartography: J. Samuels File Number: S:\GIS-DATA\PRMD_BASE\PRMD Department Projects\Comprhensive Planning\Local Coastal Plan\Map mxds\2014 Revisions\LCP_Coastal_Zone_Full_County_20150929.mxd.mxd Date: 9/29/2015



Sea Level Rise Viewer
Petaluma, CA, USA (Sonoma County)
WATER LEVEL
10ft
9ft
8ft
7ft
6ft
5ft
4ft
3ft
2ft
1ft
Current MHHW
UNITS
Sea Level Rise
Local Scenarios
Mapping Confidence
Marsh Migration
Vulnerability
High Tide Flooding
Grocery Outlet
Lucky
Walnut Park
Wickersham Park
Petaluma River
McNear
Miwok Park
Memorial Dog Park
Haystack
McNear Park
Approximate Location
Caulfield Lane Bridge & Extension Project

Approximate location of Caulfield Lane Bridge over Petaluma River
200 cm Sea level rise
100 year Base Flood
Year 2100
Petaluma River
Petaluma River
OCOF Interactive Map
map help
clear
navigate
1) Choose a topic.
Flooding shows the inundation due to SLR, waves, and storm surge.
Flooding
Waves
Current
Duration
Flood Potential
What do the Topics represent?
Compare Flooding Scenarios
2) Choose an Amount of Sea Level Rise (cm).
0 25 50 75 100 125 150 175 200 500
What Sea Level Rise scenario should I use?
3) Choose an Event
Choose Storm Scenario Frequency
None Annual 20 year 100 year
Or Choose SF Bay King Tide Scenario
King Tide
What are Storm Scenarios?
What is a King Tide scenario?
4) Choose Shoreline Change (Southern California only)
Cliffs
Shoreline Position
And Choose Management Options
"Hold the Line" yes no
Beach nourishment yes no
5) Choose other layers to view with topic data.
"Hold the Line" Assumptions
Enter an address or placename
Pan Zoom
Draw Report
GIS File Report
Known Issues
King Tides
Get Data
Print Map
Navigation Channels
CSMW Piers & Jetties
King Tide Photos
Max Wave Runup during Flood 200cm SLR + Wave 100
Flood-prone Low-lying Areas 200cm SLR + Wave 100
Flood Hazard 200cm SLR + Wave 100
Monterey Flood Depth 200cm SLR + Wave 100
No Data
0 cm (0 ft)
250 cm (8.2 ft)
500 cm (16.4 ft)
750 cm (24.6 ft)
Flood Depth 200cm SLR + Wave 100
No Data
0 cm (0 ft)
250 cm (8.2 ft)
500 cm (16.4 ft)
750 cm (24.6 ft)
Public Transportation
Ferry Landing
BART Station
Caltrans Facility
Bus Stop
Metro Stop
Public Parking
Roads
Bus Route
Ferry Route
OCOF
CoSMoS
https://data.pointblue.org/apps/ocof/map/#

APPENDIX I –
Planning Level Cost Estimate

PROJECT

PLANNING COST ESTIMATE

EA: DS-123456 PID: DS1234567

EA: **DS-123456**

PID: **DS1234567**

District-County-Route: 04-SON-NA

PM: NA

Type of Estimate : Planning Level

Program Code : NA

Project Limits : Caulfield Lane Extension & Bridge

Project Description: Caulfield Lane Extension & Bridge - City of Petaluma's "Southern Connection"

Scope :

Alternative : Preferred - Single Span - Dual Rolling Leaf Bascule Bridge w/Overhead Counterweight; 200' Horiz Clear

SUMMARY OF PROJECT COST ESTIMATE

	Current Year Cost		Escalated Cost	
TOTAL ROADWAY COST	**$**	**2,777,321**	**$**	**3,040,738**
TOTAL STRUCTURES COST	**$**	**28,532,930**	**$**	**31,239,156**
SUBTOTAL CONSTRUCTION COST	**$**	**31,310,251**	**$**	**34,279,894**
TOTAL RIGHT OF WAY COST	**$**	**-**	**$**	**-**
TOTAL CAPITAL OUTLAY COSTS	**$**	**31,311,000**	**$**	**34,280,000**
PR/ED SUPPORT	**$**	**750,000**	**$**	**750,000**
PS&E SUPPORT	**$**	**3,925,000**	**$**	**3,925,000**
RIGHT OF WAY SUPPORT	**$**	**200,000**	**$**	**200,000**
CONSTRUCTION SUPPORT	**$**	**3,750,000**	**$**	**3,750,000**
TOTAL SUPPORT COST	**$**	**8,625,000**	**$**	**8,625,000**
TOTAL PROJECT COST	**$**	**39,950,000**	**$**	**42,950,000**

If Project has been programmed enter Programmed Amount

	Month	/	Year
Date of Estimate (Month/Year)	11	/	2021
Estimated Construction Start (Month/Year)	1	/	2024
Number of Working Days =			652.5
Estimated Mid-Point of Construction (Month/Year)	3	/	2025
Estimated Construction End (Month/Year)	6	/	2026
Number of Plant Establishment Days			0

Estimated Project Schedule

PID Approval	xx/xx/xxxx
PA/ED Approval	xx/xx/xxxx
PS&E	xx/xx/xxxx
RTL	xx/xx/xxxx
Begin Construction	xx/xx/xxxx

Reviewed by District O.E. or Cost Estimate Certifier		**xx/xx/xxxx**	(xxx) xxx-xxxx
	Office Engineer / Cost Estimate Certifier	**Date**	**Phone**
Approved by Project Manager		**xx/xx/xxxx**	(xxx) xxx-xxxx
	Project Manager	**Date**	**Phone**

I. ROADWAY ITEMS SUMMARY

	Section	Cost	
1	**Earthwork**	$	46,500
2	**Pavement Structural Section**	$	198,521
3	**Drainage**	$	42,800
4	**Specialty Items**	$	15,000
5	**Environmental**	$	259,700
6	**Traffic Items**	$	103,000
7	**Detours**	$	-
8	**Minor Items**	$	103,200
9	**Roadway Mobilization**	$	76,900
10	**Supplemental Work**	$	78,500
11	**State Furnished**	$	30,800.00
12	**Time-Related Overhead**	$	1,359,500.00
13	**Roadway Contingency**	$	462,900.00
	TOTAL ROADWAY ITEMS	**$**	**2,777,321**

Estimate Prepared By :

Name and Title Date Phone

Estimate Reviewed By :

Name and Title Date Phone

By signing this estimate you are attesting that you have discussed your project with all functional units and have incorporated all their comments or have discussed with them why they will not be incorporated.

EA: DS-123456 PID: DS1234567

SECTION 1: EARTHWORK

Item code		Unit	Quantity		Unit Price ($)			Cost
190101	Roadway Excavation	CY	200	x	100.00	=	$	20,000
19010X	Roadway Excavation (Type X) ADL	CY		x	120.00	=	$	-
194001	Ditch Excavation	CY		x		=	$	-
19801X	Imported Borrow	CY		x	5.00	=	$	-
192037	Structure Excavation (Retaining Wall)	CY		x	100.00	=	$	-
193013	Structure Backfill (Retaining Wall)	CY		x	80.00	=	$	-
193031	Pervious Backfill Material (Retaining Wall)	CY		x		=	$	-
16010X	Clearing & Grubbing	LS	1	x	15,000.00	=	$	15,000
170101	Develop Water Supply	LS	1	x	10,000.00	=	$	10,000
						=	$	-
210130	Duff	ACRE	1	x	1,500.00	=	$	1,500
XXXXXX	Some Item	Unit						

TOTAL EARTHWORK SECTION ITEMS $ 46,500

SECTION 2: PAVEMENT STRUCTURAL SECTION

Item code		Unit	Quantity		Unit Price ($)			Cost	THK
401050	Jointed Plain Concrete Pavement	CY		x		=	$	-	
400050	Continuously Reinforced Concrete Pavement	CY		x		=	$	-	
404092	Seal Pavement Joint	LF		x		=	$	-	
404093	Seal Isolation Joint	LF		x		=	$	-	
413117	Seal Concrete Pavement Joint (Silicone)	LF		x		=	$	-	
413118	Seal Pavement Joint (Asphalt Rubber)	LF		x		=	$	-	
280010	Rapid Strength Concrete Base	CY		x		=	$	-	
410095	Dowel Bar (Drill and Bond)	EA		x		=	$	-	
390132	Hot Mix Asphalt (Type A)	TON	323	x	220.00	=	$	71,060	0.50'
390137	Rubberized Hot Mix Asphalt (Gap Graded)	TON	97	x	250.00	=	$	24,250	0.15'
39300X	Geosynthetic Pavement Interlayer (Type X)	SQYD		x		=	$	-	
260203	Class 2 Aggregate Base	CY	582	x	160.00	=	$	93,120	0.90'
290201	Asphalt Treated Permeable Base	CY		x		=	$	-	
250201	Class 2 Aggregate Subbase	CY	647	x	105.00	=	$	67,935	1.00'
374002	Asphaltic Emulsion (Fog Seal Coat)	TON		x		=	$	-	
397005	Tack Coat	TON	0.44	x	2,000.00	=	$	880	
377501	Slurry Seal	TON		x		=	$	-	
3750XX	Screenings (Type XX)	TON		x		=	$	-	
374492	Asphaltic Emulsion (Polymer Modified)	TON		x		=	$	-	
370001	Sand Cover (Seal)	TON		x		=	$	-	
731521	Minor Concrete (Sidewalk)	SQFT	3,464	x	8.00	=	$	27,712	
730020	Minor Concrete (Curb)	LF	377	x	30.00	=	$	11,310	
39407X	Place Hot Mix Asphalt Dike (Type X)	LF		x		=	$	-	
150771	Remove Asphalt Concrete Dike	LF		x		=	$	-	
420201	Grind Existing Concrete Pavement	SQYD		x		=	$	-	
150860	Remove Base and Surfacing	CY		x		=	$	-	
390095	Replace Asphalt Concrete Surfacing	CY		x		=	$	-	
15312X	Remove Concrete	LF/CY/LS		x		=	$	-	
394090	Place Hot Mix Asphalt (Miscellaneous Area)	SQYD		x		=	$	-	
153103	Cold Plane Asphalt Concrete Pavement	SQYD		x		=	$	-	
39405X	Shoulder Rumble Strip (HMA, X-In Indentations)	STA		x		=	$	-	
413113	Repair Spalled Joints, Polyester Grout	SQYD		x		=	$	-	
420102	Groove Existing Concrete Pavement	SQYD		x		=	$	-	
390136	Minor Hot Mix Asphalt	TON		x		=	$	-	
394095	Roadside Paving (Miscellaneous Areas)	SQYD		x		=	$	-	
XXXXXX	Some Item	Unit		x		=	$	-	

TOTAL PAVEMENT STRUCTURAL SECTION ITEMS $ 198,521

EA: DS-123456 PID: DS1234567

SECTION 3: DRAINAGE

Item code		Unit	Quantity		Unit Price ($)			Cost
15080X	Remove Culvert	EA/LF		x		=	$	-
150820	Modify Inlet	EA		x		=	$	-
155232	Sand Backfill	CY		x		=	$	-
15020X	Abandon Culvert	EA/LF		x		=	$	-
152430	Adjust Inlet	LF		x		=	$	-
155003	Cap Inlet	EA		x		=	$	-
510501	Minor Concrete	CY		x		=	$	-
510502	Minor Concrete (Minor Structure)	CY		x		=	$	-
5105XX	Minor Concrete (Type XX)	CY		x		=	$	-
620XXX	18" Alternative Pipe Culvert (Type X)	LF	240	x	120.00	=	$	28,800
6411XX	XX" Plastic Pipe	LF		x		=	$	-
65XXXX	XX" Reinforced Concrete Pipe (Type X)	LF		x		=	$	-
6650XX	XX" Corrugated Steel Pipe (0.XXX" Thick)	LF		x		=	$	-
68XXXX	XX" Plastic Pipe (Edge Drain)	LF		x		=	$	-
69011X	XX" Corrugated Steel Pipe Downdrain (0.XXX" Thi	LF		x		=	$	-
70321X	XX" Corrugated Steel Pipe Inlet (0.XXX" Thick)	LF		x		=	$	-
70XXXX	XX" Corrugated Steel Pipe Riser (0.XXX" Thick)	LF		x		=	$	-
7050XX	XX" Steel Flared End Section	EA		x		=	$	-
703233	Grated Line Drain	LF		x		=	$	-
72XXXX	Rock Slope Protection (Type and Method)	CY/TON		x		=	$	-
72901X	Rock Slope Protection Fabric (Class X)	SQYD		x		=	$	-
721420	Concrete (Ditch Lining)	CY		x		=	$	-
721430	Concrete (Channel Lining)	CY		x		=	$	-
750001	Miscellaneous Iron and Steel	LB		x		=	$	-
XXXXXX	Drainage Inlet	EA	4	x	3,500.00	=	$	14,000

TOTAL DRAINAGE ITEMS $ 42,800

SECTION 4: SPECIALTY ITEMS

Item code		Unit	Quantity		Unit Price ($)			Cost
080050	Progress Schedule (Critical Path Method)	LS	1	x	15,000.00	=	$	15,000
582001	Sound Wall (Masonry Block)	SQFT		x		=	$	-
510530	Minor Concrete (Wall)	CY		x		=	$	-
15325X	Remove Sound Wall	LF/LS		x		=	$	-
070030	Lead Compliance Plan	LS		x		=	$	-
141120	Treated Wood Waste	LB		x		=	$	-
153221	Remove Concrete Barrier	LF		x		=	$	-
150662	Remove Metal Beam Guard Railing	LF		x		=	$	-
150668	Remove Flared End Section	EA		x		=	$	-
8000XX	Chain Link Fence (Type XX)	LF		x		=	$	-
80XXXX	XX" Chain Link Gate (Type CL-6)	EA		x		=	$	-
832001	Metal Beam Guard Railing	LF		x		=	$	-
839301	Single Thrie Beam Barrier	LF		x		=	$	-
839310	Double Thrie Beam Barrier	LF		x		=	$	-
839521	Cable Railing	LF		x		=	$	-
8395XX	Terminal System (Type CAT)	EA		x		=	$	-
839585	Alternative Flared Terminal System	EA		x		=	$	-
839584	Alternative In-line Terminal System	EA		x		=	$	-
4906XX	CIDH Concrete Piling (Insert Diameter)	LF		x		=	$	-
839XXX	Crash Cushion (Insert Type)	EA		x		=	$	-
83XXXX	Concrete Barrier (Insert Type)	LF		x		=	$	-
520103	Bar Reinforced Steel (Retaining Wall)	LB		x		=	$	-
510060	Structural Concrete, Retaining Wall	CY		x		=	$	-
513553	Retaining Wall (Masonry Wall)	SQFT		x		=	$	-
511035	Architectural Treatment	SQFT		x		=	$	-
598001	Anti-Graffiti Coating	SQFT		x		=	$	-
203070	Rock Stain	SQFT		x		=	$	-
5136XX	Reinforced Concrete Crib Wall (Type X)	SQFT		x		=	$	-
83954X	Transition Railing (Type X)	EA		x		=	$	-
597601	Prepare and Stain Concrete	SQFT		x		=	$	-
839561	Rail Tensioning Assembly	EA		x		=	$	-
83958X	End Anchor Assembly (Type X)	EA		x		=	$	-
XXXXXX	Some Item	Unit		x		=	$	-

TOTAL SPECIALTY ITEMS $ 15,000

EA: DS-123456 PID: DS1234567

SECTION 5: ENVIRONMENTAL

5A - ENVIRONMENTAL MITIGATION

Item code		Unit	Quantity		Unit Price ($)			Cost
	Biological Mitigation	LS	1	x	50,000.00	=	$	50,000
130670	Temporary Reinforced Silt Fence	LF	600	x	6.00	=	$	3,600
141000	Temporary Fence (Type ESA)	LF	600	x	15.00	=	$	9,000
					Subtotal Environmental Mitigation		*$*	*62,600*

5B - LANDSCAPE AND IRRIGATION

Item code		Unit	Quantity		Unit Price ($)			Cost
20XXXX	Highway Planting	LS	1	x	40,000.00	=	$	40,000
20XXXX	Irrigation System	LS	1	x	30,000.00	=	$	30,000
204099	Plant Establishment Work	LS		x		=	$	-
204101	Extend Plant Establishment Work	LS		x		=	$	-
20XXXX	Follow-up Landscape Project	LS		x		=	$	-
150685	Remove Irrigation Facility	LS		x		=	$	-
20XXXX	Maintain Existing (Irrigation or Planted Areas)	LS		x		=	$	-
206400	Check and Test Existing Irrigation Facilities	LS		x		=	$	-
21011X	Imported Topsoil (X)	CY/TON		x		=	$	-
20XXXX	Rock Blanket, Rock Mulch, DG, Gravel Mulch	SQFT/SQYD		x		=	$	-
200122	Weed Germination	SQYD		x		=	$	-
208304	Water Meter	EA		x		=	$	-
2087XX	XX" Conduit (Use for Irrigation x-overs)	LF		x		=	$	-
20890X	Extend X" Conduit (Use for Extension of Irrigation x-overs)	LF		x		=	$	-
					Subtotal Landscape and Irrigation		*$*	*70,000*

5C - EROSION CONTROL

Item code		Unit	Quantity		Unit Price ($)			Cost
210010	Move In/Move Out (Erosion Control)	EA	2	x	25,000.00	=	$	50,000
210350	Fiber Rolls	LF	500	x	3.00	=	$	1,500
210360	Compost Sock	LF		x		=	$	-
2102XX	Rolled Erosion Control Product (X)	SQFT		x		=	$	-
21025X	Bonded Fiber Matrix	SQFT/ACRE		x		=	$	-
210300	Hydromulch	SQFT	12,000	x	0.75	=	$	9,000
210420	Straw	SQFT		x		=	$	-
210430	Hydroseed	SQFT	12,000	x	0.30	=	$	3,600
210600	Compost	SQFT		x		=	$	-
210630	Incorporate Materials	SQFT		x		=	$	-
					Subtotal Erosion Control		*$*	*64,100*

5D - NPDES

Item code		Unit	Quantity		Unit Price ($)			Cost
130300	Prepare SWPPP	LS	1	x	15,000.00	=	$	15,000
130200	Prepare WPCP	LS	1	x	7,500.00	=	$	7,500
130100	Job Site Management	LS	1	x	20,000.00	=	$	20,000
130330	Storm Water Annual Report	EA	2	x	5,000.00	=	$	10,000
130310	Rain Event Action Plan (REAP)	EA	10	x	500.00	=	$	5,000
130320	Storm Water Sampling and Analysis Day	EA		x		=	$	-
130520	Temporary Hydraulic Mulch	SQYD		x		=	$	-
130550	Temporary Hydroseed	SQYD		x		=	$	-
130505	Move-In/Move-Out (Temporary Erosion Control)	EA	1	x	5,500.00	=	$	5,500
130640	Temporary Fiber Roll	LF		x		=	$	-
130900	Temporary Concrete Washout	LS		x		=	$	-
130710	Temporary Construction Entrance	EA		x		=	$	-
130610	Temporary Check Dam	LF		x		=	$	-
130620	Temporary Drainage Inlet Protection	EA		x		=	$	-
130730	Street Sweeping	LS		x		=	$	-
					Subtotal NPDES		*$*	*63,000*

TOTAL ENVIRONMENTAL	**$**	**259,700**

Supplemental Work for NPDES

		Unit	Quantity		Unit Price ($)			Cost
066595	Water Pollution Control Maintenance Sharing*	LS		x		=	$	-
066596	Additional Water Pollution Control**	LS		x		=	$	-
066597	Storm Water Sampling and Analysis***	LS	1	x	15,000.00	=	$	15,000
XXXXXX	Some Item	LS		x		=	$	-
					Subtotal Supplemental Work for NDPS		*$*	*15,000*

*Applies to all SWPPPs and those WPCPs with sediment control or soil stabilization BMPs.

**Applies to both SWPPPs and WPCP projects.

*** Applies only to project with SWPPPs.

EA: DS-123456 PID: DS1234567

SECTION 6: TRAFFIC ITEMS

6A - Traffic Electrical

Item code		Unit	Quantity		Unit Price ($)			Cost
860460	Lighting and Sign Illumination	LS	1	x	50,000.00	=	$	50,000
860201	Signal and Lighting	LS		x		=	$	-
860990	Closed Circuit Television System	LS		x		=	$	-
86110X	Ramp Metering System (Location X)	LS		x		=	$	-
86070X	Interconnection Conduit and Cable	LF/LS		x		=	$	-
5602XX	Furnish Sign Structure (Type X)	LB		x		=	$	-
5602XX	Install Sign Structure (Type X)	LB		x		=	$	-
498040	XX" CIDHC Pile (Sign Foundation)	LF		x		=	$	-
86080X	Inductive Loop Detectors	EA/LS		x		=	$	-
8609XX	Traffic Monitoring Station (Type X)	LS		x		=	$	-
15075X	Remove Sign Structure	EA/LS		x		=	$	-
151581	Reconstruct Sign Structure	EA		x		=	$	-
152641	Modify Sign Structure	EA		x		=	$	-
860090	Maintain Existing Traffic Management System Ele	LS		x		=	$	-
86XXXX	Fiber Optic Conduit System	LS		x		=	$	-
XXXXX	Some Item	LS		x		=	$	-

Subtotal Traffic Electrical *$* *50,000*

6B - Traffic Signing and Striping

Item code		Unit	Quantity		Unit Price ($)			Cost
566011	Roadside Sign - One Post	EA	10	x	300.00	=	$	3,000
566012	Roadside Sign - Two Post	EA		x		=	$	-
5602XX	Furnish Sign	SQFT		x		=	$	-
568016	Install Sign Panel on Existing Frame	SQFT		x		=	$	-
150711	Remove Painted Traffic Stripe	LF		x		=	$	-
141101	Remove Yellow Painted Traffic Stripe (Hazardous Waste)	LF		x		=	$	-
150712	Remove Painted Pavement Marking	SQFT		x		=	$	-
150742	Remove Roadside Sign	EA		x		=	$	-
152320	Reset Roadside Sign	EA		x		=	$	-
152390	Relocate Roadside Sign	EA		x		=	$	-
82010X	Delineator (Class X)	EA		x		=	$	-
840502	Thermoplastic Traffic Stripe (Enhanced Wet Night	LF		x		=	$	-
846012	Thermoplastic Crosswalk and Pavement Marking (	SQFT		x		=	$	-
120090	Construction Area Signs	LS		x		=	$	-
84XXXX	Permanent Pavement Delineation	LS		x		=	$	-

Subtotal Traffic Signing and Striping *$* *3,000*

6C - Traffic Management Plan

Item code		Unit	Quantity		Unit Price ($)			Cost
12865X	Portable Changeable Message Signs	EA/LS		x		=	$	-

Subtotal Traffic Management Plan *$* *-*

6C - Stage Construction and Traffic Handling

Item code		Unit	Quantity		Unit Price ($)			Cost
120199	Traffic Plastic Drum	EA		x		=	$	-
12016X	Channelizer (Type X)	EA		x		=	$	-
120120	Type III Barricade	EA		x		=	$	-
129100	Temporary Crash Cushion Module	EA		x		=	$	-
120100	Traffic Control System	LS	1	x	50,000.00	=	$	50,000
129110	Temporary Crash Cushion	EA		x		=	$	-
129000	Temporary Railing (Type K)	LF		x		=	$	-
120149	Temporary Pavement Marking (Paint)	SQFT		x		=	$	-
82010X	Delineator (Class X)	EA		x		=	$	-
XXXXXX	Some Item	Unit		x		=	$	-

Subtotal Stage Construction and Traffic Handling *$* *50,000*

TOTAL TRAFFIC ITEMS **$** **103,000**

SECTION 7: DETOURS

Includes constructing, maintaining, and removal

Item code		Unit	Quantity		Unit Price ($)		Cost	
190101	Roadway Excavation	CY		x		=	$	-
19801X	Imported Borrow	CY/TON		x		=	$	-
390132	Hot Mix Asphalt (Type A)	TON		x		=	$	-
26020X	Class 2 Aggregate Base	TON/CY		x		=	$	-
250401	Class 4 Aggregate Subbase	CY		x		=	$	-
130620	Temporary Drainage Inlet Protection	EA		x		=	$	-
129000	Temporary Railing (Type K)	LF		x		=	$	-
128601	Temporary Signal System	LS		x		=	$	-
120149	Temporary Pavement Marking (Paint)	SQFT		x		=	$	-
80010X	Temporary Fence (Type X)	LF		x		=	$	-
XXXXXX	Some Item	Unit		x		=	$	-

TOTAL DETOURS $ -

SUBTOTAL SECTIONS 1 through 7 $ 665,521

SECTION 8: MINOR ITEMS

8A - Americans with Disabilities Act Items							
ADA Items				2.5%		$	16,638
8B - Bike Path Items							
Bike Path Items				5.0%		$	33,276
8C - Other Minor Items							
Other Minor Items				8.0%		$	53,242
Total of Section 1-7	$	665,521	x	15.5%	=	$	103,156

TOTAL MINOR ITEMS $ 103,200

SECTIONS 9: MOBILIZATION

Item code								
999990	Total Section 1-8	$	768,721	x	10%	=	$	76,873

TOTAL MOBILIZATION $ 76,900

SECTION 10: SUPPLEMENTAL WORK

Item code		Unit	Quantity		Unit Price ($)		Cost	
066670	Payment Adjustments For Price Index Fluctuations	LS		x		=	$	-
066094	Value Analysis	LS		x		=	$	-
066070	Maintain Traffic	LS		x		=	$	-
066919	Dispute Resolution Board	LS		x		=	$	-
066921	Dispute Resolution Advisor	LS		x		=	$	-
066015	Federal Trainee Program	LS		x		=	$	-
066610	Partnering	LS		x		=	$	-
066204	Remove Rock and Debris	LS		x		=	$	-
066222	Locate Existing Crossover	LS		x		=	$	-
XXXXXX	Some Item	LS	1	x	25,000.00	=	$	25,000

Cost of ***NPDES*** *Supplemental Work specified in Section 5D* = $ 15,000

Total Section 1-8 $ 768,721 5% = $ 38,437

TOTAL SUPPLEMENTAL WORK $ 78,500

EA: DS-123456 PID: DS1234567

SECTION 11: STATE FURNISHED MATERIALS AND EXPENSES

Item code		*Unit*	*Quantity*		*Unit Price ($)*		*Cost*
066105	Resident Engineers Office	LS		x		=	$0
066063	Traffic Management Plan - Public Information	LS		x		=	$0
066901	Water Expenses	LS		x		=	$0
8609XX	Traffic Monitoring Station (X)	LS		x		=	$0
066841	Traffic Controller Assembly	LS		x		=	$0
066840	Traffic Signal Controller Assembly	LS		x		=	$0
066062	COZEEP Contract	LS		x		=	$0
066838	Reflective Numbers and Edge Sealer	LS		x		=	$0
066065	Tow Truck Service Patrol	LS		x		=	$0
066916	Annual Construction General Permit Fee	LS		x		=	$0
XXXXXX	Some Item	Unit		x		=	$0
	Total Section 1-8		$ 768,721		4%	=	$ 30,749

TOTAL STATE FURNISHED **$30,800**

SECTION 12: TIME-RELATED OVERHEAD

Total of Roadway and Structures Contract Items excluding Mobilization	$27,188,100	(used to calculate TRO)
Total Construction Cost (excluding TRO and Contingency)	$29,487,851	(used to check if project is greater than $5 million excluding contingency)

Estimated Time-Related Overhead (TRO) Percentage (0% to 10%) = **5%**

Item code		*Unit*	*Quantity*		*Unit Price ($)*		*Cost*
070018	Time-Related Overhead	WD	653	X	$2,084	=	$1,359,500

TOTAL TIME-RELATED OVERHEAD **$1,359,500**

Note: If the building portion of the project is greater than 50% of the total project cost, then TRO is not included.

SECTION 13: ROADWAY CONTINGENCY

Recommended Contingency: (Pre-PSR 30%-50%, PSR 25%, Draft PR 20%, PR 15%, after PR approval 10%, Final PS&E 5%)

Total Section 1-12	$	2,314,421	x	**20%**	=	$462,885

TOTAL CONTINGENCY **$462,900**

EA: DS-123456 PID: DS1234567

II. STRUCTURE ITEMS

	Bridge 1		Bridge 2		
DATE OF ESTIMATE	11/19/21		11/19/21		00/00/00
Bridge Name	Caulfield		Caulfield		xxxxxxxxxxxxxxxxxxx
Bridge Number	C20-XX1		C20-XX1		57-XXX
Structure Type	Rolling Dbl-Leaf Bascule		6'-0" Cantilever Walkway		xxxxxxxxxxxxxxxxxxx
Width (Feet) [out to out]	37 LF		12 LF		0 LF
Total Bridge Length (Feet)	293 LF		293 LF		0 LF
Total Area (Square Feet)	10920 SQFT		3516 SQFT		0 SQFT
Structure Depth (Feet)	4 FT		2 FT		0 LF
Footing Type (pile or spread)	CIDH		Super-structure		xxxxxxxxxxxxxxxxxxx
Cost Per Square Foot	$1,855		$250		$0
COST OF EACH	**$20,256,504**		**$879,000**		**$0**

DATE OF ESTIMATE	00/00/00		00/00/00		00/00/00
Name	xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx
Bridge Number	57-XXX		57-XXX		57-XXX
Structure Type	xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx
Width (Feet) [out to out]	0 LF		0 LF		0 LF
Total Length (Feet)	0 LF		0 LF		0 LF
Total Area (Square Feet)	0 SQFT		0 SQFT		0 SQFT
Structure Depth (Feet)	0 LF		0 LF		0 LF
Footing Type (pile or spread)	xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx		xxxxxxxxxxxxxxxxxxx
Cost Per Square Foot	$100		$0		$0
COST OF EACH	**$0**		**$0**		**$0**

TOTAL COST OF BRIDGES		**$21,135,504**
TOTAL COST OF BUILDINGS		**$0**
Structures Mobilization Percentage	10%	**$2,113,550**

Recommended Contingency: **(Pre-PSR 30%-50%**, PSR 25%, Draft PR 20%, PR 15%, after PR approval 10%, Final PS&E 5%)

Structures Contingency Percentage	25%	**$5,283,876**
TOTAL COST OF STRUCTURES		**$28,532,930**

Estimate Prepared By: ______________________________ ______________________________

XXXXXXXXXXXXXXXXX ------ Division of Structures   Date

EA: DS-123456 PID: DS1234567

III. RIGHT OF WAY

Fill in all of the available information from the Right of Way data sheet.

A)	A1) Acquisition, including Excess Land Purchases, Damages & Goodwill, Fees		$	0
	A2) SB-1210		$	0
B)	Acquisition of Offsite Mitigation		$	0
C)	C1) Utility Relocation (State Share)		$	0
	C2) Potholing (Design Phase)		$	0
D)	Railroad Acquisition		$	0
E)	Clearance / Demolition		$	0
F)	Relocation Assistance (RAP and/or Last Resort Housing Costs)		$	0
G)	Title and Escrow		$	0
H)	Environmental Review		$	0
I)	Condemnation Settlements	0%	$	0
J)	Design Appreciation Factor	0%	$	0
K)	Utility Relocation (Construction Cost)		$	0

L)	**TOTAL RIGHT OF WAY ESTIMATE**	**$0**
M)	**TOTAL R/W ESTIMATE: Escalated**	
N)	**RIGHT OF WAY SUPPORT**	**$200,000**

Support Cost Estimate Prepared By ______________________
Project Coordinator[1] Phone

Utility Estimate Prepared By ______________________
Utiliy Coordinator[2] Phone

R/W Acquistion Estimate Prepared By ______________________
Right of Way Estimator[3] Phone

Note: Items G & H applied to items A + B

[1] When estimate has Support Costs only [2] When estimate has Utility Relocation [3] When R/W Acquisition is required

DO NOT PRINT THIS SHEET AS PART OF COST ESTIMATE ATTACHMENT TO PROJECT INITIATION OR APPROVAL DOCUMENTS.

EA: DS-123456 PID: DS1234567

IV. SUPPORT COST ESTIMATE SUMMARY

Note: Use PRSM project data.

		Escalated Support Cost for Estimate To Completion (ETC)				
Total by FY		PA&ED	PS&E	RW	CON	Total $
< 2015	Expended					
	ETC					
2016	Expended					
	ETC					
2017	Expended					
	ETC					
2018	Expended					
	ETC					
2019	Expended					
	ETC					
2020	Expended	$200,000				$200,000
	ETC					
2021	Expended	$100,000				$1,300,000
	ETC	$450,000	$750,000			
2022	Expended					$1,950,000
	ETC		$1,950,000			
2023	Expended					$750,000
	ETC		$550,000	$200,000		
2024	Expended					$2,000,000
	ETC		$250,000		$1,750,000	
2025	Expended					$2,000,000
	ETC		$250,000		$1,750,000	
2026	Expended					$425,000
	ETC		$175,000		$250,000	
2027	Expended					
	ETC					
2028	Expended					
	ETC					
2029	Expended					
	ETC					
2030 >	Expended					
	ETC					
EAC (Expended + ETC)		$750,000	$3,925,000	$200,000	$3,750,000	$8,625,000
Approved Budget (PRSM)						
Difference (Budget - EAC)		-$750,000	-$3,925,000	-$200,000	-$3,750,000	-$8,625,000
Support Ratio (EAC / Cap Cost)		2.4%	12.5%	0.6%	12.0%	27.5%

Total Capital Cost:	**$31,311,000**
Total Capital Outlay Support Cost:	**$8,625,000**
Overall Percent Support Cost:	**27.55%**

PRSM workplan hours/costs verified against approved MWA:

Office Chief - ____________________ Date ________

Approved by:

Project Control - ____________________ Date ________

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