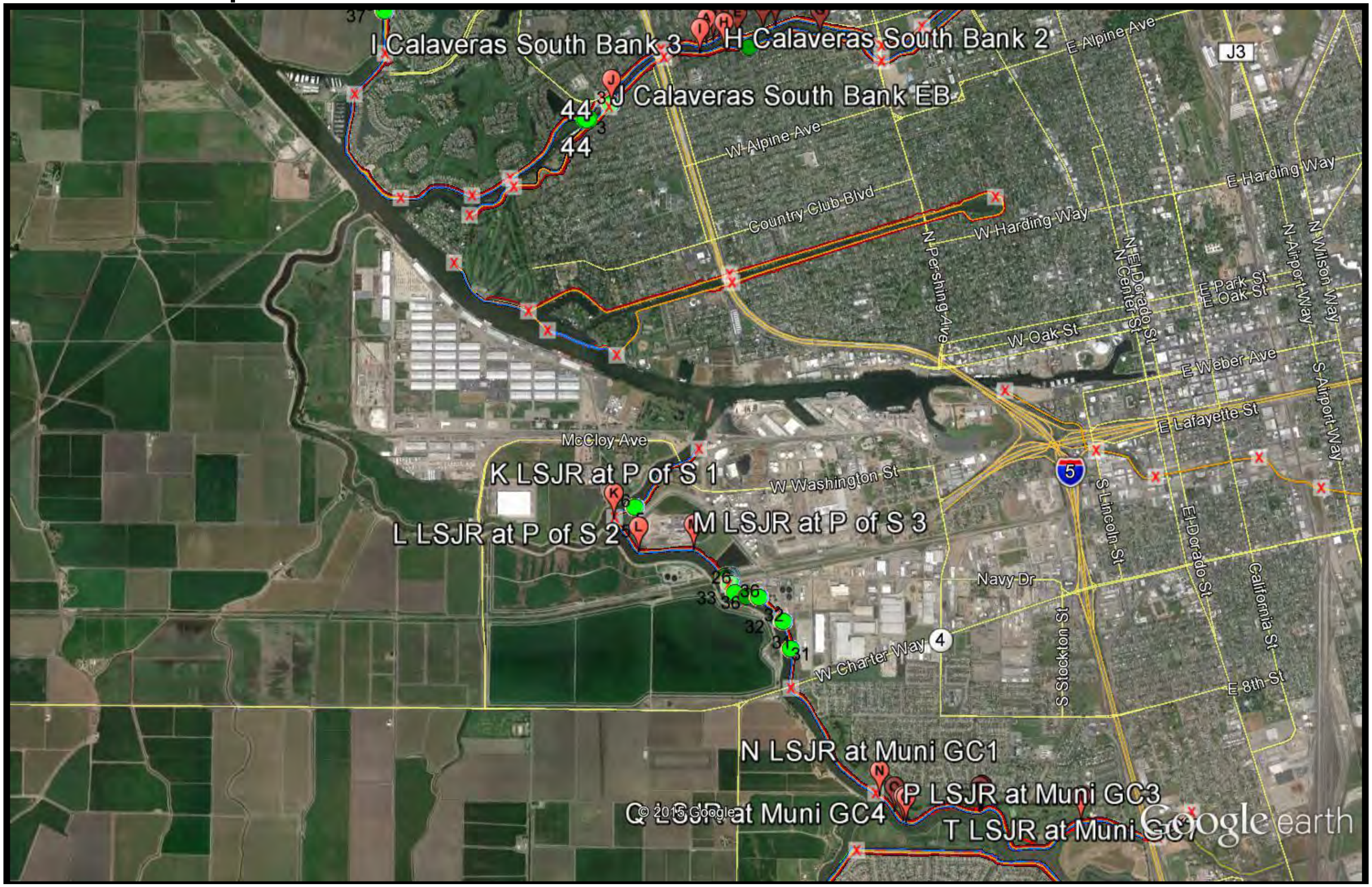
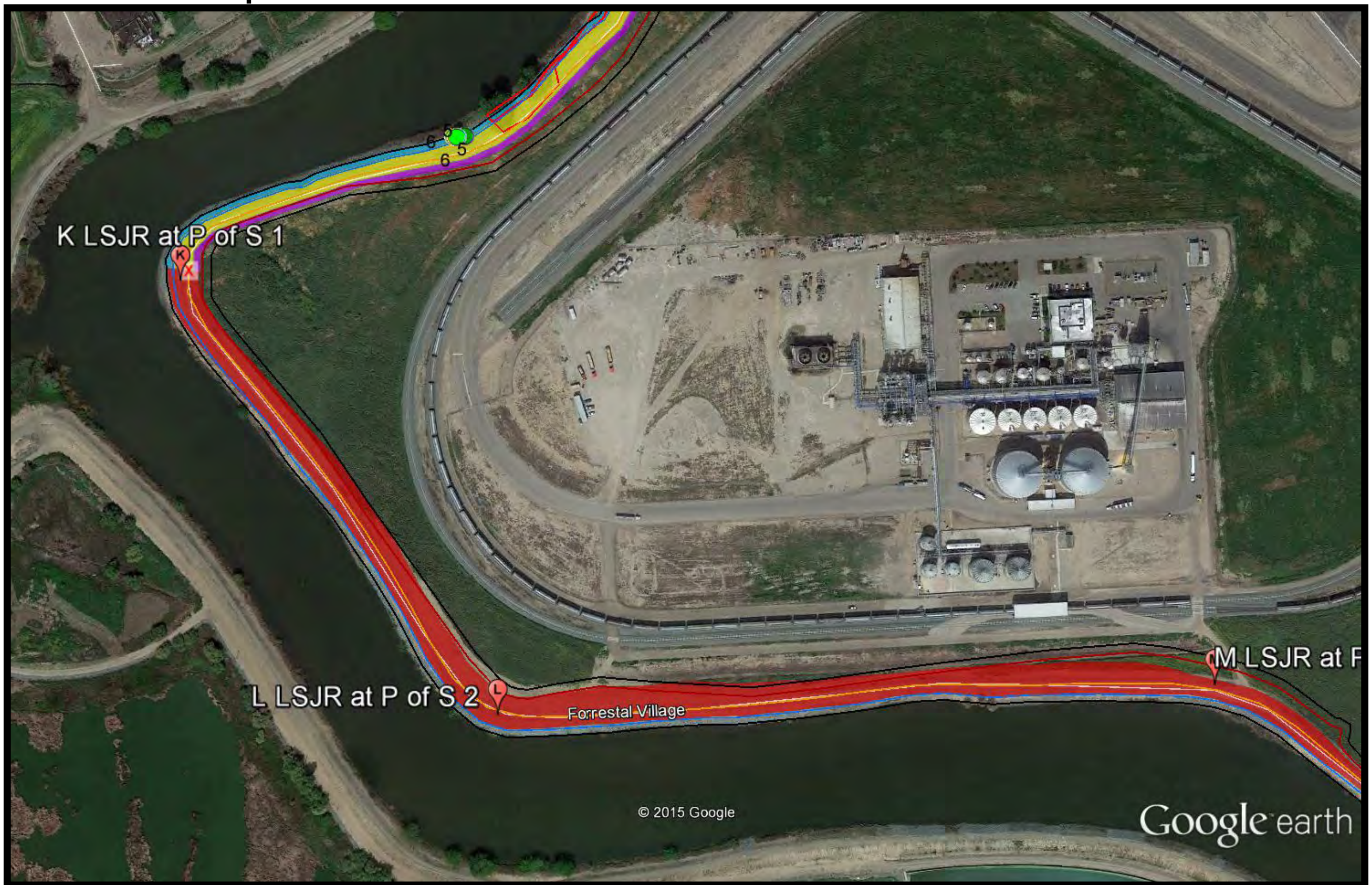
Calaveras River South Bank – Photo Point "J"

Lower San Joaquin River – Photo Points



San Joaquin River – Photo Points

Lower San Joaquin River – Photo Points

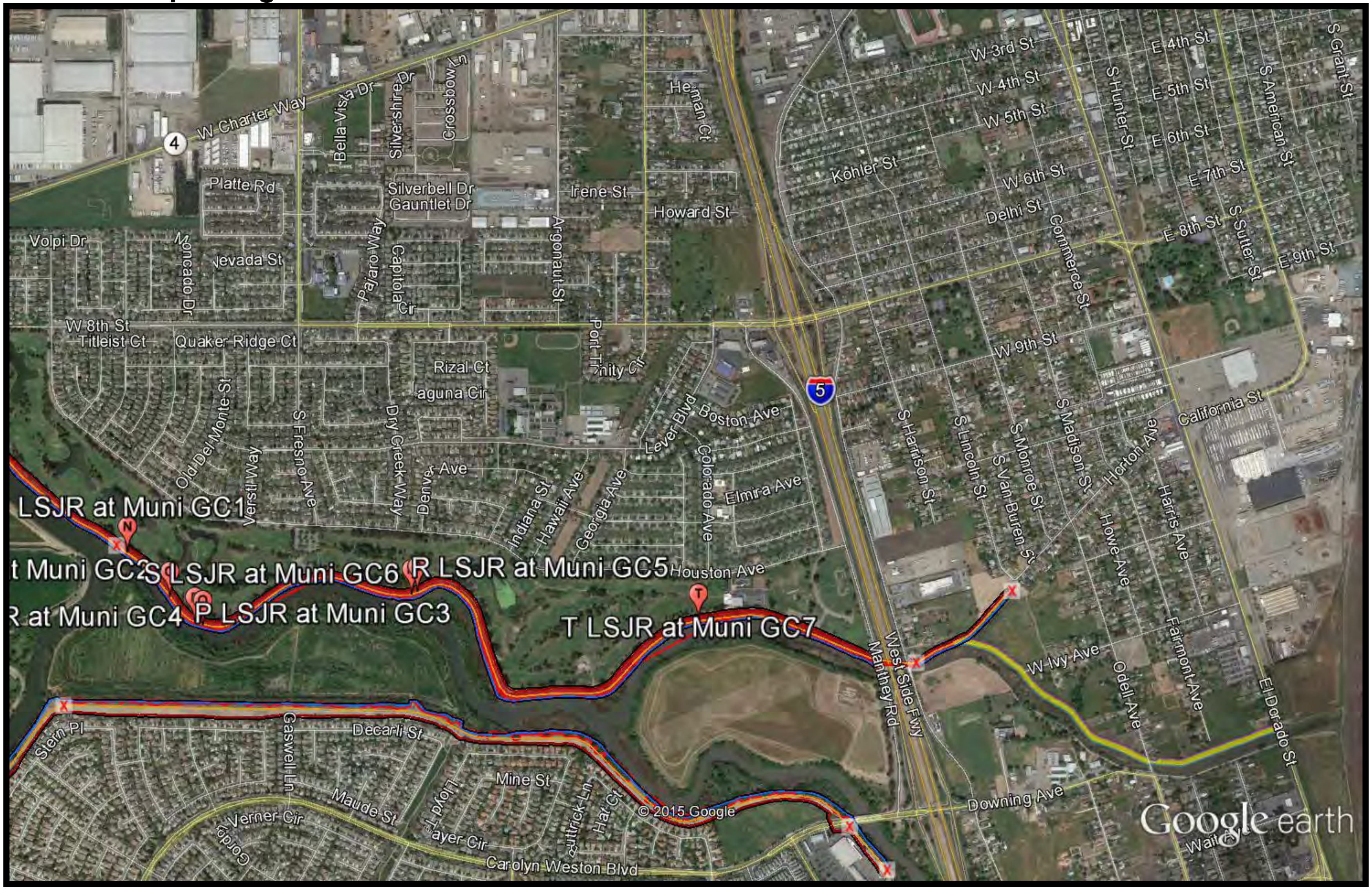


Lower San Joaquin River – Photo Point “K” (6/23/15)

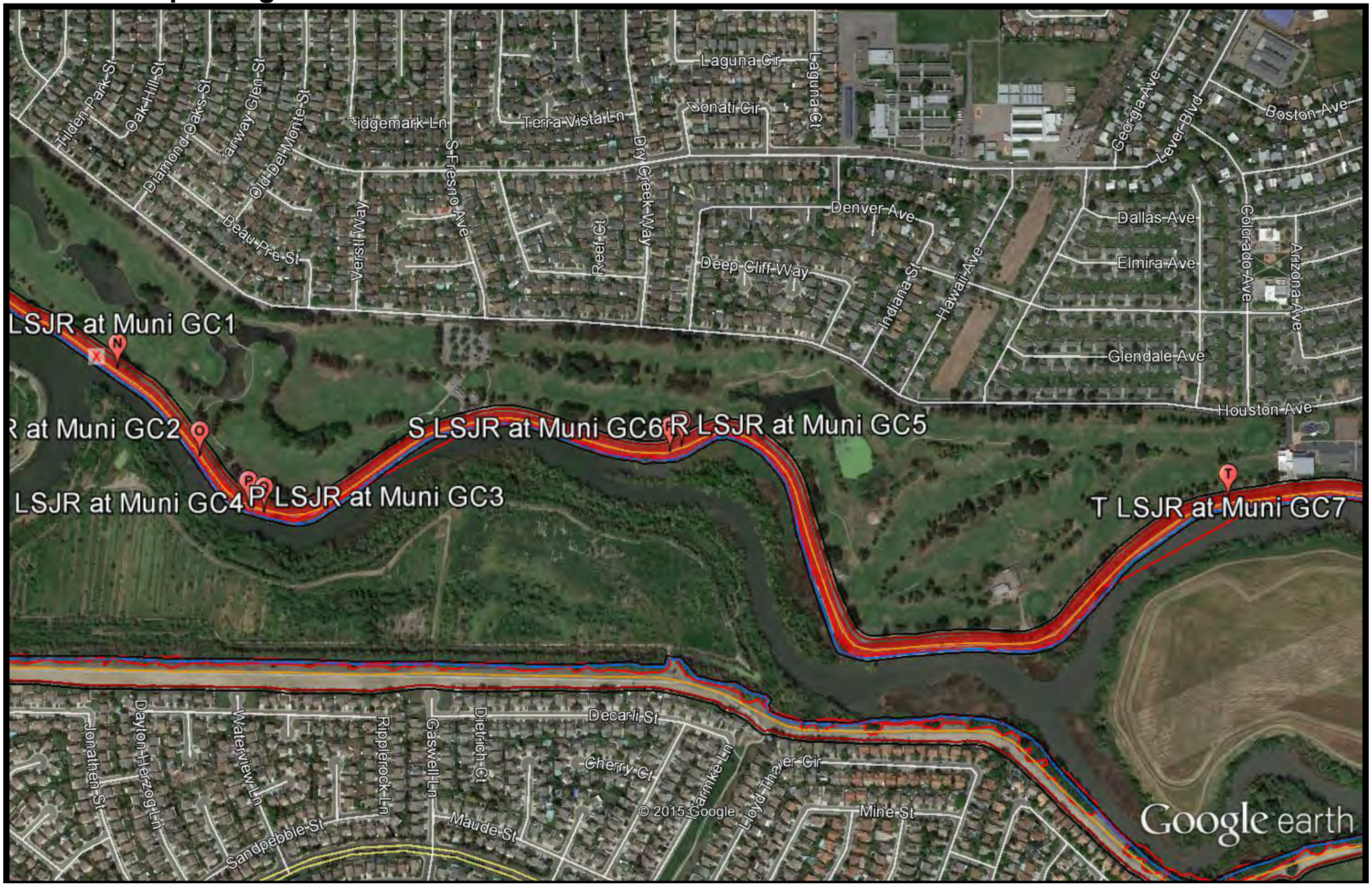
Lower San Joaquin River – Photo Point “L” (6/23/15)

Lower San Joaquin River – Photo Point "M" (6/23/15)

French Camp Slough – Photo Points



French Camp Slough – Photo Points



French Camp Slough – Photo Points "N" to "Q" on the West End of the Slough

French Camp Slough – Photo Point "N"

French Camp Slough – Photo Point "O"

French Camp Slough – Photo Point "P"

French Camp Slough – Photo Point “Q”

French Camp Slough – Photo Points "R" and "S"

French Camp Slough – Photo Point "R"

French Camp Slough – Photo Point "S"

French Camp Slough – Photo Point “T”

French Camp Slough – Photo Point "T" (6/23/15)

FIGURES

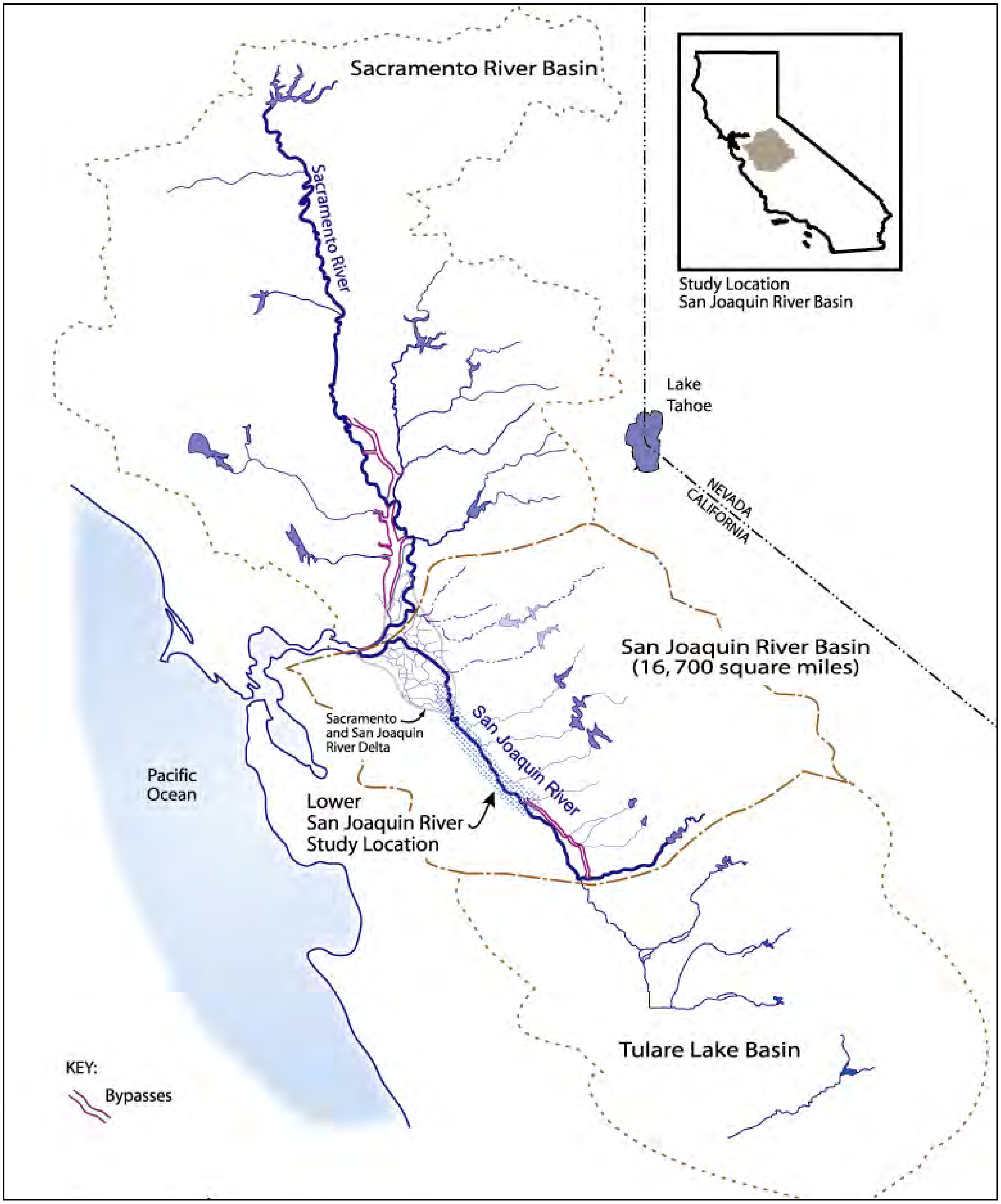


Figure 1. Study Location

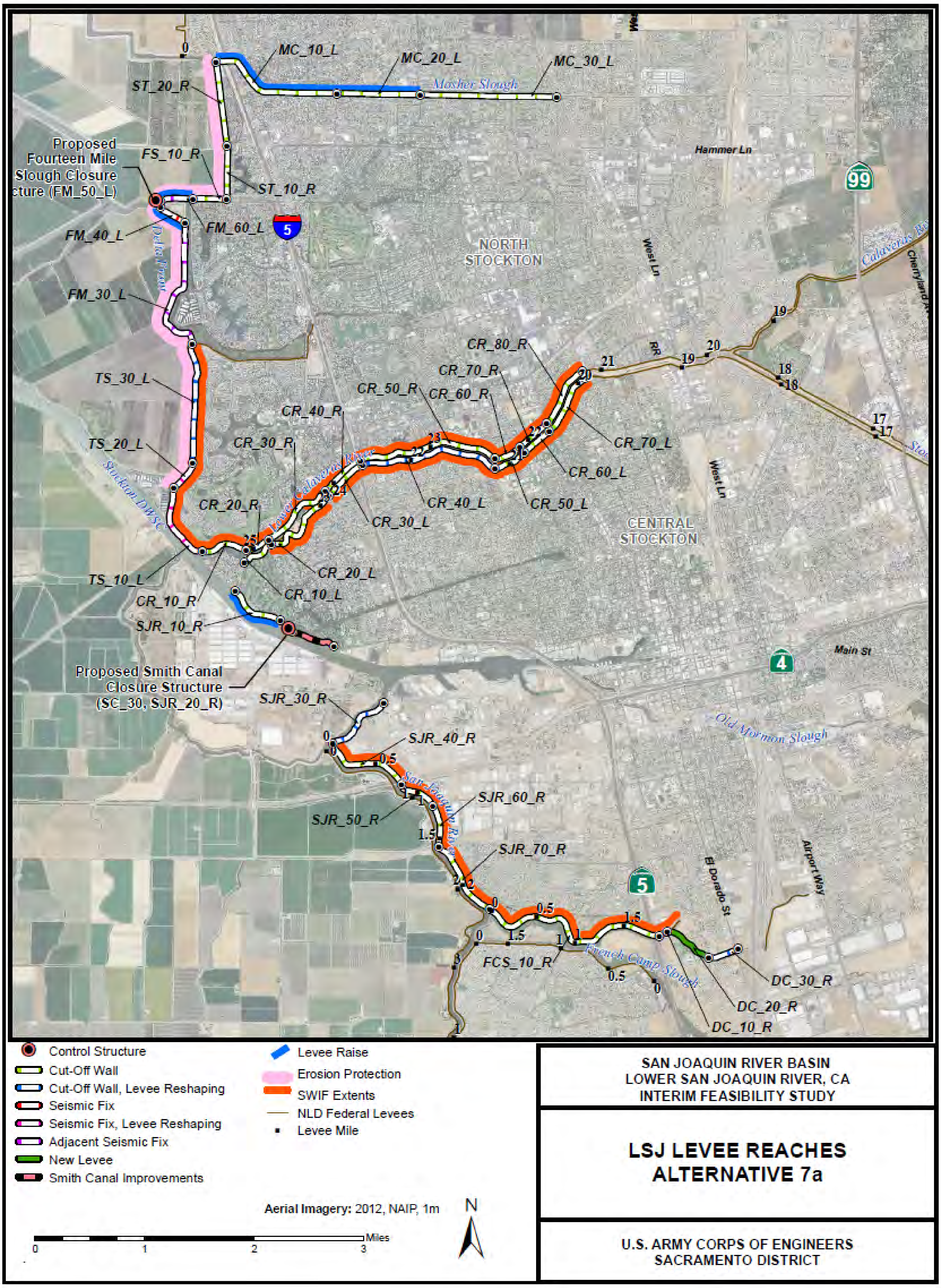


Figure 2. Lower San Joaquin River Feasibility Study Action Area and Recommended Plan Alternative 7a

Figure 3. Federal and non-Federal levees included in the Recommended Plan

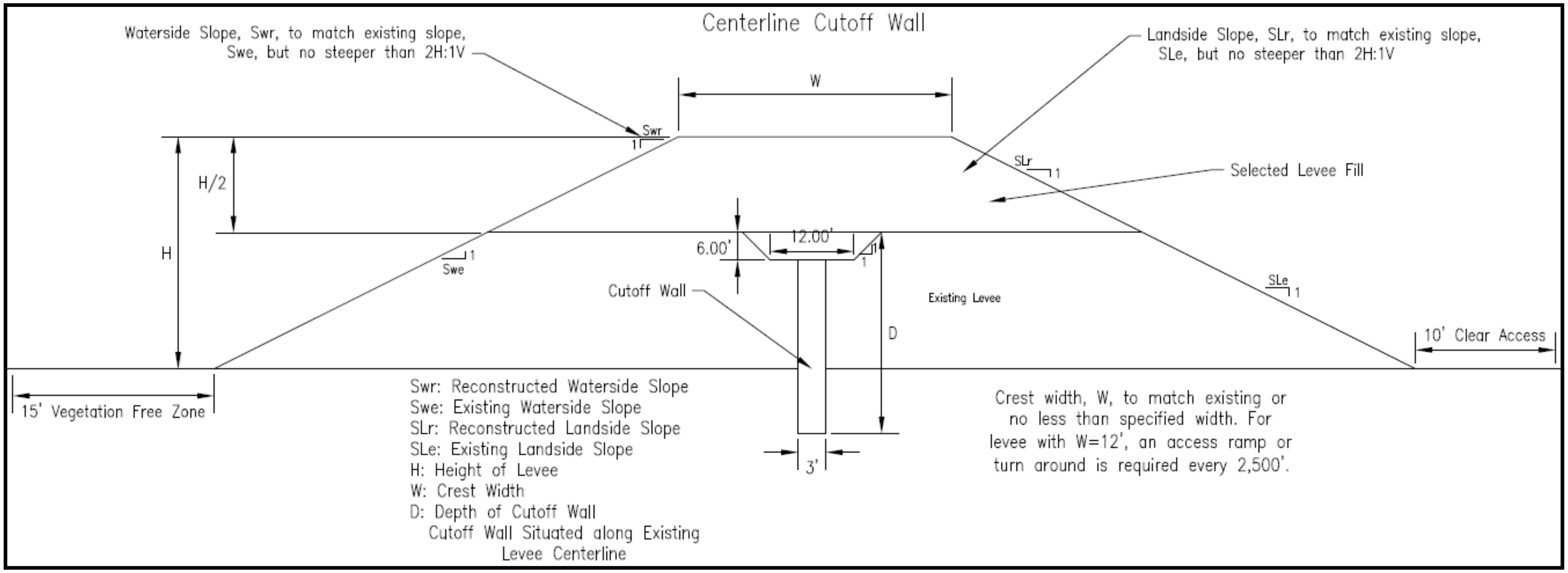


Figure 4. Cutoff Wall Typical Plan

Note that the landside easement (right side) shown would be the minimum easement; landside easements would range from 10 feet to 20 feet from the levee toe.

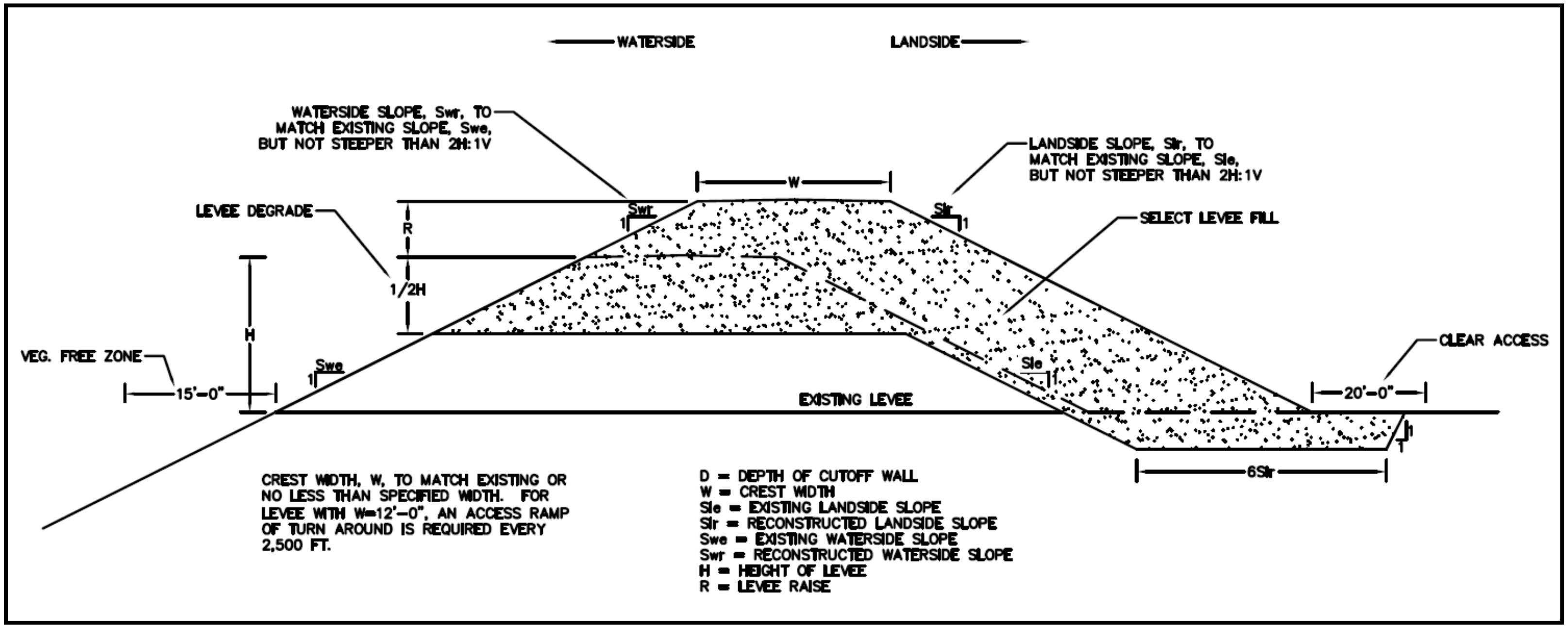


Figure 5. Levee Reshaping and Levee Raise Typical Plan

Note that the landside easement (right side) shown would be the maximum clear access easement; landside easements would range from 10 feet to 20 feet from the levee toe. Half levee degradation is generally not proposed unless a cutoff wall would be installed. Instead, an internal drain may be constructed between the existing levee materials and the new fill.

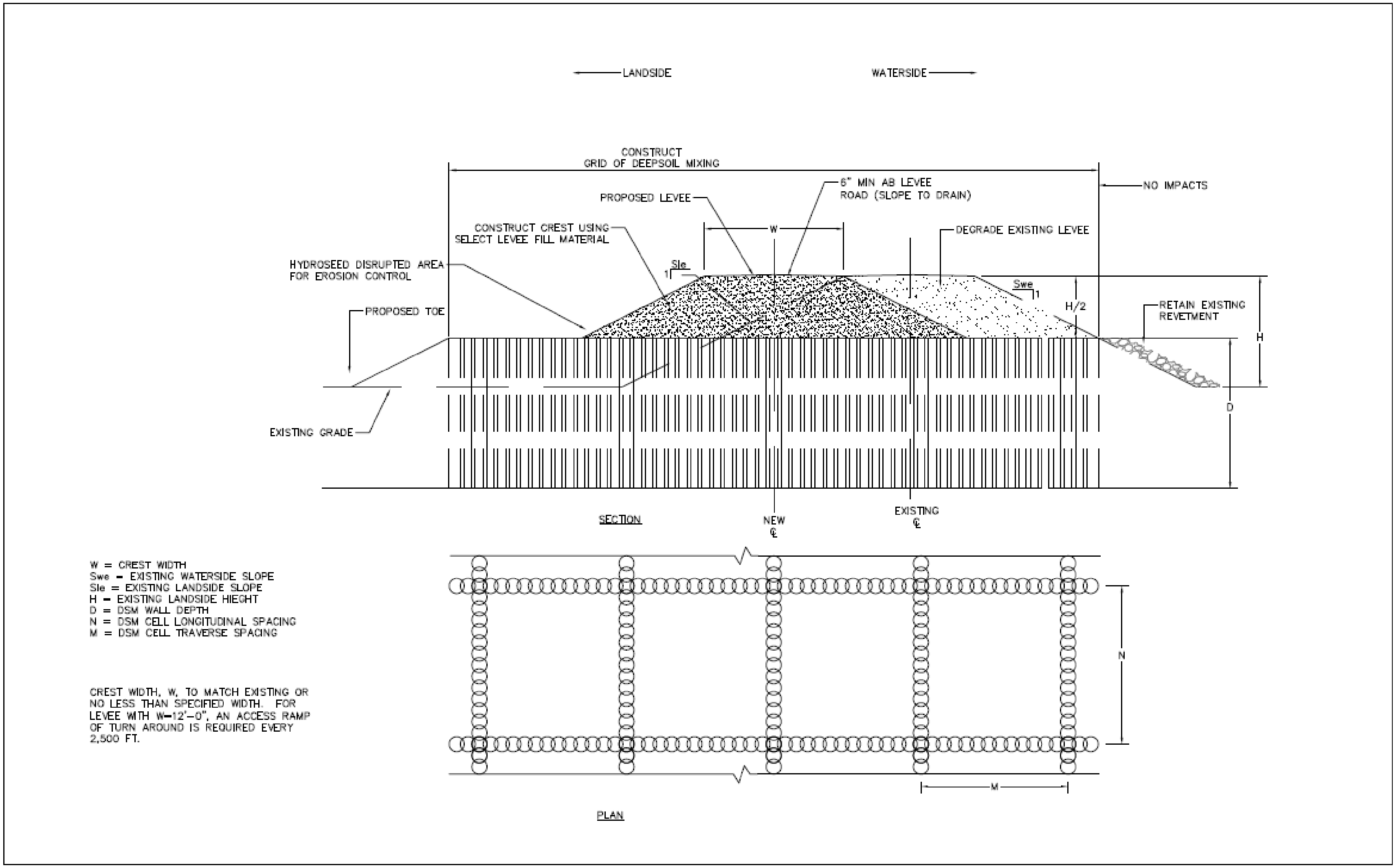


Figure 6. Seismic Remediation Typical Plan

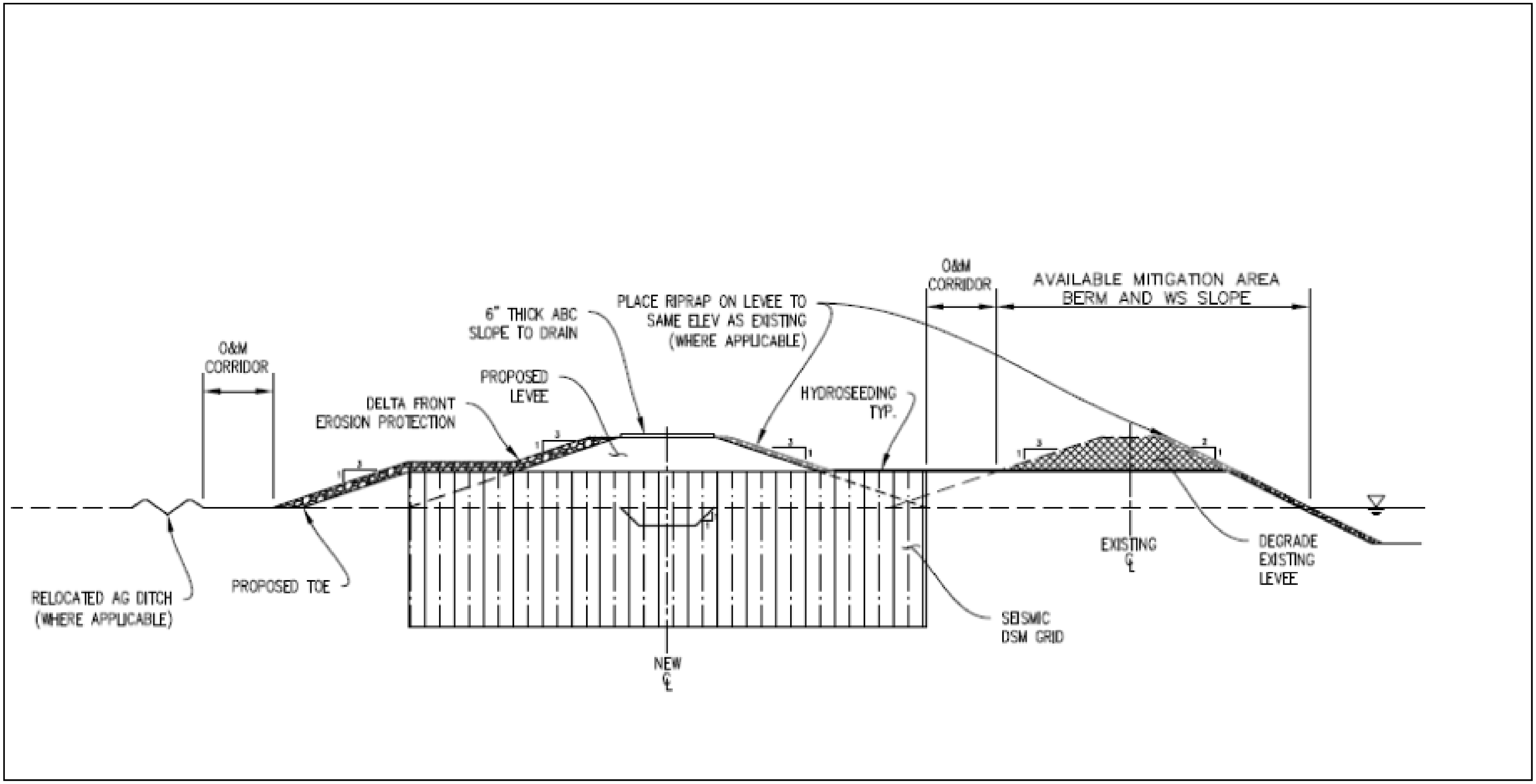


Figure 7. Seismic Remediation Typical Plan with Setback Levee

Figure 8. Levee Setback and Compensation Area

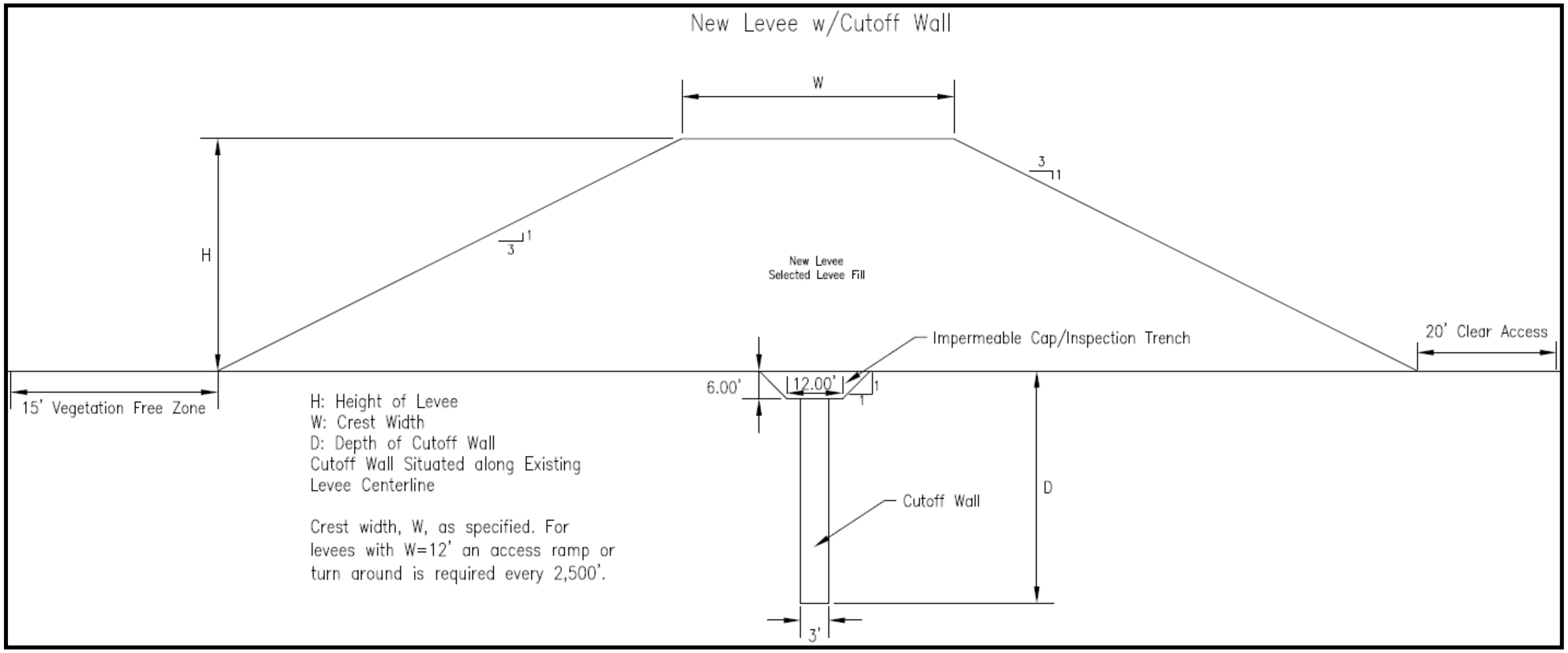


Figure 9. New Levee with Cutoff Wall Typical Plan

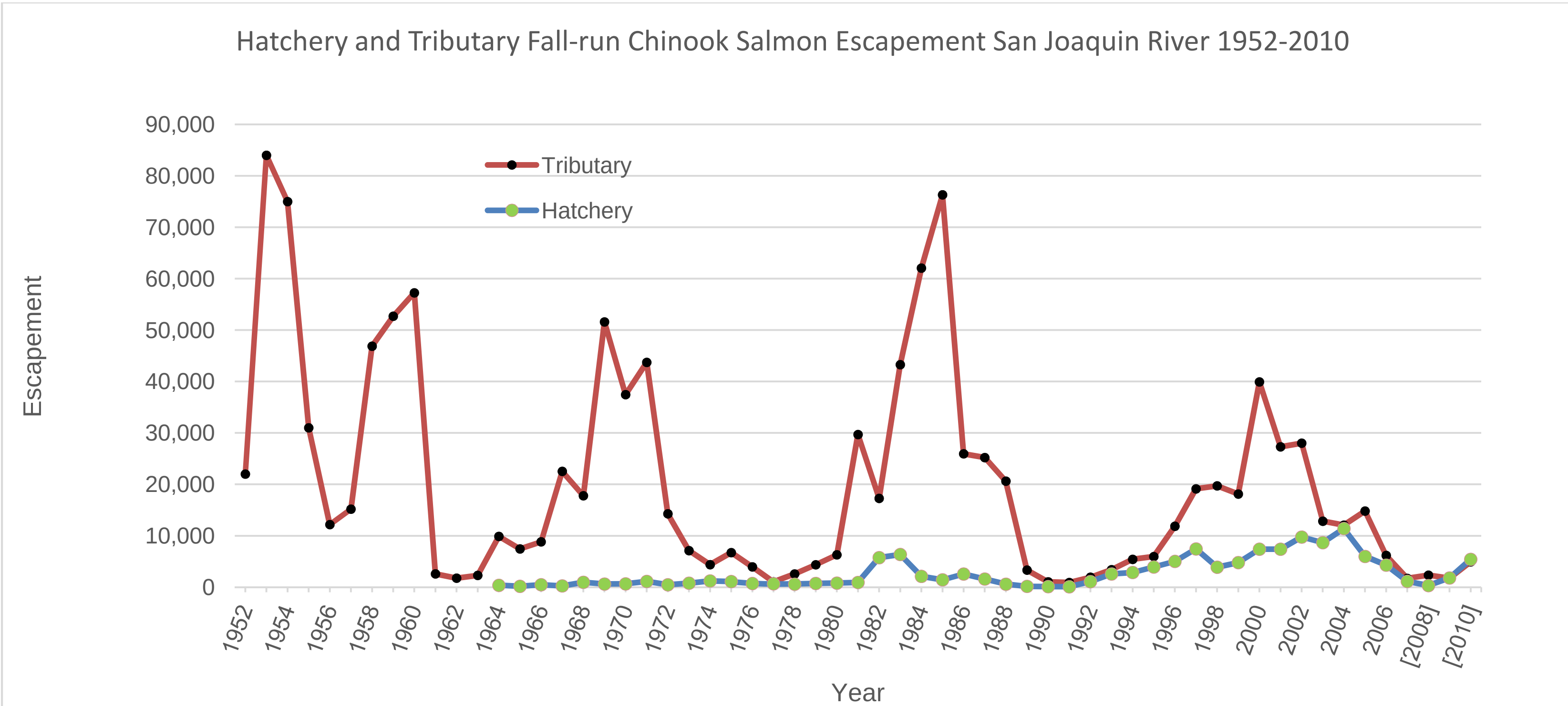


Figure 10: San Joaquin River Tributary and Hatchery Fall-run Chinook Salmon Escapement 1952-2010

Plates

1-1g Elderberry Shrub Locations
2 GGS Habitat Location

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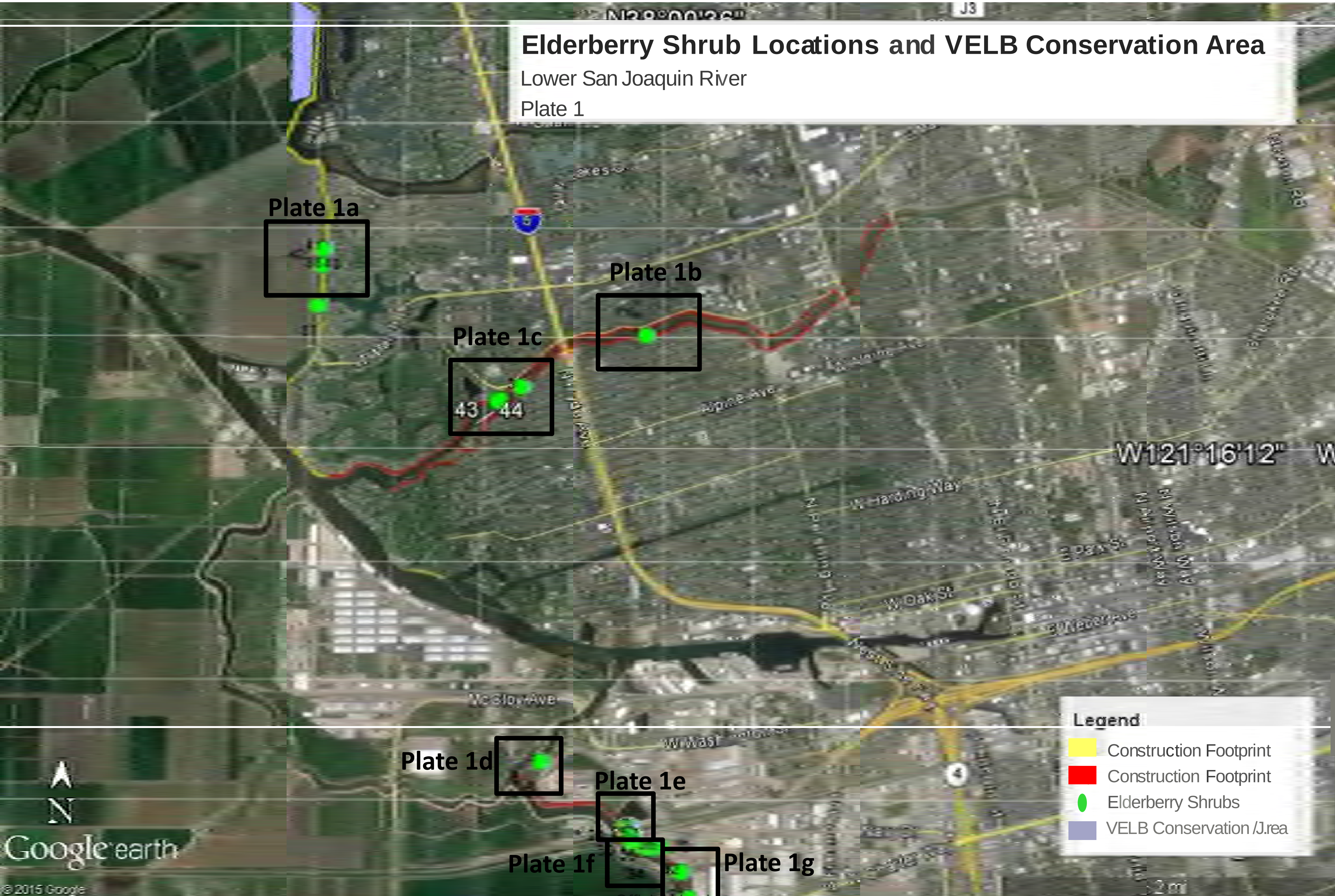
Elderberry Shrub Locations and VELB Conservation Area
Lower San Joaquin River
Plate 1
Plate 1a
Plate 1b
Plate 1c
43
44
Plate 1d
Plate 1e
Plate 1f
Plate 1g
W121°16'12"
W Harding Way
W Oak St
Alpine Ave
Legend
Construction Footprint
Construction Footprint
Elderberry Shrubs
VELB Conservation Area
N
Google earth
© 2015 Google
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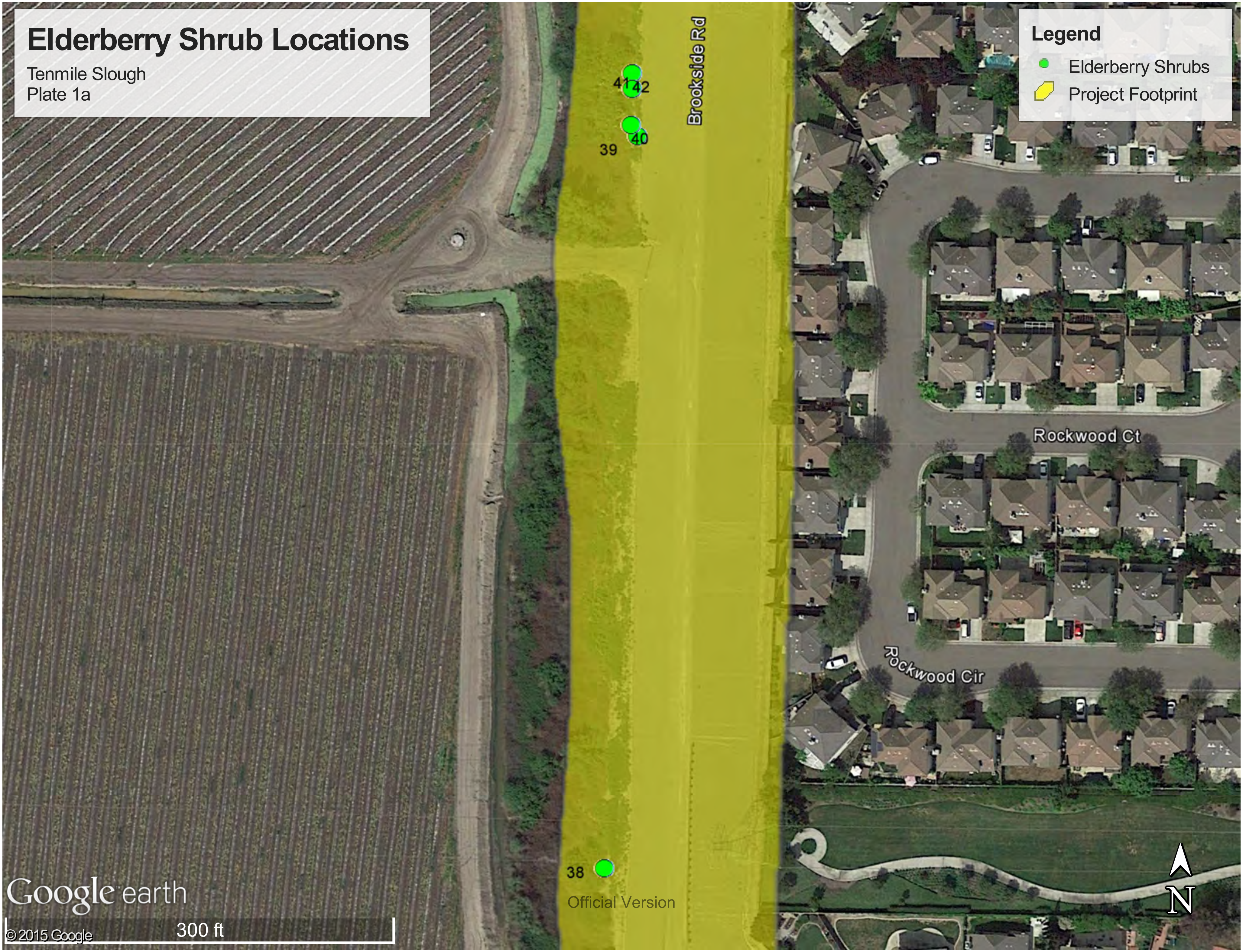
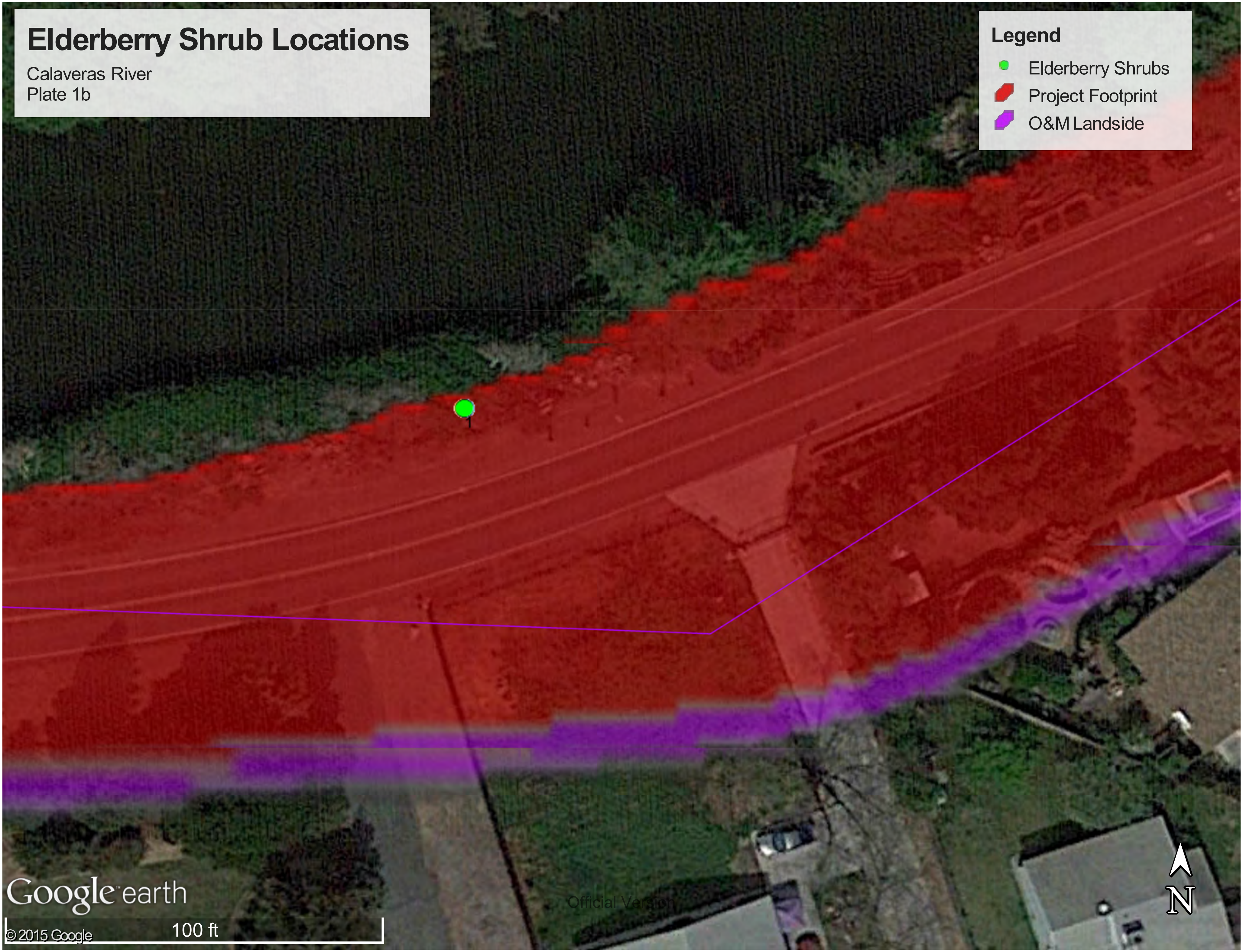


Elderberry Shrub Locations
Tenmile Slough
Plate 1a
Legend
Elderberry Shrubs
Project Footprint
Brookside Rd
Rockwood Ct
Rockwood Cir
41
42
39
40
38
Official Version
Google earth
© 2015 Google
300 ft
N


Elderberry Shrub Locations
Calaveras River
Plate 1b
Legend
Elderberry Shrubs
Project Footprint
O&M Landside
Google earth
© 2015 Google
100 ft
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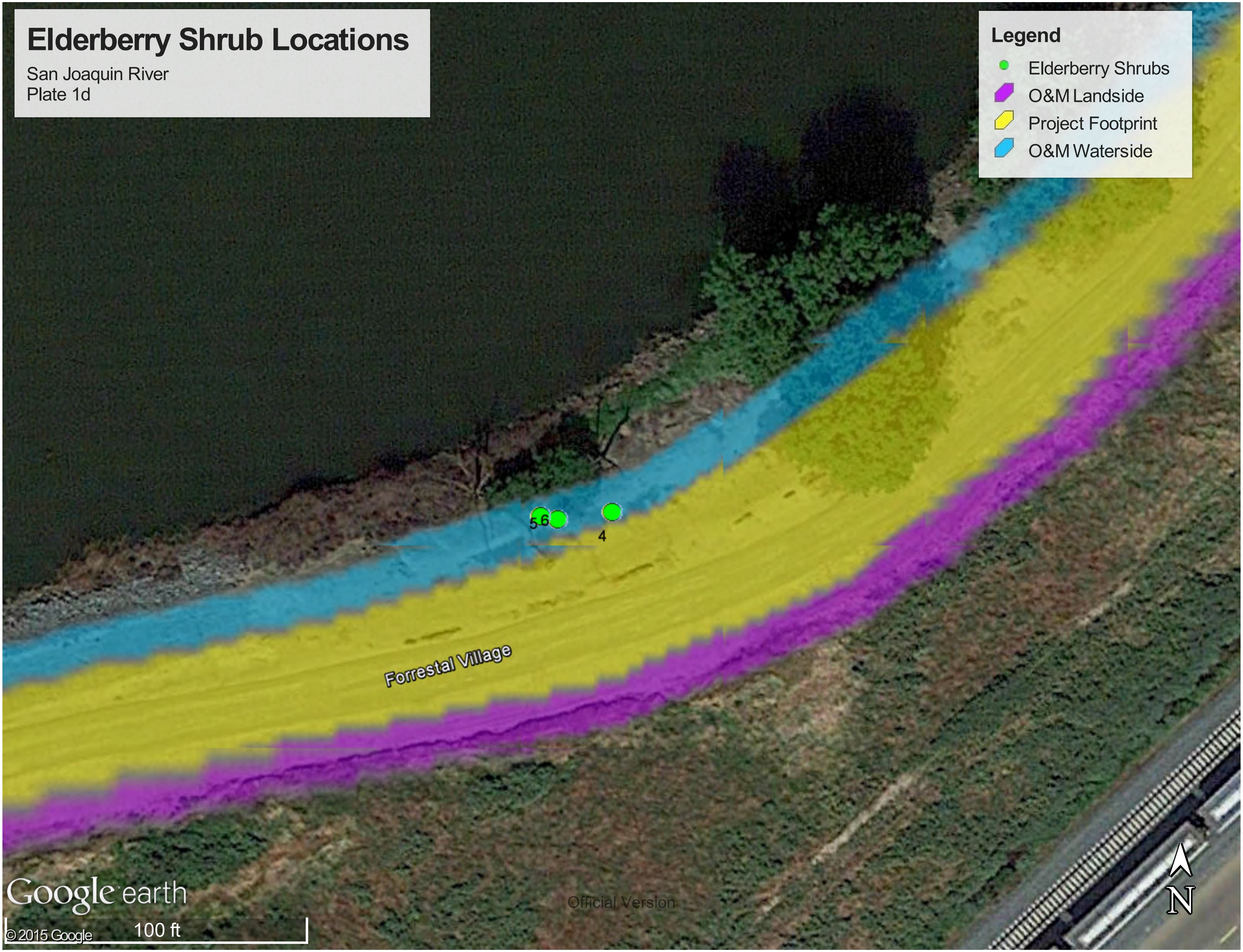
Official Version

Elderberry Shrub Locations

Calaveras River
Plate 1c


Elderberry Shrub Locations
San Joaquin River
Plate 1d
Legend
Elderberry Shrubs
O&M Landside
Project Footprint
O&M Waterside
5
6
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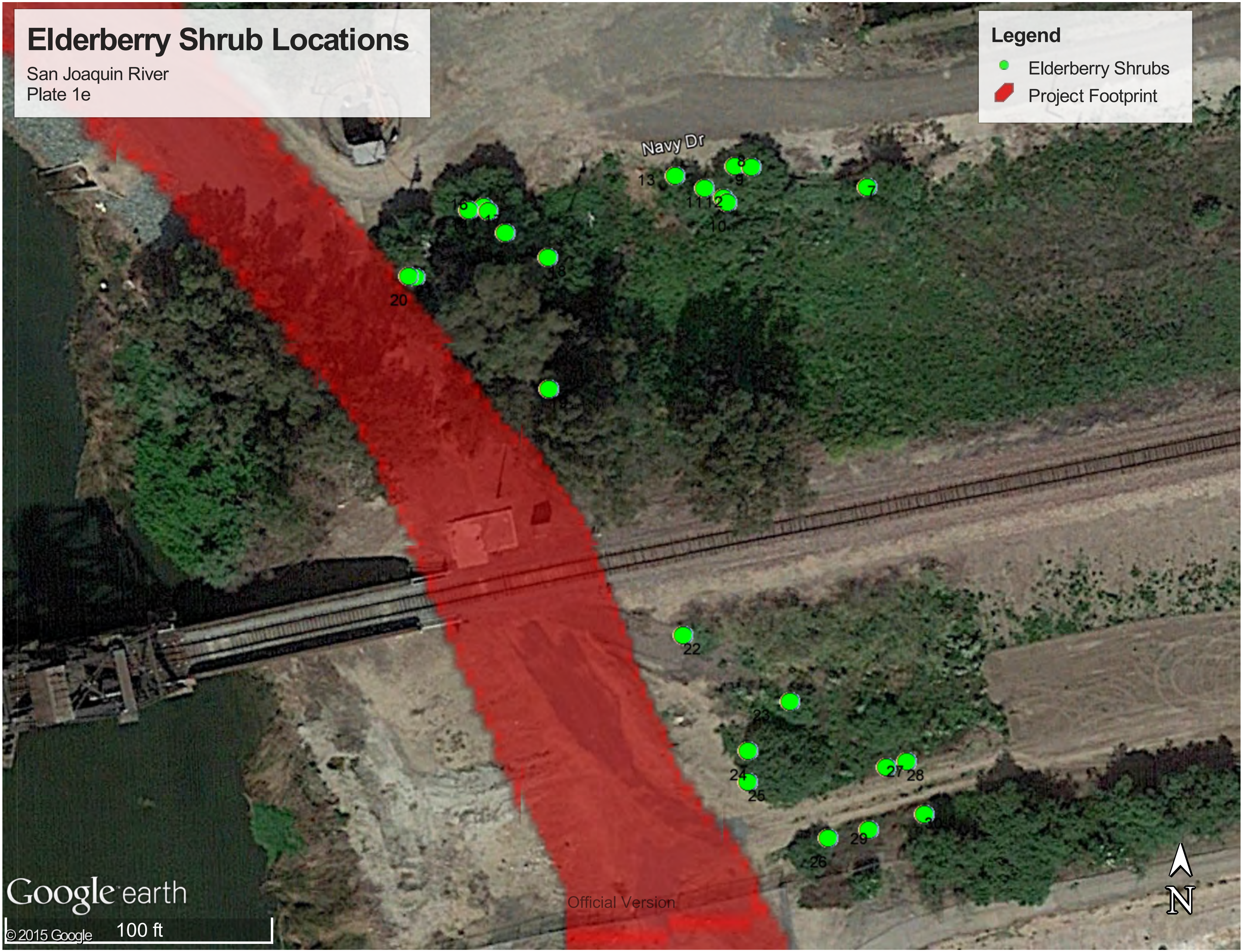
Forrestal Village
Google earth
© 2015 Google
100 ft
Official Version
N


Elderberry Shrub Locations
San Joaquin River
Plate 1e
Legend
Elderberry Shrubs
Project Footprint
Navy Dr
13
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22
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26
Google earth
© 2015 Google
100 ft
Official Version
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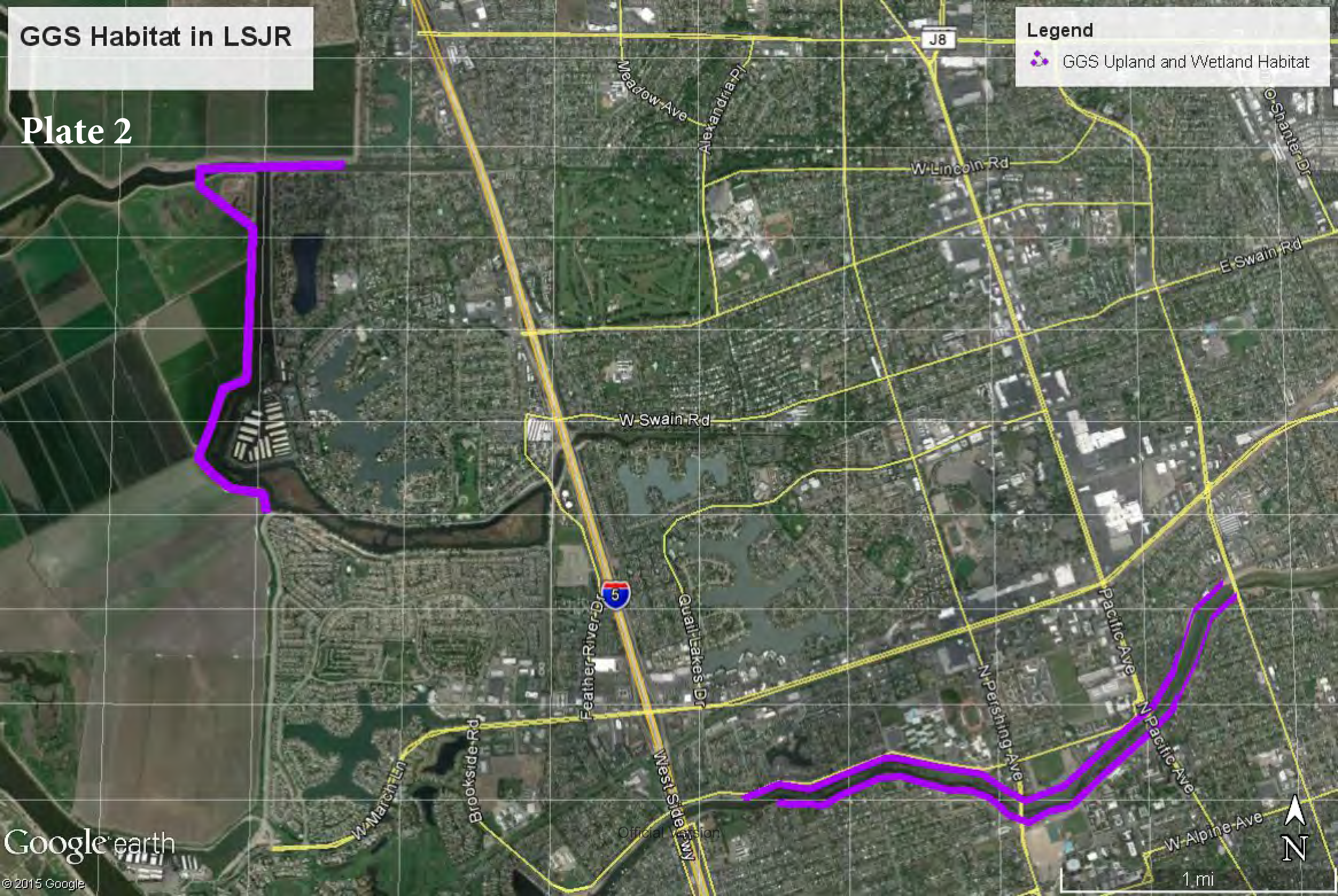
Elderberry Shrub Locations
San Joaquin River
Plate 1f
Legend
Elderberry Shrubs
Project Footprint
33
34
35
36
200 ft
N
Google earth
© 2015 Google
Official Version


Elderberry Shrub Locations
San Joaquin River
Plate 1g
Legend
Elderberry Shrubs
Project Footprint
32
N37°55'59.52"
31
Official Version
Google earth
© 2015 Google
300 ft
N

GGS Habitat in LSJR

Plate 2



3/10/2016 (Toland)

SUMMARY

LSJR FS: POTENTIAL IMPACTS ON POTENTIAL GGS HABITAT

	Acres
TOTAL TEMPORARY Impacts on Potential UPLAND GGS Habitat TEMPORARILY Affected	114.00
TOTAL PERMANENT Impacts on Potential UPLAND GGS Habitat	12.5*
TOTAL TEMPORARY Impacts on Potential AQUATIC GGS Habitat	0.5
TOTAL PERMANENT Impacts on Potential AQUATIC GGS Habitat	1

* Note: Permanent upland impacts should be subtracted from temporary impacts to avoid double counting the same land.

LSJR FS: TEMPORARY IMPACTS TO POTENTIAL UPLAND GGS HABITAT.

lengths from ED spreadsheet. Widths from Google Earth image with Project footprint and using Google Earth measurement tools.

Cost Reach	Length of Cost Reach	Length of Cost Reach	Potential Upland Habitat?	Length X 200 feet (ft2)	Maxiumum Potential Upland Affected (length of reach X 200 ft= Acres)	Width of Potential Upland GGS Habitat (acres)	Potential Upland GGS Habitat Temporarily Affected (E X H= ft2)	Acres Potential Upland GGS Habitat TEMPORARILY AFFECTED (Acres)	Notes
MC_10L,	(6.600 ft)	6600		1,320,000	30.30	25.00	165000	3.79	Highly urbanized. Paved/graveled crown road. Measure from levee midline to outer edge of waterside easement.
MC_20L	(4,100 ft),	4100		820,000	18.82	25.00	102500	2.35	Highly urbanized. Paved/graveled crown road. Measure from levee midline to outer edge of waterside easement.
ST_10R	(2,600 ft)	2600	No	0	0.00	0.00	0	0.00	Dry land
ST_20R,	(4,100 ft)	4100		820,000	18.82	130.00	533000	12.24	relocate ditch & ag land
FS_10R	(1,700 ft)	1700	No	0	0.00	0.00	0	0.00	Ditch (dry) beyond footprint
FM_60_L	(1,600 ft)	1600		320,000	7.35	120.00	192000	4.41	Ditch (dry) beyond footprint; construction w/in 200 feet.
FM_50_L,	(300 ft)	200		40,000	0.92	200.00	40000	0.92	Closure Structure 300 = length across slough. 100 = width of construction footprint along slough. 200 foot width for cross levee so used 200 ft.
FM_40_L,	(1,500 ft)	0	Most not. Some w/in 200 ft. Addressed within FM_60_L	0	0.00	0.00	0	0.00	

FM_30_L	(7,000 ft),	7000		1,400,000	32.14	200.00	1400000	32.14	
TS_30_L	(5,900 ft)	5900		1,180,000	27.09	50.00	295000	6.77	paved road on crown - 85 ft wide.
TS_20_L	(1,600 ft),	1600		320,000	7.35	0.00	0	0.00	Almost all hardscaped - paved crown and riprap and rock on both sides of levee. Abuts urban infrastructure.
TS_10_L	(4,000 ft)	4000		800,000	18.37	0.00	0	0.00	Almost all hardscaped - paved crown and riprap and rock on both sides of levee. Abuts urban infrastructure.
CR_10_R	(2,300 ft),	2300		460,000	10.56	0.00	0	0.00	Almost all hardscaped - paved crown and riprap and rock on both sides of levee. Abuts urban infrastructure.
CR_20_R	(1,300 ft),	650		130,000	2.98	60.00	39000	0.90	50% of reach almost all hardscaped - paved crown and riprap and rock on both sides of levee. Abuts urban infrastructure.
CR_30_R	(3,800 ft)	3800		760,000	17.45	65.00	247000	5.67	
CR_40_R	(2,300 ft),	2300		460,000	10.56	20.00	46000	1.06	lower levee and waterside easement only
CR_50_R	(6,900 ft),	6900		1,380,000	31.68	32.00	220800	5.07	lower levee and waterside easement only
CR_60_R	(1,400 ft),	1400		280,000	6.43	40.00	56000	1.29	lower levee and waterside easement only
CR_70_R	(1,800 ft),	1800		360,000	8.26	30.00	54000	1.24	lower levee and waterside easement only
CR_80_R	(3,200 ft)	3200		640,000	14.69	20.00	64000	1.47	lower levee and waterside easement only
CR_10_L	(1,700 ft),	850		170,000	3.90	20.00	17000	0.39	Boat docks. Human disturbance.
CR_20_L	(4,300 ft),	4300		860,000	19.74	20.00	86000	1.97	Boat docks.
CR_30_L	(2,300 ft)	2300		460,000	10.56	22.00	50600	1.16	
CR_40_L	(6,900 ft)	6900		1,380,000	31.68	20.00	138000	3.17	Human activity. Boat docks.
CR_50_L	(1,700 ft),	1700		340,000	7.81	23.00	39100	0.90	
CR_60_L	(1,600 ft)	1600		320,000	7.35	25.00	40000	0.92	

CR_70_L	(3,200 ft)	3200		640,000	14.69	25.00	80000	1.84	
SC_30	(800 ft)	800	NO	0	0.00		0	0.00	
SJR_10_R,	(8,600 ft)	8600	NO	0	0.00	25.00	215000	4.94	water to edge of crown road. Note this is mainstem SJR/DWSC
SJR_20_R	(600 ft)	600	NO	0	0.00	0.00	0	0.00	
SJR_30_R	(3,500 ft)	3500	NO	0	0.00	0.00	0	0.00	
SJR_40_R	(4,400 ft),	4400	NO	0	0.00	0.00	0	0.00	
SJR_50_R	(2,000 ft),	2000	NO	0	0.00	0.00	0	0.00	
SJR_60_R	(2,100 ft),	2100	NO	0	0.00	0.00	0	0.00	
SJR_70_R	(4,100 ft)	4100		820,000	18.82	30.00	123000	2.82	Note: mainstem SJR at French Camp Slough. Edge of paved crown to end of waterside easement.
FCS_10_R	(9,000 ft)	9000		1,800,000	41.32	26.00	234000	5.37	edge of road to end of waterside easement.
DC_10_R	(450 ft)	450		90,000	2.07	83.00	37350	0.86	edge of waterside easement to edge of landside easement because new an on ag land.
DC_20_R	(2,450 ft)	2450		490,000	11.25	90.00	220500	5.06	edge of waterside easement to edge of landside easement because new an on ag land.
DC_30_R	(2,450 ft)	2450		490,000	11.25	90.00	220500	5.06	edge of waterside easement to edge of landside easement because new an on ag land.
Maximum Potential Impact (reach length X 200 feet)				19,350,000	444				
Total Potential Upland GGS Habitat Temporarily Affected (ft2)							4,955,350.00		
TOTAL Potential Upland GGS Habitat TEMPORARILY Affected (Acres)								**113.76**	

10 March 2016 (Toland)

LSJR FS: PERMANENT IMPACTS OF THE RECOMMENDED PLAN ON POTENTIAL UPLAND GGS HABITAT

lengths from ED spreadsheet. Widths from Google Earth image with Project footprint and using Google Earth measurement tools.

Cost Reach	Length of Cost Reach	Length of Cost Reach Modified	Potential Upland Habitat?	Permanent Impact on Potential Upland Habitat?	Width of Permanent Impact on Potential Upland GGS Habitat (feet)	Potential Upland Habtiat Peramantly Affected (E X H= ft2)	Potential Upland Habitat Permanently Affected (Acres)	Notes
MC_10L,	(6.600 ft)	6600		No		0	0.00	
MC_20L	(4,100 ft),	4100		No		0	0.00	
ST_10R	(2,600 ft)	2600	No	No		0	0.00	
ST_20R,	(4,100 ft)	4100		Yes	35.00	143500	3.29	landside edge of levee crown to outter edge of 15 foot landside easement.
FS_10R	(1,700 ft)	1700	No	No	0.00	0	0.00	
FM_60_L	(1,600 ft)	1600		Yes-landside armoring	50.00	80000	1.84	
FM_50_L,	(300 ft)	200		Yes-Closure Structure	200.00	40000	0.92	
FM_40_L,	(1,500 ft)	0		No	0.00	0	0.00	
FM_30_L	(7,000 ft),	7000		Yes-landside armoring	25.00	175000	4.02	
TS_30_L	(5,900 ft)	5900		No		0	0.00	
TS_20_L	(1,600 ft),	1600		No		0	0.00	
TS_10_L	(4,000 ft)	4000		No		0	0.00	
CR_10_R	(2,300 ft),	2300		No		0	0.00	

CR_20_R	(1,300 ft),	650		No		0	0.00	
CR_30_R	(3,800 ft)	3800		No		0	0.00	
CR_40_R	(2,300 ft),	2300		No		0	0.00	
CR_50_R	(6,900 ft),	6900		No		0	0.00	
CR_60_R	(1,400 ft),	1400		No		0	0.00	
CR_70_R	(1,800 ft),	1800		No		0	0.00	
CR_80_R	(3,200 ft)	3200		No		0	0.00	
CR_10_L	(1,700 ft),	850		No		0	0.00	
CR_20_L	(4,300 ft),	4300		No		0	0.00	
CR_30_L	(2,300 ft)	2300		No		0	0.00	
CR_40_L	(6,900 ft)	6900		No		0	0.00	
CR_50_L	(1,700 ft),	1700		No		0	0.00	
CR_60_L	(1,600 ft)	1600		No		0	0.00	
CR_70_L	(3,200 ft)	3200		No		0	0.00	
SC_30	(800 ft)	800	NO	No		0	0.00	
SJR_10_R,	(8,600 ft)	8600	NO	No		0	0.00	
SJR_20_R	(600 ft)	600	NO	No		0	0.00	
SJR_30_R	(3,500 ft)	3500	NO	No		0	0.00	
SJR_40_R	(4,400 ft),	4400	NO	No		0	0.00	
SJR_50_R	(2,000 ft),	2000	NO	No		0	0.00	
SJR_60_R	(2,100 ft),	2100	NO	No		0	0.00	

SJR_70_R	(4,100 ft)	4100		No		0	0.00	
FCS_10_R	(9,000 ft)	9000		No		0	0.00	
DC_10_R	(450 ft)	450			20.00	9000	0.21	New road width
DC_20_R	(2,450 ft)	2450			20.00	49000	1.12	
DC_30_R	(2,450 ft)	2450			20.00	49000	1.12	
Total PERMANENT Impacts on Potential GGS Upland Habitat (ft2)						545,500.00		
TOTAL PERMANENT Impacts on Potential GGS Upland Habitat Affected (Acres)							**12.52**	

10 March 2016 (Toland)

LSJR FS: PERMANENT AND TEMPORARY IMPACTS ON POTENTIAL GGS AQUATIC HABITAT

lengths from ED spreadsheet. Widths from Google Earth image with Project footprint and using Google Earth measurement tools.

	Potential GGS Aquatic Habitat?	Permanent Impacts (Acres)	Temporary Impacts (Acres)
Fourteenmile Slough Closure Structure	Yes	0.5	1
Smith Canal Closure Structure	No	0.5	3

Closure Structures:

Overview. Two closure structures would be constructed as part of the Recommended Plan. One would be located on Fourteenmile Slough and one would be on Smith Canal. The gates will be open except during routine maintenance, when the delta exceeds a flood stage of 8 feet NAVD88, or a levee breach has occurred within the slough reach. For reference, the 100-yr elevation is 10.1 ft NAVD88 and the 200-yr elevation is 12.1 ft NAVD88.

Operating Criteria

Normal. The gate would be closed when the delta stage is at 8.0 feet NAVD88 and rising and would be opened when the delta stage was 8.0 feet NAVD88 and falling. The gate would also be opened if the stage on the slough side of the gate rose higher than the delta stage. This would allow accumulated interior drainage behind the gate to flow out.

Emergency. One or both of these gates could also be closed indefinitely if a levee failure occurred along Smith Canal or Fourteenmile Slough. The gate could be reopened once the levee repairs were made.

Maintenance. Maintenance requirements would include exercising each gate briefly (closed and immediately opened) once or twice a year for O&M purposes. All routine maintenance of the motors, gears, etc. for the gate can be accomplished from above while the gate is in the open position. For major maintenance, the gates can be removed with a barge mounted crane and inspected, repaired, and/or replaced. This would eliminate the need to place stop logs across the opening for routine maintenance.

Frequency and Duration of Operations.

An analysis of hypothetical gate operations was conducted for 2010 and 2070 sea level conditions using 32 water years (1982 to 2014) of recorded daily minimum, mean, and maximum tide stages. Delta stages are the result of ocean tide conditions in combination with runoff from the Sacramento and San Joaquin River systems. The historical record is a good indicator of the potential operations because it includes the historical combination of tides and flow. The analysis compared historical stages to the proposed operating criteria described above.

The assessment of 2010 sea level conditions was based on adjusting the historical record to 2010 conditions using the historical rate of sea level rise. The assessment of 2070 conditions was conducted for four potential rates of sea level rise described in EC 1165-2-212. The USACE Low estimate is based on the historical rate of sea level rise of 0.3 feet between 2010 and 2070. The USACE Intermediate estimate is 0.9 feet of SLR between 2010 and 2070 and is based on Curve I. The USACE Curve II estimate reflects a rate greater than the intermediate rate of 1.66 feet between 2010 and 2070. The USACE high estimate is 2.5 feet of SLR between 2010 and 2070 and is based on Curve III. The results of the assessment are provided in Tables 1 through 5.

The number of days the gate would have to be closed for a full day was also assessed for each scenario.

2010 conditions – none
2070 historical SLR – none
2070 Curve I SLR – 0 days in 1998, 1 day in 1997, 0 days in 1995, 0 days in 1983
2070 Curve II SLR – 2 days in 1998, 3 days in 1997, 0 days in 1995, 3 days in 1983
2070 Curve III SLR – 13 days in 1998, 11 days in 1997, 1 day in 1995, 13 days in 1983

Table 1. Total hours per month gate would have been closed assuming 2010 Sea Level Conditions, Sea Level Rise based on Historical Rate of Sea Level Rise

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1983	0	5	8	46	17	59	0	0	0	0	0	0
1984	0	0	11	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	2	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	3	0	11	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	1	99	6	0	0	0	0	0	0	0
1998	0	0	0	0	95	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	2	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	2	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	0	0	1	0	0	0	0	0	0	0	0
2006	0	0	7	16	0	0	1	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	1	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	0	5	11	99	95	59	1	0	0	0	0	0
Mean	0	0	1	5	4	2	0	0	0	0	0	0
Minimum	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Total hours per month gate would have been closed assuming 2070 Sea Level Conditions, Sea Level Rise based on Historical Rate of Sea Level Rise

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1983	0	6	19	60	52	104	0	0	1	0	0	1
1984	0	2	25	3	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	8	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	1	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	16	0	38	0	0	0	0	0	0
1996	0	0	0	0	3	0	0	0	0	0	0	0
1997	0	0	3	148	19	0	0	0	0	0	0	0
1998	0	0	0	2	144	1	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	4	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	1	0	0	0	0	0	0	0	0	0
2003	0	0	3	0	0	0	0	0	0	0	0	0
2004	0	0	1	0	0	0	0	0	0	0	0	0
2005	0	0	0	6	0	0	0	0	0	0	0	0
2006	0	0	10	25	0	0	15	2	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	0	0	0
2008	0	0	0	2	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	5	0	0	9	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	0	6	25	148	144	104	15	2	1	0	0	1
Mean	0	0	2	8	7	5	0	0	0	0	0	0
Minimum	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Total hours per month gate would have been closed assuming 2070 Sea Level Conditions, Sea Level Rise based on Curve I Rate of Sea Level Rise

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1983	0	13	50	89	136	254	16	19	28	16	8	13
1984	4	14	78	25	0	0	0	0	0	0	0	0
1985	0	2	0	0	0	0	0	0	0	0	0	0
1986	0	1	0	0	0	33	0	1	0	0	0	0
1987	0	0	0	0	0	0	0	0	1	4	4	0
1988	0	0	2	1	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	1	0	0	0
1990	0	0	0	0	0	0	0	0	2	1	0	0
1991	0	0	0	0	0	0	0	0	0	1	0	0
1992	1	0	0	0	10	0	0	0	2	0	0	0
1993	0	0	2	20	7	0	0	0	2	1	0	0
1994	0	0	1	0	0	0	0	0	0	0	0	0
1995	0	0	0	62	2	102	3	16	3	2	0	0
1996	0	0	0	0	31	3	0	1	0	0	0	0
1997	0	0	18	272	59	0	0	0	0	0	2	0
1998	0	1	1	23	261	35	7	5	22	11	2	0
1999	0	0	1	0	3	0	0	0	0	0	0	0
2000	0	0	0	0	23	1	0	0	1	1	0	0
2001	0	0	0	0	0	0	0	0	0	0	0	0
2002	0	0	4	0	0	0	0	0	0	1	0	0
2003	0	2	15	0	0	0	0	0	0	1	0	0
2004	1	0	6	3	1	0	0	0	1	5	1	0
2005	2	0	1	19	0	0	0	11	3	10	2	0
2006	0	0	21	67	0	10	83	24	11	5	10	0
2007	0	0	0	0	0	0	0	0	0	1	0	0
2008	0	0	0	6	0	0	0	0	1	5	0	0
2009	0	0	2	0	0	0	0	0	3	2	0	0
2010	0	0	0	7	1	0	0	0	0	2	0	0
2011	0	0	21	2	0	34	5	5	6	3	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	3	0	0	0	0	0	2	2	0	0
2014	0	0	0	0	0	0	0	0	1	3	0	0
Maximum	4	14	78	272	261	254	83	24	28	16	10	13
Mean	0	1	7	19	17	15	4	3	3	2	1	0
Minimum	0	0	0	0	0	0	0	0	0	0	0	0

Table 4. Total hours per month gate would have been closed assuming 2070 Sea Level Conditions, Sea Level Rise based on Curve II Rate of Sea Level Rise

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1983	13	71	152	173	297	477	115	114	126	113	99	127
1984	64	88	208	108	16	6	0	2	29	58	41	25
1985	2	20	19	9	0	0	1	0	28	41	18	0
1986	0	9	2	0	7	80	14	16	28	43	26	12
1987	9	6	15	9	9	1	2	17	32	35	44	15
1988	4	3	22	13	1	0	1	2	15	44	40	6
1989	5	6	7	2	1	5	1	11	29	31	19	8
1990	1	3	1	3	0	1	4	10	21	45	40	8
1991	2	3	8	4	1	9	0	4	21	53	27	17
1992	11	1	11	11	55	21	1	20	43	51	28	14
1993	19	2	19	90	75	22	14	29	57	78	31	11
1994	8	4	15	10	13	0	2	8	9	46	10	0
1995	0	2	14	170	59	259	56	106	63	63	46	22
1996	2	1	14	12	146	88	8	27	18	45	20	4
1997	0	2	102	461	152	6	0	17	38	52	54	8
1998	11	39	40	140	451	151	86	74	129	92	64	48
1999	1	8	25	22	67	21	8	14	30	38	14	10
2000	1	0	1	8	98	62	2	10	39	48	29	15
2001	0	0	1	17	3	18	0	21	13	29	16	11
2002	0	1	29	24	1	0	6	10	22	42	39	16
2003	5	17	66	38	18	3	5	19	42	51	44	20
2004	14	1	36	39	36	12	3	27	38	59	46	16
2005	17	11	32	61	34	30	13	60	54	82	59	17
2006	4	2	57	182	22	96	263	139	78	72	74	42
2007	15	8	7	15	5	0	2	16	36	51	35	18
2008	0	3	3	36	10	0	0	27	41	89	65	32
2009	3	6	15	1	15	12	2	28	50	61	38	14
2010	18	8	30	71	40	13	19	11	30	62	27	6
2011	2	10	72	28	20	102	78	53	74	91	32	21
2012	12	7	0	7	2	4	14	12	41	46	39	1
2013	7	11	57	7	1	2	4	5	33	40	14	11
2014	1	0	4	3	3	0	1	5	31	49	29	30
Maximum	64	88	208	461	451	477	263	139	129	113	99	127
Mean	8	11	34	55	52	47	23	29	42	56	38	19
Minimum	0	0	0	0	0	0	0	0	9	29	10	0

Table 5. Total hours per month gate would have been closed assuming 2070 Sea Level Conditions, Sea Level Rise based on Curve III Rate of Sea Level Rise

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1983	150	202	302	319	462	646	288	284	279	265	249	279
1984	205	234	372	267	111	83	31	57	122	198	171	173
1985	69	94	106	71	42	29	37	52	129	147	110	91
1986	45	56	47	67	53	143	84	93	130	153	127	121
1987	86	74	95	63	77	65	42	81	119	147	169	119
1988	83	53	96	76	40	20	37	46	98	156	159	102
1989	66	44	48	26	25	69	44	78	133	147	146	110
1990	51	57	49	57	28	37	59	72	108	171	176	126
1991	78	63	82	63	65	92	26	67	115	179	149	151
1992	107	59	93	93	178	161	87	129	166	180	170	140
1993	120	69	101	228	216	165	102	152	180	223	177	130
1994	98	74	81	80	90	66	44	78	96	175	128	107
1995	65	50	83	327	204	460	188	273	199	213	192	175
1996	103	53	109	103	303	240	91	142	127	177	157	130
1997	63	46	231	624	305	121	53	113	163	193	207	140
1998	134	165	182	298	595	331	240	235	283	248	214	185
1999	61	76	101	119	197	167	76	125	137	165	125	116
2000	51	33	35	80	226	202	76	106	158	171	161	107
2001	83	27	41	83	77	94	33	100	102	164	140	126
2002	73	70	98	114	47	67	62	83	113	167	173	144
2003	91	84	178	158	73	32	69	127	158	178	185	144
2004	110	51	129	140	142	135	54	123	142	196	176	149
2005	115	75	119	179	156	178	112	193	178	219	204	136
2006	81	61	152	337	131	270	451	305	215	208	219	173
2007	127	79	89	89	79	40	45	102	136	177	156	128
2008	0	64	62	147	105	34	39	108	154	235	221	178
2009	66	76	76	48	90	82	57	120	179	187	175	131
2010	116	75	133	197	163	83	122	98	132	180	153	103
2011	66	72	183	132	114	240	220	186	221	235	178	154
2012	107	66	51	65	55	73	107	113	159	182	177	128
2013	97	82	190	75	45	32	68	85	136	181	137	110
2014	62	61	61	53	54	58	72	98	152	197	177	180
Maximum	205	234	372	624	595	646	451	305	283	265	249	279
Mean	88	76	118	149	142	141	97	126	154	188	170	140
Minimum	0	27	35	26	25	20	26	46	96	147	110	91

Water Year 1983

Water Year 1983
Number of Days Each Month the Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	1	0	0	0	0
Nov	14	4	3	0	0
Dec	23	15	10	1	0
Jan	19	13	9	7	0
Feb	28	28	24	12	0
Mar	31	31	31	21	3
Apr	19	14	9	0	0
May	20	15	11	0	0
Jun	22	16	9	0	0
Jul	23	16	8	0	0
Aug	23	8	2	0	0
Sep	30	16	5	0	0

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
10/1/1982	0.0
10/2/1982	0.0
10/3/1982	0.5
10/4/1982	1.3
10/5/1982	1.2
10/6/1982	2.7
10/7/1982	1.2
10/8/1982	0.1
10/9/1982	0.1
10/10/1982	0.3
10/11/1982	0.2
10/12/1982	0.5
10/13/1982	0.4
10/14/1982	0.0
10/15/1982	0.0
10/16/1982	0.5
10/17/1982	0.0
10/18/1982	0.0
10/19/1982	1.1
10/20/1982	0.7
10/21/1982	0.0
10/22/1982	0.0
10/23/1982	0.0
10/24/1982	0.0
10/25/1982	0.0
10/26/1982	0.0
10/27/1982	0.0
10/28/1982	0.0
10/29/1982	0.0
10/30/1982	0.7
10/31/1982	1.2
11/1/1982	1.6
11/2/1982	2.8
11/3/1982	3.0
11/4/1982	3.7
11/5/1982	3.9
11/6/1982	3.1
11/7/1982	2.1
11/8/1982	1.3
11/9/1982	0.7
11/10/1982	2.0
11/11/1982	0.2
11/12/1982	0.0
11/13/1982	1.2
11/14/1982	0.4

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
11/15/1982	1.6
11/16/1982	2.6
11/17/1982	3.5
11/18/1982	6.5
11/19/1982	3.9
11/20/1982	1.5
11/21/1982	0.0
11/22/1982	0.0
11/23/1982	0.0
11/24/1982	0.0
11/25/1982	0.0
11/26/1982	0.0
11/27/1982	2.8
11/28/1982	4.3
11/29/1982	6.7
11/30/1982	11.3
12/1/1982	9.3
12/2/1982	7.5
12/3/1982	5.4
12/4/1982	3.7
12/5/1982	1.7
12/6/1982	0.0
12/7/1982	0.4
12/8/1982	0.0
12/9/1982	1.1
12/10/1982	2.2
12/11/1982	1.6
12/12/1982	2.5
12/13/1982	3.7
12/14/1982	2.7
12/15/1982	3.7
12/16/1982	4.7
12/17/1982	3.8
12/18/1982	2.0
12/19/1982	0.0
12/20/1982	2.3
12/21/1982	4.6
12/22/1982	11.5
12/23/1982	13.8
12/24/1982	4.2
12/25/1982	5.4
12/26/1982	7.0
12/27/1982	8.6
12/28/1982	9.6
12/29/1982	10.1
12/30/1982	10.0
12/31/1982	8.8
1/1/1983	6.5
1/2/1983	4.2
1/3/1983	1.2
1/4/1983	0.0
1/5/1983	0.0
1/6/1983	0.7
1/7/1983	0.3
1/8/1983	0.5
1/9/1983	1.2
1/10/1983	1.1
1/11/1983	1.1
1/12/1983	2.3
1/13/1983	2.5
1/14/1983	2.1
1/15/1983	3.1
1/16/1983	4.2
1/17/1983	3.4
1/18/1983	5.1
1/19/1983	1.4
1/20/1983	0.2
1/21/1983	0.1
1/22/1983	2.8
1/23/1983	4.6

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/24/1983	12.3
1/25/1983	10.2
1/26/1983	12.8
1/27/1983	17.4
1/28/1983	16.2
1/29/1983	18.6
1/30/1983	19.5
1/31/1983	17.6
2/1/1983	15.5
2/2/1983	13.2
2/3/1983	14.7
2/4/1983	13.3
2/5/1983	11.4
2/6/1983	9.0
2/7/1983	11.4
2/8/1983	12.9
2/9/1983	12.4
2/10/1983	12.6
2/11/1983	12.2
2/12/1983	13.2
2/13/1983	12.2
2/14/1983	9.9
2/15/1983	9.5
2/16/1983	7.5
2/17/1983	5.8
2/18/1983	10.4
2/19/1983	5.4
2/20/1983	4.6
2/21/1983	5.4
2/22/1983	6.1
2/23/1983	9.4
2/24/1983	10.8
2/25/1983	10.3
2/26/1983	11.9
2/27/1983	12.2
2/28/1983	13.3
3/1/1983	17.2
3/2/1983	22.0
3/3/1983	24.0
3/4/1983	24.0
3/5/1983	24.0
3/6/1983	19.2
3/7/1983	16.3
3/8/1983	12.2
3/9/1983	11.2
3/10/1983	12.1
3/11/1983	11.0
3/12/1983	11.0
3/13/1983	14.3
3/14/1983	18.0
3/15/1983	19.4
3/16/1983	19.0
3/17/1983	23.2
3/18/1983	21.6
3/19/1983	16.4
3/20/1983	12.8
3/21/1983	12.9
3/22/1983	13.4
3/23/1983	9.6
3/24/1983	14.8
3/25/1983	11.5
3/26/1983	10.5
3/27/1983	11.7
3/28/1983	12.3
3/29/1983	11.2
3/30/1983	10.0
3/31/1983	10.0
4/1/1983	6.5
4/2/1983	7.3
4/3/1983	3.7

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
4/4/1983	0.3
4/5/1983	0.0
4/6/1983	0.0
4/7/1983	0.0
4/8/1983	0.1
4/9/1983	1.6
4/10/1983	1.3
4/11/1983	2.7
4/12/1983	1.9
4/13/1983	1.7
4/14/1983	1.8
4/15/1983	2.9
4/16/1983	3.9
4/17/1983	6.4
4/18/1983	6.1
4/19/1983	4.5
4/20/1983	4.5
4/21/1983	2.6
4/22/1983	1.2
4/23/1983	5.1
4/24/1983	4.8
4/25/1983	5.8
4/26/1983	6.2
4/27/1983	7.2
4/28/1983	8.1
4/29/1983	8.6
4/30/1983	8.9
5/1/1983	6.7
5/2/1983	3.2
5/3/1983	0.0
5/4/1983	0.0
5/5/1983	0.3
5/6/1983	0.3
5/7/1983	0.0
5/8/1983	1.9
5/9/1983	1.2
5/10/1983	3.1
5/11/1983	2.8
5/12/1983	4.6
5/13/1983	6.1
5/14/1983	6.3
5/15/1983	6.0
5/16/1983	4.4
5/17/1983	2.9
5/18/1983	0.9
5/19/1983	0.0
5/20/1983	0.0
5/21/1983	1.2
5/22/1983	4.1
5/23/1983	6.0
5/24/1983	6.8
5/25/1983	6.3
5/26/1983	7.2
5/27/1983	7.7
5/28/1983	8.2
5/29/1983	7.1
5/30/1983	5.1
5/31/1983	3.1
6/1/1983	0.0
6/2/1983	0.0
6/3/1983	0.0
6/4/1983	0.4
6/5/1983	0.8
6/6/1983	1.4
6/7/1983	3.9
6/8/1983	8.8
6/9/1983	7.5
6/10/1983	7.3
6/11/1983	7.8
6/12/1983	7.7

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
6/13/1983	6.7
6/14/1983	7.1
6/15/1983	4.7
6/16/1983	1.7
6/17/1983	2.7
6/18/1983	3.6
6/19/1983	2.8
6/20/1983	4.7
6/21/1983	5.6
6/22/1983	5.8
6/23/1983	6.1
6/24/1983	5.6
6/25/1983	5.8
6/26/1983	6.6
6/27/1983	4.9
6/28/1983	3.1
6/29/1983	2.3
6/30/1983	0.7
7/1/1983	0.0
7/2/1983	0.4
7/3/1983	0.4
7/4/1983	1.5
7/5/1983	3.1
7/6/1983	5.1
7/7/1983	6.2
7/8/1983	6.8
7/9/1983	6.3
7/10/1983	6.0
7/11/1983	6.9
7/12/1983	7.2
7/13/1983	7.0
7/14/1983	6.2
7/15/1983	3.3
7/16/1983	4.6
7/17/1983	4.6
7/18/1983	4.4
7/19/1983	4.8
7/20/1983	4.3
7/21/1983	3.4
7/22/1983	3.6
7/23/1983	4.1
7/24/1983	4.1
7/25/1983	3.8
7/26/1983	2.6
7/27/1983	2.0
7/28/1983	0.0
7/29/1983	0.0
7/30/1983	0.0
7/31/1983	0.0
8/1/1983	0.4
8/2/1983	1.4
8/3/1983	2.0
8/4/1983	2.6
8/5/1983	3.6
8/6/1983	4.0
8/7/1983	5.0
8/8/1983	6.6
8/9/1983	6.5
8/10/1983	5.3
8/11/1983	3.4
8/12/1983	1.4
8/13/1983	3.2
8/14/1983	2.7
8/15/1983	3.0
8/16/1983	3.6
8/17/1983	4.0
8/18/1983	5.6
8/19/1983	4.9
8/20/1983	3.6
8/21/1983	4.2

Water Year 1983 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/22/1983	4.0
8/23/1983	3.3
8/24/1983	2.5
8/25/1983	1.7
8/26/1983	0.0
8/27/1983	0.0
8/28/1983	0.7
8/29/1983	2.0
8/30/1983	3.1
8/31/1983	4.2
9/1/1983	4.3
9/2/1983	4.1
9/3/1983	4.2
9/4/1983	5.5
9/5/1983	6.3
9/6/1983	8.4
9/7/1983	7.4
9/8/1983	6.1
9/9/1983	2.6
9/10/1983	2.1
9/11/1983	2.9
9/12/1983	3.7
9/13/1983	3.7
9/14/1983	2.6
9/15/1983	3.1
9/16/1983	3.6
9/17/1983	3.8
9/18/1983	4.4
9/19/1983	4.0
9/20/1983	2.7
9/21/1983	3.2
9/22/1983	4.2
9/23/1983	2.5
9/24/1983	2.1
9/25/1983	3.4
9/26/1983	5.3
9/27/1983	4.1
9/28/1983	5.2
9/29/1983	6.3
9/30/1983	4.9

Water Year 1984

Water Year 1984
Number of Days Each Month Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	12	9	2	0	0
Nov	16	9	4	0	0
Dec	27	21	18	6	0
Jan	18	12	8	0	0
Feb	4	1	0	0	0
Mar	1	0	0	0	0
Apr	6	0	0	0	0
May	0	0	0	0	0
Jun	8	0	0	0	0
Jul	18	0	0	0	0
Aug	12	0	0	0	0
Sep	4	0	0	0	0

Water Year 1984
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/1983	3.8
10/2/1983	4.6
10/3/1983	5.2
10/4/1983	4.1
10/5/1983	4.2
10/6/1983	4.5
10/7/1983	6.0
10/8/1983	7.3
10/9/1983	6.1
10/10/1983	4.2
10/11/1983	2.3
10/12/1983	1.3
10/13/1983	0.0
10/14/1983	0.0
10/15/1983	0.0
10/16/1983	0.0
10/17/1983	0.0
10/18/1983	0.0
10/19/1983	0.0
10/20/1983	0.0
10/21/1983	0.0
10/22/1983	0.8
10/23/1983	2.5
10/24/1983	1.7
10/25/1983	1.1
10/26/1983	1.4
10/27/1983	1.9
10/28/1983	0.9
10/29/1983	0.0
10/30/1983	0.0
10/31/1983	0.5
11/1/1983	1.4
11/2/1983	1.7
11/3/1983	2.3
11/4/1983	3.6
11/5/1983	3.3
11/6/1983	3.2
11/7/1983	1.3
11/8/1983	0.0
11/9/1983	0.0
11/10/1983	5.5
11/11/1983	0.0
11/12/1983	0.9
11/13/1983	1.5
11/14/1983	0.0
11/15/1983	0.0
11/16/1983	1.7
11/17/1983	5.4

Water Year 1984 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
11/18/1983	3.8
11/19/1983	4.7
11/20/1983	8.6
11/21/1983	7.6
11/22/1983	6.6
11/23/1983	5.0
11/24/1983	7.3
11/25/1983	3.1
11/26/1983	0.0
11/27/1983	0.0
11/28/1983	0.9
11/29/1983	2.7
11/30/1983	5.4
12/1/1983	6.9
12/2/1983	7.3
12/3/1983	12.6
12/4/1983	6.2
12/5/1983	4.0
12/6/1983	3.8
12/7/1983	3.4
12/8/1983	2.4
12/9/1983	6.5
12/10/1983	0.2
12/11/1983	7.8
12/12/1983	0.8
12/13/1983	0.0
12/14/1983	1.3
12/15/1983	3.6
12/16/1983	5.7
12/17/1983	6.8
12/18/1983	7.3
12/19/1983	7.8
12/20/1983	7.6
12/21/1983	7.0
12/22/1983	5.5
12/23/1983	3.9
12/24/1983	3.6
12/25/1983	8.1
12/26/1983	9.6
12/27/1983	13.1
12/28/1983	12.7
12/29/1983	14.6
12/30/1983	15.3
12/31/1983	12.6
1/1/1984	11.8
1/2/1984	10.7
1/3/1984	9.4
1/4/1984	7.5
1/5/1984	6.5
1/6/1984	3.6
1/7/1984	0.8
1/8/1984	0.0
1/9/1984	0.0
1/10/1984	0.0
1/11/1984	0.0
1/12/1984	0.0
1/13/1984	3.7
1/14/1984	4.2
1/15/1984	4.6
1/16/1984	6.8
1/17/1984	7.2
1/18/1984	6.1
1/19/1984	5.9
1/20/1984	4.4
1/21/1984	3.1
1/22/1984	0.4
1/23/1984	0.0
1/24/1984	0.0
1/25/1984	0.0
1/26/1984	1.1

Water Year 1984 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
1/27/1984	0.1
1/28/1984	0.7
1/29/1984	2.1
1/30/1984	2.9
1/31/1984	4.0
2/1/1984	2.9
2/2/1984	1.0
2/3/1984	0.0
2/4/1984	0.0
2/5/1984	0.0
2/6/1984	0.0
2/7/1984	0.0
2/8/1984	0.0
2/9/1984	0.0
2/10/1984	0.0
2/11/1984	0.0
2/12/1984	0.0
2/13/1984	2.1
2/14/1984	1.3
2/15/1984	2.3
2/16/1984	4.0
2/17/1984	1.6
2/18/1984	0.1
2/19/1984	0.0
2/20/1984	0.0
2/21/1984	0.0
2/22/1984	0.0
2/23/1984	0.0
2/24/1984	0.5
2/25/1984	0.0
2/26/1984	0.0
2/27/1984	0.0
2/28/1984	0.0
2/29/1984	0.1
3/1/1984	0.0
3/2/1984	0.0
3/3/1984	0.0
3/4/1984	0.0
3/5/1984	0.0
3/6/1984	0.0
3/7/1984	0.0
3/8/1984	0.0
3/9/1984	0.0
3/10/1984	0.0
3/11/1984	0.0
3/12/1984	0.0
3/13/1984	0.9
3/14/1984	1.2
3/15/1984	2.9
3/16/1984	0.0
3/17/1984	0.0
3/18/1984	0.0
3/19/1984	0.0
3/20/1984	0.0
3/21/1984	0.9
3/22/1984	0.0
3/23/1984	0.0
3/24/1984	0.0
3/25/1984	0.0
3/26/1984	0.0
3/27/1984	0.0
3/28/1984	0.0
3/29/1984	0.0
3/30/1984	0.0
3/31/1984	0.0
4/1/1984	0.0
4/2/1984	0.0
4/3/1984	0.0
4/4/1984	0.0
4/5/1984	0.0

Water Year 1984 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
4/6/1984	0.0
4/7/1984	0.0
4/8/1984	0.0
4/9/1984	0.0
4/10/1984	0.0
4/11/1984	0.0
4/12/1984	0.0
4/13/1984	0.0
4/14/1984	0.0
4/15/1984	0.0
4/16/1984	0.0
4/17/1984	0.0
4/18/1984	0.0
4/19/1984	0.0
4/20/1984	0.0
4/21/1984	0.0
4/22/1984	0.0
4/23/1984	0.0
4/24/1984	0.0
4/25/1984	0.0
4/26/1984	0.0
4/27/1984	0.0
4/28/1984	0.0
4/29/1984	0.0
4/30/1984	0.0
5/1/1984	0.0
5/2/1984	0.0
5/3/1984	0.0
5/4/1984	0.0
5/5/1984	0.0
5/6/1984	0.0
5/7/1984	0.0
5/8/1984	0.0
5/9/1984	0.0
5/10/1984	0.0
5/11/1984	0.0
5/12/1984	0.0
5/13/1984	0.0
5/14/1984	0.0
5/15/1984	0.0
5/16/1984	0.0
5/17/1984	0.1
5/18/1984	0.0
5/19/1984	0.0
5/20/1984	0.0
5/21/1984	0.0
5/22/1984	0.0
5/23/1984	0.0
5/24/1984	0.0
5/25/1984	0.0
5/26/1984	0.0
5/27/1984	0.0
5/28/1984	0.0
5/29/1984	0.5
5/30/1984	1.2
5/31/1984	2.0
6/1/1984	1.8
6/2/1984	2.2
6/3/1984	1.5
6/4/1984	0.9
6/5/1984	0.0
6/6/1984	0.0
6/7/1984	0.0
6/8/1984	0.0
6/9/1984	0.0
6/10/1984	0.0
6/11/1984	0.0
6/12/1984	1.6
6/13/1984	2.0
6/14/1984	2.8

Water Year 1984 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/15/1984	3.4
6/16/1984	2.0
6/17/1984	0.5
6/18/1984	0.0
6/19/1984	0.0
6/20/1984	0.0
6/21/1984	0.0
6/22/1984	0.0
6/23/1984	0.0
6/24/1984	0.0
6/25/1984	0.0
6/26/1984	0.8
6/27/1984	1.3
6/28/1984	3.0
6/29/1984	3.0
6/30/1984	2.4
7/1/1984	2.2
7/2/1984	1.3
7/3/1984	1.6
7/4/1984	0.0
7/5/1984	0.0
7/6/1984	0.1
7/7/1984	1.6
7/8/1984	2.5
7/9/1984	2.4
7/10/1984	2.4
7/11/1984	2.7
7/12/1984	2.9
7/13/1984	3.2
7/14/1984	3.1
7/15/1984	2.2
7/16/1984	0.1
7/17/1984	0.0
7/18/1984	0.0
7/19/1984	0.0
7/20/1984	0.0
7/21/1984	1.7
7/22/1984	2.1
7/23/1984	1.3
7/24/1984	2.8
7/25/1984	3.6
7/26/1984	3.3
7/27/1984	3.2
7/28/1984	3.6
7/29/1984	3.1
7/30/1984	2.5
7/31/1984	2.1
8/1/1984	0.0
8/2/1984	0.0
8/3/1984	0.0
8/4/1984	0.0
8/5/1984	0.0
8/6/1984	1.0
8/7/1984	0.9
8/8/1984	1.6
8/9/1984	2.7
8/10/1984	3.1
8/11/1984	3.7
8/12/1984	1.0
8/13/1984	0.0
8/14/1984	0.0
8/15/1984	0.0
8/16/1984	0.0
8/17/1984	0.0
8/18/1984	0.0
8/19/1984	0.9
8/20/1984	2.7
8/21/1984	2.7
8/22/1984	3.2
8/23/1984	2.9

Water Year 1984 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
8/24/1984	3.2
8/25/1984	3.3
8/26/1984	2.7
8/27/1984	2.5
8/28/1984	1.0
8/29/1984	0.0
8/30/1984	0.0
8/31/1984	0.0
9/1/1984	0.0
9/2/1984	1.3
9/3/1984	1.4
9/4/1984	1.4
9/5/1984	1.9
9/6/1984	2.0
9/7/1984	0.4
9/8/1984	0.0
9/9/1984	0.0
9/10/1984	0.4
9/11/1984	1.6
9/12/1984	0.0
9/13/1984	0.0
9/14/1984	0.2
9/15/1984	0.5
9/16/1984	0.0
9/17/1984	0.0
9/18/1984	1.1
9/19/1984	2.3
9/20/1984	2.4
9/21/1984	2.7
9/22/1984	1.7
9/23/1984	2.5
9/24/1984	0.2
9/25/1984	0.0
9/26/1984	0.0
9/27/1984	0.0
9/28/1984	0.2
9/29/1984	1.1
9/30/1984	0

Water Year 1997

Water Year 1997 Number of Days Each Month Gates Would be Closed for X Hours or Longer.					
Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	18	14	7	0	0
Jan	31	31	31	22	3
Feb	17	13	12	4	0
Mar	0	0	0	0	0
Apr	0	0	0	0	0
May	4	0	0	0	0
Jun	11	0	0	0	0
Jul	28	2	0	0	0
Aug	10	4	0	0	0
Sep	0	0	0	0	0

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
10/1/1996	0.0
10/2/1996	0.0
10/3/1996	0.0
10/4/1996	0.0
10/5/1996	0.0
10/6/1996	0.0
10/7/1996	0.0
10/8/1996	0.0
10/9/1996	0.0
10/10/1996	0.0
10/11/1996	0.0
10/12/1996	0.0
10/13/1996	0.0
10/14/1996	0.0
10/15/1996	0.0
10/16/1996	0.0
10/17/1996	0.0
10/18/1996	0.0
10/19/1996	0.0
10/20/1996	0.0
10/21/1996	0.0
10/22/1996	0.0
10/23/1996	0.0
10/24/1996	0.0
10/25/1996	0.3
10/26/1996	0.0
10/27/1996	0.0
10/28/1996	0.0
10/29/1996	0.0
10/30/1996	0.0
10/31/1996	0.0
11/1/1996	0.0
11/2/1996	0.0
11/3/1996	0.0
11/4/1996	0.0
11/5/1996	0.0
11/6/1996	0.0
11/7/1996	0.0
11/8/1996	0.0
11/9/1996	0.0
11/10/1996	0.0
11/11/1996	0.0
11/12/1996	0.0
11/13/1996	0.0
11/14/1996	0.0
11/15/1996	0.0
11/16/1996	0.0
11/17/1996	0.0
11/18/1996	0.0

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
11/19/1996	0.0
11/20/1996	0.0
11/21/1996	0.0
11/22/1996	1.7
11/23/1996	0.0
11/24/1996	0.0
11/25/1996	0.0
11/26/1996	0.0
11/27/1996	0.0
11/28/1996	0.0
11/29/1996	0.0
11/30/1996	0.0
12/1/1996	0.0
12/2/1996	0.0
12/3/1996	0.0
12/4/1996	0.0
12/5/1996	0.0
12/6/1996	0.0
12/7/1996	0.0
12/8/1996	1.5
12/9/1996	3.5
12/10/1996	6.4
12/11/1996	5.7
12/12/1996	5.3
12/13/1996	4.5
12/14/1996	1.6
12/15/1996	0.0
12/16/1996	0.0
12/17/1996	1.1
12/18/1996	0.7
12/19/1996	2.3
12/20/1996	3.6
12/21/1996	7.7
12/22/1996	10.6
12/23/1996	7.1
12/24/1996	4.9
12/25/1996	4.6
12/26/1996	4.4
12/27/1996	6.3
12/28/1996	3.5
12/29/1996	6.0
12/30/1996	4.2
12/31/1996	6.3
1/1/1997	12.2
1/2/1997	15.9
1/3/1997	24.0
1/4/1997	24.0
1/5/1997	24.0
1/6/1997	21.8
1/7/1997	20.1
1/8/1997	19.9
1/9/1997	19.9
1/10/1997	18.9
1/11/1997	17.5
1/12/1997	15.0
1/13/1997	14.8
1/14/1997	9.6
1/15/1997	8.4
1/16/1997	8.0
1/17/1997	6.5
1/18/1997	6.3
1/19/1997	8.1
1/20/1997	9.8
1/21/1997	9.2
1/22/1997	10.9
1/23/1997	14.4
1/24/1997	13.4
1/25/1997	15.9
1/26/1997	19.2
1/27/1997	18.6

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/28/1997	15.1
1/29/1997	14.4
1/30/1997	12.6
1/31/1997	12.7
2/1/1997	12.8
2/2/1997	11.6
2/3/1997	11.6
2/4/1997	12.4
2/5/1997	12.7
2/6/1997	12.3
2/7/1997	11.7
2/8/1997	11.4
2/9/1997	9.3
2/10/1997	7.7
2/11/1997	8.1
2/12/1997	7.6
2/13/1997	3.7
2/14/1997	2.3
2/15/1997	1.8
2/16/1997	2.7
2/17/1997	4.3
2/18/1997	0.9
2/19/1997	0.9
2/20/1997	1.1
2/21/1997	0.1
2/22/1997	0.7
2/23/1997	0.0
2/24/1997	0.0
2/25/1997	0.0
2/26/1997	0.2
2/27/1997	3.2
2/28/1997	0.8
3/1/1997	0.0
3/2/1997	0.4
3/3/1997	0.0
3/4/1997	0.0
3/5/1997	0.0
3/6/1997	1.9
3/7/1997	1.8
3/8/1997	0.9
3/9/1997	0.0
3/10/1997	0.0
3/11/1997	0.4
3/12/1997	0.6
3/13/1997	0.0
3/14/1997	0.0
3/15/1997	0.0
3/16/1997	0.0
3/17/1997	0.0
3/18/1997	0.0
3/19/1997	0.0
3/20/1997	0.0
3/21/1997	0.0
3/22/1997	0.0
3/23/1997	0.0
3/24/1997	0.0
3/25/1997	0.0
3/26/1997	0.0
3/27/1997	0.0
3/28/1997	0.0
3/29/1997	0.0
3/30/1997	0.0
3/31/1997	0.0
4/1/1997	0.0
4/2/1997	0.0
4/3/1997	0.0
4/4/1997	0.0
4/5/1997	0.0
4/6/1997	0.0
4/7/1997	0.0

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
4/8/1997	0.0
4/9/1997	0.0
4/10/1997	0.0
4/11/1997	0.0
4/12/1997	0.0
4/13/1997	0.0
4/14/1997	0.0
4/15/1997	0.0
4/16/1997	0.0
4/17/1997	0.0
4/18/1997	0.0
4/19/1997	0.0
4/20/1997	0.0
4/21/1997	0.0
4/22/1997	0.0
4/23/1997	0.0
4/24/1997	0.0
4/25/1997	0.0
4/26/1997	0.0
4/27/1997	0.0
4/28/1997	0.0
4/29/1997	0.0
4/30/1997	0.0
5/1/1997	0.0
5/2/1997	0.0
5/3/1997	0.0
5/4/1997	0.0
5/5/1997	0.0
5/6/1997	0.0
5/7/1997	0.0
5/8/1997	0.6
5/9/1997	0.2
5/10/1997	0.0
5/11/1997	0.2
5/12/1997	0.0
5/13/1997	0.0
5/14/1997	0.0
5/15/1997	0.0
5/16/1997	0.0
5/17/1997	0.0
5/18/1997	0.0
5/19/1997	1.1
5/20/1997	2.6
5/21/1997	2.2
5/22/1997	1.9
5/23/1997	1.7
5/24/1997	2.7
5/25/1997	2.3
5/26/1997	1.0
5/27/1997	0.0
5/28/1997	0.0
5/29/1997	0.0
5/30/1997	0.0
5/31/1997	0.0
6/1/1997	0.0
6/2/1997	2.2
6/3/1997	3.6
6/4/1997	2.3
6/5/1997	3.5
6/6/1997	3.4
6/7/1997	3.3
6/8/1997	2.6
6/9/1997	2.3
6/10/1997	0.0
6/11/1997	0.0
6/12/1997	0.0
6/13/1997	0.0
6/14/1997	0.0
6/15/1997	1.9
6/16/1997	0.8

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/17/1997	1.1
6/18/1997	1.4
6/19/1997	1.2
6/20/1997	2.1
6/21/1997	2.5
6/22/1997	2.5
6/23/1997	0.9
6/24/1997	0.0
6/25/1997	0.0
6/26/1997	0.0
6/27/1997	0.0
6/28/1997	0.0
6/29/1997	0.0
6/30/1997	0.7
7/1/1997	0.1
7/2/1997	0.5
7/3/1997	0.3
7/4/1997	1.4
7/5/1997	1.2
7/6/1997	0.6
7/7/1997	0.5
7/8/1997	0.2
7/9/1997	0.0
7/10/1997	0.0
7/11/1997	0.0
7/12/1997	0.0
7/13/1997	0.6
7/14/1997	1.1
7/15/1997	2.3
7/16/1997	1.9
7/17/1997	2.6
7/18/1997	2.9
7/19/1997	3.2
7/20/1997	4.3
7/21/1997	3.5
7/22/1997	2.7
7/23/1997	1.3
7/24/1997	0.0
7/25/1997	0.3
7/26/1997	3.4
7/27/1997	3.4
7/28/1997	3.5
7/29/1997	4.2
7/30/1997	3.8
7/31/1997	2.1
8/1/1997	1.2
8/2/1997	1.0
8/3/1997	1.0
8/4/1997	0.0
8/5/1997	0.0
8/6/1997	0.0
8/7/1997	0.0
8/8/1997	2.8
8/9/1997	3.7
8/10/1997	0.5
8/11/1997	2.0
8/12/1997	3.2
8/13/1997	3.4
8/14/1997	4.1
8/15/1997	4.8
8/16/1997	5.8
8/17/1997	4.9
8/18/1997	3.9
8/19/1997	2.5
8/20/1997	1.3
8/21/1997	0.0
8/22/1997	0.6
8/23/1997	0.3
8/24/1997	0.3
8/25/1997	1.2

Water Year 1997 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
8/26/1997	1.2
8/27/1997	1.2
8/28/1997	1.8
8/29/1997	0.9
8/30/1997	0.0
8/31/1997	0.0
9/1/1997	0.0
9/2/1997	0.0
9/3/1997	0.0
9/4/1997	1.3
9/5/1997	0.0
9/6/1997	0.0
9/7/1997	0.0
9/8/1997	0.0
9/9/1997	0.3
9/10/1997	0.4
9/11/1997	0.4
9/12/1997	0.3
9/13/1997	0.7
9/14/1997	0.4
9/15/1997	0.0
9/16/1997	0.0
9/17/1997	0.0
9/18/1997	0.0
9/19/1997	0.0
9/20/1997	0.8
9/21/1997	1.2
9/22/1997	0.3
9/23/1997	0.1
9/24/1997	0.5
9/25/1997	0.8
9/26/1997	0.9
9/27/1997	0.0
9/28/1997	0.0
9/29/1997	0.0
9/30/1997	0.0

Water Year 1998

Water Year 1998
Number of Days Each Month Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	2	0	0	0	0
Nov	9	2	1	0	0
Dec	9	1	0	0	0
Jan	26	19	7	0	0
Feb	28	28	28	20	2
Mar	24	14	13	0	0
Apr	61	33	12	0	0
May	16	7	1	0	0
Jun	27	16	8	0	0
Jul	20	10	2	0	0
Aug	14	7	0	0	0
Sep	14	3	0	0	0

Water Year 1998
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/1997	1.3
10/2/1997	0.0
10/3/1997	0.0
10/4/1997	0.0
10/5/1997	0.0
10/6/1997	2.3
10/7/1997	0.0
10/8/1997	0.0
10/9/1997	0.0
10/10/1997	0.2
10/11/1997	0.5
10/12/1997	0.0
10/13/1997	0.0
10/14/1997	0.0
10/15/1997	0.0
10/16/1997	0.0
10/17/1997	0.8
10/18/1997	1.7
10/19/1997	2.2
10/20/1997	1.2
10/21/1997	0.9
10/22/1997	0.0
10/23/1997	0.0
10/24/1997	0.0
10/25/1997	0.0
10/26/1997	0.0
10/27/1997	0.0
10/28/1997	0.0
10/29/1997	0.0
10/30/1997	0.0
10/31/1997	0.0
11/1/1997	0.0
11/2/1997	0.0
11/3/1997	0.3
11/4/1997	0.9
11/5/1997	1.8
11/6/1997	1.6
11/7/1997	0.0
11/8/1997	0.0
11/9/1997	0.0
11/10/1997	0.3
11/11/1997	2.0
11/12/1997	2.5
11/13/1997	4.8
11/14/1997	3.5
11/15/1997	3.2
11/16/1997	2.8
11/17/1997	1.9
11/18/1997	0.0

Water Year 1998 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
11/19/1997	0.1
11/20/1997	0.0
11/21/1997	0.0
11/22/1997	0.0
11/23/1997	0.0
11/24/1997	0.0
11/25/1997	0.0
11/26/1997	6.4
11/27/1997	1.1
11/28/1997	1.0
11/29/1997	2.2
11/30/1997	2.9
12/1/1997	3.0
12/2/1997	2.9
12/3/1997	2.1
12/4/1997	1.4
12/5/1997	0.0
12/6/1997	0.3
12/7/1997	3.3
12/8/1997	2.4
12/9/1997	0.2
12/10/1997	0.0
12/11/1997	0.0
12/12/1997	0.0
12/13/1997	1.7
12/14/1997	4.6
12/15/1997	3.4
12/16/1997	1.6
12/17/1997	0.7
12/18/1997	1.1
12/19/1997	0.0
12/20/1997	0.0
12/21/1997	0.0
12/22/1997	0.0
12/23/1997	0.0
12/24/1997	0.1
12/25/1997	0.0
12/26/1997	1.0
12/27/1997	0.9
12/28/1997	1.1
12/29/1997	1.9
12/30/1997	2.7
12/31/1997	3.2
1/1/1998	3.4
1/2/1998	4.5
1/3/1998	2.0
1/4/1998	2.9
1/5/1998	0.2
1/6/1998	0.0
1/7/1998	1.0
1/8/1998	2.2
1/9/1998	3.4
1/10/1998	5.2
1/11/1998	4.3
1/12/1998	6.0
1/13/1998	4.9
1/14/1998	4.3
1/15/1998	5.4
1/16/1998	3.5
1/17/1998	2.0
1/18/1998	2.8
1/19/1998	5.6
1/20/1998	5.1
1/21/1998	4.8
1/22/1998	3.9
1/23/1998	4.6
1/24/1998	5.4
1/25/1998	6.0
1/26/1998	7.0
1/27/1998	8.1

Water Year 1998 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/28/1998	7.7
1/29/1998	9.0
1/30/1998	7.2
1/31/1998	7.5
2/1/1998	7.6
2/2/1998	9.0
2/3/1998	19.0
2/4/1998	19.5
2/5/1998	20.1
2/6/1998	22.8
2/7/1998	24.0
2/8/1998	24.0
2/9/1998	22.3
2/10/1998	21.5
2/11/1998	20.7
2/12/1998	18.1
2/13/1998	16.9
2/14/1998	16.8
2/15/1998	21.1
2/16/1998	14.4
2/17/1998	16.8
2/18/1998	11.0
2/19/1998	8.7
2/20/1998	10.3
2/21/1998	13.6
2/22/1998	11.8
2/23/1998	16.6
2/24/1998	16.4
2/25/1998	13.7
2/26/1998	13.0
2/27/1998	11.9
2/28/1998	9.7
3/1/1998	8.6
3/2/1998	9.2
3/3/1998	9.6
3/4/1998	7.0
3/5/1998	6.5
3/6/1998	7.0
3/7/1998	3.8
3/8/1998	3.2
3/9/1998	2.3
3/10/1998	2.1
3/11/1998	2.6
3/12/1998	3.8
3/13/1998	3.8
3/14/1998	3.1
3/15/1998	1.6
3/16/1998	2.7
3/17/1998	1.6
3/18/1998	1.4
3/19/1998	1.0
3/20/1998	1.7
3/21/1998	0.4
3/22/1998	0.8
3/23/1998	3.3
3/24/1998	4.6
3/25/1998	7.2
3/26/1998	8.0
3/27/1998	8.4
3/28/1998	9.6
3/29/1998	8.8
3/30/1998	8.3
3/31/1998	9.0
4/1/1998	8.5
4/2/1998	6.0
4/3/1998	3.9
4/4/1998	3.4
4/5/1998	3.1
4/6/1998	2.7
4/7/1998	1.7

Water Year 1998 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
4/8/1998	0.0
4/9/1998	0.6
4/10/1998	3.3
4/11/1998	4.8
4/12/1998	4.5
4/13/1998	2.6
4/14/1998	2.1
4/15/1998	1.9
4/16/1998	0.5
4/17/1998	0.0
4/18/1998	0.0
4/19/1998	0.0
4/20/1998	0.0
4/21/1998	0.0
4/22/1998	0.0
4/23/1998	4.1
4/24/1998	3.9
4/25/1998	4.0
4/26/1998	3.5
4/27/1998	4.4
4/28/1998	5.2
4/29/1998	5.2
4/30/1998	6.4
5/1/1998	3.9
5/2/1998	1.2
5/3/1998	0.3
5/4/1998	0.0
5/5/1998	0.2
5/6/1998	1.1
5/7/1998	1.4
5/8/1998	1.9
5/9/1998	2.0
5/10/1998	1.2
5/11/1998	2.1
5/12/1998	2.9
5/13/1998	4.0
5/14/1998	3.1
5/15/1998	2.1
5/16/1998	3.1
5/17/1998	0.0
5/18/1998	0.0
5/19/1998	0.0
5/20/1998	0.9
5/21/1998	1.1
5/22/1998	1.5
5/23/1998	3.5
5/24/1998	4.8
5/25/1998	5.7
5/26/1998	6.3
5/27/1998	5.3
5/28/1998	5.2
5/29/1998	4.7
5/30/1998	2.9
5/31/1998	1.4
6/1/1998	2.2
6/2/1998	2.5
6/3/1998	2.4
6/4/1998	2.8
6/5/1998	3.6
6/6/1998	5.1
6/7/1998	6.0
6/8/1998	4.7
6/9/1998	5.7
6/10/1998	6.2
6/11/1998	6.2
6/12/1998	5.9
6/13/1998	4.5
6/14/1998	3.0
6/15/1998	0.8
6/16/1998	2.2

Water Year 1998 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/17/1998	3.4
6/18/1998	3.6
6/19/1998	4.8
6/20/1998	6.8
6/21/1998	7.8
6/22/1998	7.6
6/23/1998	7.1
6/24/1998	7.0
6/25/1998	7.2
6/26/1998	4.8
6/27/1998	2.7
6/28/1998	2.2
6/29/1998	0.0
6/30/1998	0.0
7/1/1998	0.0
7/2/1998	0.0
7/3/1998	0.2
7/4/1998	1.3
7/5/1998	2.9
7/6/1998	4.0
7/7/1998	3.8
7/8/1998	5.2
7/9/1998	6.0
7/10/1998	5.5
7/11/1998	3.7
7/12/1998	2.3
7/13/1998	2.1
7/14/1998	0.4
7/15/1998	0.1
7/16/1998	2.3
7/17/1998	3.3
7/18/1998	3.7
7/19/1998	4.4
7/20/1998	5.8
7/21/1998	6.3
7/22/1998	5.7
7/23/1998	6.2
7/24/1998	6.0
7/25/1998	4.6
7/26/1998	3.5
7/27/1998	1.8
7/28/1998	0.4
7/29/1998	0.1
7/30/1998	0.1
7/31/1998	0.0
8/1/1998	0.0
8/2/1998	0.4
8/3/1998	1.0
8/4/1998	2.9
8/5/1998	4.2
8/6/1998	5.5
8/7/1998	5.2
8/8/1998	4.4
8/9/1998	3.2
8/10/1998	1.8
8/11/1998	0.7
8/12/1998	1.2
8/13/1998	2.6
8/14/1998	4.1
8/15/1998	4.6
8/16/1998	4.4
8/17/1998	3.7
8/18/1998	3.4
8/19/1998	3.3
8/20/1998	2.9
8/21/1998	1.7
8/22/1998	0.9
8/23/1998	0.4
8/24/1998	0.0
8/25/1998	0.2

Water Year 1998 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
8/26/1998	0.0
8/27/1998	0.0
8/28/1998	0.0
8/29/1998	0.0
8/30/1998	0.1
8/31/1998	0.8
9/1/1998	1.0
9/2/1998	3.2
9/3/1998	4.1
9/4/1998	4.0
9/5/1998	4.0
9/6/1998	3.2
9/7/1998	2.4
9/8/1998	3.0
9/9/1998	2.1
9/10/1998	1.7
9/11/1998	1.9
9/12/1998	2.1
9/13/1998	2.2
9/14/1998	2.7
9/15/1998	3.9
9/16/1998	3.6
9/17/1998	2.5
9/18/1998	0.6
9/19/1998	0.0
9/20/1998	0.0
9/21/1998	0.0
9/22/1998	0.0
9/23/1998	0.0
9/24/1998	0.0
9/25/1998	0.0
9/26/1998	0.0
9/27/1998	0.0
9/28/1998	0.0
9/29/1998	0.0
9/30/1998	0.0

Water Year 2002

Water Year 2002
Number of Days Each Month Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	6	3	1	0	0
Jan	4	1	0	0	0
Feb	0	0	0	0	0
Mar	0	0	0	0	0
Apr	1	0	0	0	0
May	3	0	0	0	0
Jun	5	0	0	0	0
Jul	8	3	0	0	0
Aug	10	0	0	0	0
Sep	1	0	0	0	0

Water Year 2002
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/2001	0.0
10/2/2001	0.0
10/3/2001	0.0
10/4/2001	0.0
10/5/2001	0.0
10/6/2001	0.0
10/7/2001	0.0
10/8/2001	0.0
10/9/2001	0.0
10/10/2001	0.0
10/11/2001	0.0
10/12/2001	0.0
10/13/2001	0.0
10/14/2001	0.0
10/15/2001	0.0
10/16/2001	0.0
10/17/2001	0.0
10/18/2001	0.0
10/19/2001	0.0
10/20/2001	0.0
10/21/2001	0.0
10/22/2001	0.0
10/23/2001	0.0
10/24/2001	0.0
10/25/2001	0.0
10/26/2001	0.0
10/27/2001	0.0
10/28/2001	0.0
10/29/2001	0.0
10/30/2001	0.0
10/31/2001	0.0
11/1/2001	0.0
11/2/2001	0.0
11/3/2001	0.0
11/4/2001	0.0
11/5/2001	0.0
11/6/2001	0.0
11/7/2001	0.0
11/8/2001	0.0
11/9/2001	0.0
11/10/2001	0.0
11/11/2001	0.0
11/12/2001	0.0
11/13/2001	0.0
11/14/2001	0.0
11/15/2001	0.0
11/16/2001	0.5

Water Year 2002 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
11/17/2001	0.0
11/18/2001	0.0
11/19/2001	0.0
11/20/2001	0.0
11/21/2001	0.0
11/22/2001	0.0
11/23/2001	0.0
11/24/2001	0.0
11/25/2001	0.0
11/26/2001	0.0
11/27/2001	0.0
11/28/2001	0.0
11/29/2001	0.6
11/30/2001	0.2
12/1/2001	2.7
12/2/2001	6.9
12/3/2001	3.9
12/4/2001	0.5
12/5/2001	0.0
12/6/2001	0.0
12/7/2001	0.0
12/8/2001	0.0
12/9/2001	0.0
12/10/2001	0.0
12/11/2001	0.0
12/12/2001	0.0
12/13/2001	0.0
12/14/2001	1.7
12/15/2001	0.0
12/16/2001	0.0
12/17/2001	0.0
12/18/2001	0.0
12/19/2001	0.0
12/20/2001	0.0
12/21/2001	0.0
12/22/2001	0.0
12/23/2001	0.0
12/24/2001	0.0
12/25/2001	0.0
12/26/2001	0.0
12/27/2001	0.0
12/28/2001	1.2
12/29/2001	3.5
12/30/2001	4.2
12/31/2001	4.8
1/1/2002	3.9
1/2/2002	4.3
1/3/2002	0.5
1/4/2002	0.0
1/5/2002	0.0
1/6/2002	0.0
1/7/2002	0.2
1/8/2002	2.6
1/9/2002	3.7
1/10/2002	1.7
1/11/2002	0.3
1/12/2002	0.8
1/13/2002	0.7
1/14/2002	0.5
1/15/2002	0.0
1/16/2002	0.0
1/17/2002	0.0
1/18/2002	0.0
1/19/2002	0.0
1/20/2002	0.0
1/21/2002	0.0
1/22/2002	0.0
1/23/2002	0.0
1/24/2002	0.0
1/25/2002	0.0

Water Year 2002 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/26/2002	1.7
1/27/2002	1.4
1/28/2002	1.5
1/29/2002	0.0
1/30/2002	0.0
1/31/2002	0.0
2/1/2002	0.0
2/2/2002	0.0
2/3/2002	0.0
2/4/2002	0.0
2/5/2002	0.0
2/6/2002	0.0
2/7/2002	0.0
2/8/2002	0.0
2/9/2002	0.0
2/10/2002	0.0
2/11/2002	0.0
2/12/2002	0.0
2/13/2002	0.0
2/14/2002	0.0
2/15/2002	0.0
2/16/2002	0.0
2/17/2002	0.0
2/18/2002	0.0
2/19/2002	0.0
2/20/2002	0.0
2/21/2002	0.0
2/22/2002	0.0
2/23/2002	0.9
2/24/2002	0.0
2/25/2002	0.0
2/26/2002	0.0
2/27/2002	0.0
2/28/2002	0.0
3/1/2002	0.0
3/2/2002	0.0
3/3/2002	0.0
3/4/2002	0.0
3/5/2002	0.0
3/6/2002	0.0
3/7/2002	0.0
3/8/2002	0.0
3/9/2002	0.0
3/10/2002	0.0
3/11/2002	0.0
3/12/2002	0.0
3/13/2002	0.0
3/14/2002	0.0
3/15/2002	0.0
3/16/2002	0.0
3/17/2002	0.0
3/18/2002	0.0
3/19/2002	0.0
3/20/2002	0.0
3/21/2002	0.0
3/22/2002	0.0
3/23/2002	0.0
3/24/2002	0.0
3/25/2002	0.0
3/26/2002	0.0
3/27/2002	0.0
3/28/2002	0.0
3/29/2002	0.0
3/30/2002	0.0
3/31/2002	0.0
4/1/2002	0.0
4/2/2002	1.8
4/3/2002	1.9
4/4/2002	0.0
4/5/2002	0.0

Water Year 2002 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
4/6/2002	0.0
4/7/2002	0.0
4/8/2002	0.0
4/9/2002	0.0
4/10/2002	0.0
4/11/2002	0.0
4/12/2002	0.0
4/13/2002	0.0
4/14/2002	0.0
4/15/2002	2.2
4/16/2002	0.0
4/17/2002	0.0
4/18/2002	0.0
4/19/2002	0.0
4/20/2002	0.0
4/21/2002	0.0
4/22/2002	0.0
4/23/2002	0.0
4/24/2002	0.0
4/25/2002	0.0
4/26/2002	0.0
4/27/2002	0.0
4/28/2002	0.0
4/29/2002	0.3
4/30/2002	0.0
5/1/2002	0.0
5/2/2002	0.0
5/3/2002	0.0
5/4/2002	0.0
5/5/2002	0.0
5/6/2002	0.0
5/7/2002	0.0
5/8/2002	0.0
5/9/2002	0.0
5/10/2002	0.0
5/11/2002	0.0
5/12/2002	0.0
5/13/2002	0.0
5/14/2002	0.0
5/15/2002	0.2
5/16/2002	0.7
5/17/2002	0.0
5/18/2002	0.0
5/19/2002	0.0
5/20/2002	0.0
5/21/2002	0.0
5/22/2002	0.0
5/23/2002	0.0
5/24/2002	0.0
5/25/2002	0.3
5/26/2002	2.2
5/27/2002	2.7
5/28/2002	2.3
5/29/2002	1.3
5/30/2002	0.3
5/31/2002	0.1
6/1/2002	0.0
6/2/2002	0.0
6/3/2002	0.0
6/4/2002	0.0
6/5/2002	0.0
6/6/2002	0.0
6/7/2002	0.0
6/8/2002	0.0
6/9/2002	0.6
6/10/2002	0.0
6/11/2002	0.7
6/12/2002	3.9
6/13/2002	3.1
6/14/2002	1.6

Water Year 2002 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/15/2002	0.0
6/16/2002	0.0
6/17/2002	0.0
6/18/2002	0.0
6/19/2002	0.0
6/20/2002	0.0
6/21/2002	0.2
6/22/2002	0.3
6/23/2002	0.9
6/24/2002	2.0
6/25/2002	2.6
6/26/2002	3.4
6/27/2002	2.0
6/28/2002	0.9
6/29/2002	0.0
6/30/2002	0.0
7/1/2002	0.0
7/2/2002	0.0
7/3/2002	0.0
7/4/2002	0.0
7/5/2002	0.0
7/6/2002	0.0
7/7/2002	1.0
7/8/2002	1.5
7/9/2002	0.9
7/10/2002	2.0
7/11/2002	3.5
7/12/2002	3.8
7/13/2002	2.8
7/14/2002	0.6
7/15/2002	0.0
7/16/2002	0.0
7/17/2002	0.0
7/18/2002	0.0
7/19/2002	0.6
7/20/2002	2.1
7/21/2002	5.3
7/22/2002	5.1
7/23/2002	4.1
7/24/2002	3.0
7/25/2002	1.6
7/26/2002	1.3
7/27/2002	1.4
7/28/2002	1.4
7/29/2002	0.0
7/30/2002	0.0
7/31/2002	0.0
8/1/2002	0.0
8/2/2002	1.7
8/3/2002	2.6
8/4/2002	3.1
8/5/2002	1.7
8/6/2002	2.7
8/7/2002	2.1
8/8/2002	1.7
8/9/2002	1.0
8/10/2002	0.9
8/11/2002	0.5
8/12/2002	0.0
8/13/2002	0.0
8/14/2002	0.8
8/15/2002	2.5
8/16/2002	2.8
8/17/2002	3.1
8/18/2002	3.3
8/19/2002	3.2
8/20/2002	2.8
8/21/2002	1.1
8/22/2002	0.7
8/23/2002	0.0

Water Year 2002 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/24/2002	0.0
8/25/2002	0.0
8/26/2002	0.0
8/27/2002	0.0
8/28/2002	0.5
8/29/2002	0.0
8/30/2002	0.0
8/31/2002	0.0
9/1/2002	0.1
9/2/2002	0.2
9/3/2002	1.1
9/4/2002	2.0
9/5/2002	1.5
9/6/2002	1.0
9/7/2002	0.1
9/8/2002	0.0
9/9/2002	0.0
9/10/2002	0.0
9/11/2002	0.0
9/12/2002	1.2
9/13/2002	1.6
9/14/2002	1.0
9/15/2002	1.0
9/16/2002	0.9
9/17/2002	0.0
9/18/2002	0.0
9/19/2002	0.0
9/20/2002	0.0
9/21/2002	0.0
9/22/2002	0.0
9/23/2002	0.0
9/24/2002	0.0
9/25/2002	0.0
9/26/2002	1.7
9/27/2002	1.0
9/28/2002	0.5
9/29/2002	1.0
9/30/2002	0.0

Water Year 2003

Water Year 2003
Number of Days Each Month Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	1	0	0	0	0
Nov	4	1	1	0	0
Dec	11	7	5	0	0
Jan	9	2	0	0	0
Feb	4	1	0	0	0
Mar	1	0	0	0	0
Apr	1	0	0	0	0
May	4	0	0	0	0
Jun	11	1	0	0	0
Jul	12	4	0	0	0
Aug	9	1	0	0	0
Sep	4	0	0	0	0

Water Year 2003
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/2002	0.0
10/2/2002	0.0
10/3/2002	0.0
10/4/2002	0.0
10/5/2002	0.0
10/6/2002	0.0
10/7/2002	0.0
10/8/2002	0.0
10/9/2002	1.3
10/10/2002	2.5
10/11/2002	0.0
10/12/2002	0.0
10/13/2002	0.0
10/14/2002	0.0
10/15/2002	0.0
10/16/2002	0.0
10/17/2002	0.0
10/18/2002	0.0
10/19/2002	0.0
10/20/2002	0.0
10/21/2002	0.0
10/22/2002	0.0
10/23/2002	0.0
10/24/2002	0.0
10/25/2002	0.0
10/26/2002	1.0
10/27/2002	0.0
10/28/2002	0.0
10/29/2002	0.0
10/30/2002	0.0
10/31/2002	0.0
11/1/2002	0.0
11/2/2002	0.0
11/3/2002	0.0
11/4/2002	0.0
11/5/2002	0.0
11/6/2002	1.1
11/7/2002	2.4
11/8/2002	6.5
11/9/2002	3.4
11/10/2002	0.0
11/11/2002	0.0
11/12/2002	0.0
11/13/2002	0.0
11/14/2002	0.0
11/15/2002	0.0
11/16/2002	0.0
11/17/2002	0.0

Water Year 2003 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
11/18/2002	0.0
11/19/2002	0.0
11/20/2002	0.0
11/21/2002	0.0
11/22/2002	2.0
11/23/2002	1.2
11/24/2002	0.0
11/25/2002	0.0
11/26/2002	0.0
11/27/2002	0.0
11/28/2002	0.0
11/29/2002	0.0
11/30/2002	0.0
12/1/2002	0.0
12/2/2002	0.6
12/3/2002	0.9
12/4/2002	0.7
12/5/2002	1.2
12/6/2002	2.3
12/7/2002	0.9
12/8/2002	0.0
12/9/2002	0.0
12/10/2002	0.0
12/11/2002	0.0
12/12/2002	0.0
12/13/2002	0.0
12/14/2002	0.0
12/15/2002	1.6
12/16/2002	9.9
12/17/2002	6.6
12/18/2002	3.1
12/19/2002	6.3
12/20/2002	6.3
12/21/2002	5.4
12/22/2002	3.9
12/23/2002	1.5
12/24/2002	0.0
12/25/2002	0.0
12/26/2002	0.0
12/27/2002	0.0
12/28/2002	0.1
12/29/2002	4.5
12/30/2002	3.2
12/31/2002	7.0
1/1/2003	4.7
1/2/2003	4.2
1/3/2003	3.9
1/4/2003	3.6
1/5/2003	1.9
1/6/2003	0.0
1/7/2003	0.0
1/8/2003	0.0
1/9/2003	0.0
1/10/2003	0.0
1/11/2003	0.0
1/12/2003	0.0
1/13/2003	0.0
1/14/2003	0.9
1/15/2003	0.9
1/16/2003	1.0
1/17/2003	2.4
1/18/2003	2.6
1/19/2003	2.0
1/20/2003	2.2
1/21/2003	0.0
1/22/2003	0.0
1/23/2003	0.0
1/24/2003	0.0
1/25/2003	0.0
1/26/2003	0.0

Water Year 2003 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/27/2003	1.5
1/28/2003	2.0
1/29/2003	1.9
1/30/2003	1.3
1/31/2003	1.1
2/1/2003	3.3
2/2/2003	0.0
2/3/2003	0.0
2/4/2003	0.0
2/5/2003	0.0
2/6/2003	0.0
2/7/2003	0.0
2/8/2003	0.0
2/9/2003	0.0
2/10/2003	0.0
2/11/2003	0.1
2/12/2003	1.6
2/13/2003	4.0
2/14/2003	3.8
2/15/2003	3.2
2/16/2003	1.9
2/17/2003	0.0
2/18/2003	0.0
2/19/2003	0.0
2/20/2003	0.0
2/21/2003	0.0
2/22/2003	0.0
2/23/2003	0.0
2/24/2003	0.0
2/25/2003	0.0
2/26/2003	0.0
2/27/2003	0.0
2/28/2003	0.0
3/1/2003	0.0
3/2/2003	0.0
3/3/2003	0.0
3/4/2003	0.0
3/5/2003	0.0
3/6/2003	0.0
3/7/2003	0.0
3/8/2003	0.0
3/9/2003	0.0
3/10/2003	0.0
3/11/2003	0.0
3/12/2003	0.0
3/13/2003	0.0
3/14/2003	0.0
3/15/2003	2.8
3/16/2003	0.0
3/17/2003	0.0
3/18/2003	0.0
3/19/2003	0.0
3/20/2003	0.0
3/21/2003	0.0
3/22/2003	0.0
3/23/2003	0.0
3/24/2003	0.0
3/25/2003	0.0
3/26/2003	0.0
3/27/2003	0.0
3/28/2003	0.0
3/29/2003	0.0
3/30/2003	0.0
3/31/2003	0.0
4/1/2003	0.0
4/2/2003	0.0
4/3/2003	0.0
4/4/2003	0.0
4/5/2003	0.0
4/6/2003	0.0

Water Year 2003 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
4/7/2003	0.0
4/8/2003	0.0
4/9/2003	0.0
4/10/2003	0.0
4/11/2003	0.0
4/12/2003	0.0
4/13/2003	0.0
4/14/2003	0.0
4/15/2003	0.0
4/16/2003	0.0
4/17/2003	0.0
4/18/2003	0.7
4/19/2003	0.1
4/20/2003	1.0
4/21/2003	2.9
4/22/2003	0.0
4/23/2003	0.0
4/24/2003	0.0
4/25/2003	0.0
4/26/2003	0.0
4/27/2003	0.0
4/28/2003	0.0
4/29/2003	0.0
4/30/2003	0.0
5/1/2003	0.0
5/2/2003	0.0
5/3/2003	1.4
5/4/2003	2.3
5/5/2003	0.2
5/6/2003	0.0
5/7/2003	0.0
5/8/2003	0.0
5/9/2003	0.0
5/10/2003	0.0
5/11/2003	0.0
5/12/2003	0.0
5/13/2003	0.0
5/14/2003	1.4
5/15/2003	2.3
5/16/2003	1.7
5/17/2003	2.8
5/18/2003	2.4
5/19/2003	1.1
5/20/2003	0.3
5/21/2003	0.0
5/22/2003	0.0
5/23/2003	0.0
5/24/2003	0.0
5/25/2003	0.0
5/26/2003	0.0
5/27/2003	0.0
5/28/2003	0.0
5/29/2003	0.0
5/30/2003	1.7
5/31/2003	1.0
6/1/2003	1.1
6/2/2003	1.3
6/3/2003	1.8
6/4/2003	4.9
6/5/2003	2.7
6/6/2003	0.5
6/7/2003	0.0
6/8/2003	0.0
6/9/2003	0.0
6/10/2003	1.1
6/11/2003	1.2
6/12/2003	2.3
6/13/2003	2.9
6/14/2003	3.4
6/15/2003	3.1

Water Year 2003 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
6/16/2003	3.1
6/17/2003	3.0
6/18/2003	1.6
6/19/2003	0.0
6/20/2003	0.0
6/21/2003	0.0
6/22/2003	0.0
6/23/2003	0.0
6/24/2003	0.0
6/25/2003	0.0
6/26/2003	0.0
6/27/2003	0.3
6/28/2003	2.0
6/29/2003	3.0
6/30/2003	2.7
7/1/2003	1.8
7/2/2003	1.1
7/3/2003	0.5
7/4/2003	0.0
7/5/2003	0.0
7/6/2003	0.0
7/7/2003	0.0
7/8/2003	0.0
7/9/2003	0.0
7/10/2003	0.8
7/11/2003	1.9
7/12/2003	3.1
7/13/2003	3.5
7/14/2003	2.6
7/15/2003	2.7
7/16/2003	1.7
7/17/2003	0.0
7/18/2003	0.0
7/19/2003	0.0
7/20/2003	0.0
7/21/2003	0.0
7/22/2003	0.4
7/23/2003	1.3
7/24/2003	2.2
7/25/2003	3.6
7/26/2003	4.3
7/27/2003	3.3
7/28/2003	4.2
7/29/2003	4.8
7/30/2003	4.8
7/31/2003	2.7
8/1/2003	0.3
8/2/2003	0.0
8/3/2003	0.0
8/4/2003	0.9
8/5/2003	1.2
8/6/2003	3.1
8/7/2003	3.5
8/8/2003	3.8
8/9/2003	4.3
8/10/2003	3.5
8/11/2003	3.0
8/12/2003	2.2
8/13/2003	0.9
8/14/2003	0.0
8/15/2003	0.0
8/16/2003	0.0
8/17/2003	0.0
8/18/2003	0.0
8/19/2003	1.1
8/20/2003	1.7
8/21/2003	2.0
8/22/2003	2.0
8/23/2003	1.6
8/24/2003	1.9

Water Year 2003 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/25/2003	1.5
8/26/2003	2.7
8/27/2003	1.6
8/28/2003	0.7
8/29/2003	0.0
8/30/2003	0.0
8/31/2003	0.0
9/1/2003	0.9
9/2/2003	2.0
9/3/2003	3.2
9/4/2003	3.3
9/5/2003	3.2
9/6/2003	2.7
9/7/2003	1.5
9/8/2003	1.0
9/9/2003	0.2
9/10/2003	0.0
9/11/2003	0.0
9/12/2003	0.0
9/13/2003	0.0
9/14/2003	0.0
9/15/2003	0.0
9/16/2003	0.0
9/17/2003	0.0
9/18/2003	0.0
9/19/2003	0.0
9/20/2003	0.0
9/21/2003	0.0
9/22/2003	0.0
9/23/2003	0.5
9/24/2003	1.3
9/25/2003	0.0
9/26/2003	0.0
9/27/2003	0.0
9/28/2003	0.0
9/29/2003	0.0
9/30/2003	0.7

Water Year 2004

Water Year 2004
Number of Days Each Month that Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	3	1	0	0	0
Nov	0	0	0	0	0
Dec	6	3	1	0	0
Jan	8	2	1	0	0
Feb	7	1	1	0	0
Mar	2	0	0	0	0
Apr	0	0	0	0	0
May	7	0	0	0	0
Jun	9	2	0	0	0
Jul	11	8	0	0	0
Aug	14	1	0	0	0
Sep	1	0	0	0	0

Water Year 2004
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/2003	0.8
10/2/2003	1.3
10/3/2003	0.6
10/4/2003	0.6
10/5/2003	0.0
10/6/2003	0.0
10/7/2003	0.0
10/8/2003	0.0
10/9/2003	0.0
10/10/2003	0.0
10/11/2003	0.0
10/12/2003	0.0
10/13/2003	0.0
10/14/2003	0.0
10/15/2003	0.0
10/16/2003	0.0
10/17/2003	0.0
10/18/2003	0.0
10/19/2003	0.0
10/20/2003	0.0
10/21/2003	0.0
10/22/2003	0.0
10/23/2003	0.0
10/24/2003	0.0
10/25/2003	0.0
10/26/2003	0.0
10/27/2003	0.6
10/28/2003	2.4
10/29/2003	5.1
10/30/2003	2.7
10/31/2003	0.0
11/1/2003	0.0
11/2/2003	0.0
11/3/2003	0.0
11/4/2003	0.0
11/5/2003	0.0
11/6/2003	0.0
11/7/2003	0.0
11/8/2003	0.0
11/9/2003	0.0
11/10/2003	0.0
11/11/2003	0.0
11/12/2003	0.0
11/13/2003	0.0
11/14/2003	0.0
11/15/2003	0.0
11/16/2003	0.0
11/17/2003	0.0

Water Year 2004 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
11/18/2003	0.0
11/19/2003	0.0
11/20/2003	0.0
11/21/2003	0.0
11/22/2003	0.0
11/23/2003	0.0
11/24/2003	0.0
11/25/2003	1.0
11/26/2003	0.0
11/27/2003	0.0
11/28/2003	0.0
11/29/2003	0.0
11/30/2003	0.0
12/1/2003	0.0
12/2/2003	0.0
12/3/2003	0.0
12/4/2003	0.0
12/5/2003	0.0
12/6/2003	0.9
12/7/2003	2.0
12/8/2003	0.6
12/9/2003	0.8
12/10/2003	3.1
12/11/2003	1.8
12/12/2003	0.0
12/13/2003	0.0
12/14/2003	0.0
12/15/2003	0.0
12/16/2003	0.0
12/17/2003	0.0
12/18/2003	0.0
12/19/2003	0.0
12/20/2003	1.3
12/21/2003	2.7
12/22/2003	2.9
12/23/2003	4.8
12/24/2003	7.1
12/25/2003	5.8
12/26/2003	1.6
12/27/2003	0.0
12/28/2003	0.0
12/29/2003	0.0
12/30/2003	0.0
12/31/2003	0.6
1/1/2004	7.6
1/2/2004	4.1
1/3/2004	2.8
1/4/2004	1.8
1/5/2004	1.4
1/6/2004	2.5
1/7/2004	3.2
1/8/2004	2.9
1/9/2004	3.5
1/10/2004	0.8
1/11/2004	0.0
1/12/2004	0.0
1/13/2004	0.0
1/14/2004	0.0
1/15/2004	0.0
1/16/2004	0.0
1/17/2004	0.3
1/18/2004	1.4
1/19/2004	1.9
1/20/2004	2.5
1/21/2004	1.8
1/22/2004	0.5
1/23/2004	0.0
1/24/2004	0.0
1/25/2004	0.0
1/26/2004	0.0

Water Year 2004 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
1/27/2004	0.0
1/28/2004	0.0
1/29/2004	0.0
1/30/2004	0.0
1/31/2004	0.0
2/1/2004	0.0
2/2/2004	1.7
2/3/2004	1.5
2/4/2004	0.0
2/5/2004	0.0
2/6/2004	0.0
2/7/2004	0.0
2/8/2004	0.0
2/9/2004	0.0
2/10/2004	0.0
2/11/2004	0.0
2/12/2004	0.0
2/13/2004	0.0
2/14/2004	0.0
2/15/2004	0.0
2/16/2004	1.1
2/17/2004	3.3
2/18/2004	3.9
2/19/2004	1.5
2/20/2004	1.6
2/21/2004	1.7
2/22/2004	2.8
2/23/2004	2.9
2/24/2004	2.5
2/25/2004	0.1
2/26/2004	7.7
2/27/2004	2.9
2/28/2004	0.7
2/29/2004	0.0
3/1/2004	0.9
3/2/2004	3.0
3/3/2004	0.8
3/4/2004	2.0
3/5/2004	1.6
3/6/2004	0.0
3/7/2004	0.0
3/8/2004	0.0
3/9/2004	0.0
3/10/2004	0.0
3/11/2004	0.0
3/12/2004	1.1
3/13/2004	1.4
3/14/2004	1.6
3/15/2004	0.0
3/16/2004	0.0
3/17/2004	0.0
3/18/2004	0.0
3/19/2004	0.0
3/20/2004	0.0
3/21/2004	0.0
3/22/2004	0.0
3/23/2004	0.0
3/24/2004	0.0
3/25/2004	0.0
3/26/2004	0.0
3/27/2004	0.0
3/28/2004	0.0
3/29/2004	0.0
3/30/2004	0.0
3/31/2004	0.0
4/1/2004	0.0
4/2/2004	0.0
4/3/2004	0.0
4/4/2004	0.0
4/5/2004	0.0

Water Year 2004 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
4/6/2004	0.0
4/7/2004	0.0
4/8/2004	0.0
4/9/2004	0.8
4/10/2004	1.0
4/11/2004	1.6
4/12/2004	0.0
4/13/2004	0.0
4/14/2004	0.0
4/15/2004	0.0
4/16/2004	0.0
4/17/2004	0.0
4/18/2004	0.0
4/19/2004	0.0
4/20/2004	0.0
4/21/2004	0.0
4/22/2004	0.0
4/23/2004	0.0
4/24/2004	0.0
4/25/2004	0.0
4/26/2004	0.0
4/27/2004	0.0
4/28/2004	0.0
4/29/2004	0.0
4/30/2004	0.0
5/1/2004	0.0
5/2/2004	0.0
5/3/2004	0.0
5/4/2004	0.0
5/5/2004	2.4
5/6/2004	3.4
5/7/2004	3.5
5/8/2004	3.2
5/9/2004	2.5
5/10/2004	2.2
5/11/2004	0.0
5/12/2004	0.0
5/13/2004	0.0
5/14/2004	0.0
5/15/2004	0.0
5/16/2004	0.0
5/17/2004	1.2
5/18/2004	1.0
5/19/2004	0.5
5/20/2004	1.2
5/21/2004	2.1
5/22/2004	1.8
5/23/2004	1.7
5/24/2004	0.0
5/25/2004	0.0
5/26/2004	0.0
5/27/2004	0.0
5/28/2004	0.0
5/29/2004	0.0
5/30/2004	0.0
5/31/2004	0.0
6/1/2004	1.1
6/2/2004	2.9
6/3/2004	3.6
6/4/2004	2.0
6/5/2004	1.6
6/6/2004	2.3
6/7/2004	2.1
6/8/2004	0.0
6/9/2004	0.0
6/10/2004	0.0
6/11/2004	0.0
6/12/2004	0.0
6/13/2004	0.0
6/14/2004	0.0

Water Year 2004 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/15/2004	0.0
6/16/2004	1.8
6/17/2004	5.7
6/18/2004	4.0
6/19/2004	3.4
6/20/2004	2.6
6/21/2004	0.9
6/22/2004	0.0
6/23/2004	0.0
6/24/2004	0.0
6/25/2004	0.0
6/26/2004	0.0
6/27/2004	0.0
6/28/2004	0.1
6/29/2004	4.3
6/30/2004	5.0
7/1/2004	4.7
7/2/2004	4.2
7/3/2004	4.4
7/4/2004	4.0
7/5/2004	3.4
7/6/2004	2.0
7/7/2004	0.0
7/8/2004	0.0
7/9/2004	0.0
7/10/2004	0.0
7/11/2004	0.0
7/12/2004	0.1
7/13/2004	1.4
7/14/2004	1.5
7/15/2004	1.3
7/16/2004	1.6
7/17/2004	1.9
7/18/2004	1.8
7/19/2004	1.0
7/20/2004	0.0
7/21/2004	0.0
7/22/2004	0.0
7/23/2004	0.0
7/24/2004	0.0
7/25/2004	0.0
7/26/2004	1.6
7/27/2004	2.8
7/28/2004	4.8
7/29/2004	5.8
7/30/2004	5.4
7/31/2004	4.8
8/1/2004	3.3
8/2/2004	2.2
8/3/2004	0.0
8/4/2004	0.0
8/5/2004	0.0
8/6/2004	0.0
8/7/2004	0.0
8/8/2004	0.0
8/9/2004	0.6
8/10/2004	0.9
8/11/2004	0.3
8/12/2004	1.6
8/13/2004	2.7
8/14/2004	2.6
8/15/2004	0.6
8/16/2004	0.0
8/17/2004	0.0
8/18/2004	0.0
8/19/2004	0.0
8/20/2004	0.0
8/21/2004	0.9
8/22/2004	2.4
8/23/2004	2.3

Water Year 2004 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/24/2004	3.3
8/25/2004	3.4
8/26/2004	3.5
8/27/2004	2.1
8/28/2004	2.0
8/29/2004	3.0
8/30/2004	3.5
8/31/2004	1.3
9/1/2004	0.0
9/2/2004	0.0
9/3/2004	0.0
9/4/2004	0.0
9/5/2004	0.3
9/6/2004	1.0
9/7/2004	1.4
9/8/2004	0.4
9/9/2004	0.9
9/10/2004	2.4
9/11/2004	1.4
9/12/2004	1.3
9/13/2004	1.5
9/14/2004	0.0
9/15/2004	0.0
9/16/2004	0.0
9/17/2004	1.6
9/18/2004	1.3
9/19/2004	1.4
9/20/2004	0.0
9/21/2004	0.0
9/22/2004	0.0
9/23/2004	0.0
9/24/2004	0.0
9/25/2004	0.0
9/26/2004	0.0
9/27/2004	0.0
9/28/2004	0.0
9/29/2004	0.0
9/30/2004	

Water Year 2005

Water Year 2005
Number of Days Each Month that Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	4	1	0	0	0
Nov	3	0	0	0	0
Dec	8	4	0	0	0
Jan	9	6	5	0	0
Feb	8	1	0	0	0
Mar	8	1	0	0	0
Apr	2	0	0	0	0
May	10	7	3	0	0
Jun	13	6	0	0	0
Jul	20	5	3	0	0
Aug	14	5	0	0	0
Sep	3	0	0	0	0

Water Year 2005
Number of Hours Gates Closed Each Day

Date	Hours Gates Closed Each Day
10/1/2004	0.0
10/2/2004	0.0
10/3/2004	0.4
10/4/2004	0.1
10/5/2004	0.0
10/6/2004	0.0
10/7/2004	0.0
10/8/2004	0.0
10/9/2004	0.0
10/10/2004	0.0
10/11/2004	0.0
10/12/2004	0.0
10/13/2004	0.0
10/14/2004	0.0
10/15/2004	0.0
10/16/2004	2.9
10/17/2004	3.8
10/18/2004	2.8
10/19/2004	5.4
10/20/2004	1.8
10/21/2004	0.0
10/22/2004	0.0
10/23/2004	0.0
10/24/2004	0.0
10/25/2004	0.0
10/26/2004	0.0
10/27/2004	0.0
10/28/2004	0.0
10/29/2004	0.0
10/30/2004	0.0
10/31/2004	0.0
11/1/2004	0.0
11/2/2004	0.0
11/3/2004	0.0
11/4/2004	0.0
11/5/2004	0.0
11/6/2004	0.0
11/7/2004	0.0
11/8/2004	0.0
11/9/2004	0.0
11/10/2004	0.0
11/11/2004	0.0
11/12/2004	1.3
11/13/2004	2.1

Water Year 2005 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
11/14/2004	1.2
11/15/2004	2.6
11/16/2004	1.0
11/17/2004	0.0
11/18/2004	0.0
11/19/2004	0.0
11/20/2004	0.0
11/21/2004	0.0
11/22/2004	0.0
11/23/2004	0.0
11/24/2004	0.0
11/25/2004	0.0
11/26/2004	0.0
11/27/2004	2.8
11/28/2004	0.0
11/29/2004	0.0
11/30/2004	0.0
12/1/2004	0.0
12/2/2004	0.0
12/3/2004	0.0
12/4/2004	0.0
12/5/2004	0.0
12/6/2004	0.0
12/7/2004	0.0
12/8/2004	0.0
12/9/2004	0.0
12/10/2004	0.9
12/11/2004	2.4
12/12/2004	4.4
12/13/2004	3.5
12/14/2004	0.9
12/15/2004	0.0
12/16/2004	0.0
12/17/2004	0.0
12/18/2004	0.0
12/19/2004	0.0
12/20/2004	0.0
12/21/2004	0.0
12/22/2004	0.0
12/23/2004	0.0
12/24/2004	0.0
12/25/2004	0.0
12/26/2004	1.7
12/27/2004	4.5
12/28/2004	4.2
12/29/2004	4.7
12/30/2004	2.2
12/31/2004	2.9
1/1/2005	0.0
1/2/2005	0.1
1/3/2005	1.7
1/4/2005	2.8
1/5/2005	1.5
1/6/2005	2.7
1/7/2005	6.5
1/8/2005	9.9
1/9/2005	8.7
1/10/2005	7.6
1/11/2005	8.6
1/12/2005	5.1
1/13/2005	1.3
1/14/2005	0.0
1/15/2005	0.0
1/16/2005	0.0
1/17/2005	0.0
1/18/2005	0.0
1/19/2005	0.0
1/20/2005	0.0
1/21/2005	0.2
1/22/2005	0.0

Water Year 2005 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/23/2005	0.0
1/24/2005	0.5
1/25/2005	0.9
1/26/2005	2.7
1/27/2005	0.0
1/28/2005	0.0
1/29/2005	0.0
1/30/2005	0.0
1/31/2005	0.0
2/1/2005	0.0
2/2/2005	0.0
2/3/2005	0.4
2/4/2005	1.9
2/5/2005	3.5
2/6/2005	4.0
2/7/2005	3.3
2/8/2005	2.0
2/9/2005	0.2
2/10/2005	0.0
2/11/2005	0.0
2/12/2005	0.0
2/13/2005	0.0
2/14/2005	0.0
2/15/2005	0.0
2/16/2005	0.0
2/17/2005	0.4
2/18/2005	2.1
2/19/2005	1.9
2/20/2005	2.5
2/21/2005	2.6
2/22/2005	4.3
2/23/2005	3.7
2/24/2005	1.6
2/25/2005	0.0
2/26/2005	0.0
2/27/2005	0.0
2/28/2005	0.0
3/1/2005	0.0
3/2/2005	2.4
3/3/2005	1.6
3/4/2005	2.5
3/5/2005	2.4
3/6/2005	2.1
3/7/2005	1.7
3/8/2005	0.7
3/9/2005	0.0
3/10/2005	0.0
3/11/2005	0.0
3/12/2005	0.0
3/13/2005	1.3
3/14/2005	1.4
3/15/2005	0.0
3/16/2005	0.0
3/17/2005	0.0
3/18/2005	0.0
3/19/2005	2.4
3/20/2005	0.0
3/21/2005	0.0
3/22/2005	2.9
3/23/2005	2.1
3/24/2005	0.0
3/25/2005	0.0
3/26/2005	0.0
3/27/2005	0.0
3/28/2005	4.8
3/29/2005	1.9
3/30/2005	0.0
3/31/2005	0.0
4/1/2005	0.0
4/2/2005	0.0

Water Year 2005 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
4/3/2005	0.0
4/4/2005	0.0
4/5/2005	0.0
4/6/2005	0.0
4/7/2005	0.0
4/8/2005	0.0
4/9/2005	0.7
4/10/2005	0.0
4/11/2005	0.0
4/12/2005	0.1
4/13/2005	0.0
4/14/2005	0.0
4/15/2005	0.0
4/16/2005	0.0
4/17/2005	0.0
4/18/2005	0.0
4/19/2005	0.0
4/20/2005	0.0
4/21/2005	0.0
4/22/2005	0.0
4/23/2005	0.0
4/24/2005	0.1
4/25/2005	0.7
4/26/2005	1.9
4/27/2005	3.3
4/28/2005	3.7
4/29/2005	1.7
4/30/2005	0.5
5/1/2005	0.0
5/2/2005	0.0
5/3/2005	0.0
5/4/2005	0.0
5/5/2005	0.0
5/6/2005	0.3
5/7/2005	1.1
5/8/2005	1.8
5/9/2005	5.0
5/10/2005	3.0
5/11/2005	1.5
5/12/2005	0.7
5/13/2005	0.0
5/14/2005	0.0
5/15/2005	0.0
5/16/2005	0.0
5/17/2005	0.0
5/18/2005	0.0
5/19/2005	1.2
5/20/2005	0.5
5/21/2005	2.5
5/22/2005	3.8
5/23/2005	5.5
5/24/2005	6.0
5/25/2005	6.5
5/26/2005	7.9
5/27/2005	6.8
5/28/2005	5.0
5/29/2005	1.2
5/30/2005	0.0
5/31/2005	0.0
6/1/2005	0.6
6/2/2005	1.6
6/3/2005	2.7
6/4/2005	3.4
6/5/2005	5.1
6/6/2005	4.2
6/7/2005	2.8
6/8/2005	2.0
6/9/2005	1.1
6/10/2005	0.3
6/11/2005	0.0

Water Year 2005 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
6/12/2005	0.0
6/13/2005	0.0
6/14/2005	0.0
6/15/2005	0.0
6/16/2005	0.0
6/17/2005	0.0
6/18/2005	0.2
6/19/2005	2.1
6/20/2005	3.2
6/21/2005	4.6
6/22/2005	5.1
6/23/2005	4.6
6/24/2005	4.6
6/25/2005	3.6
6/26/2005	1.6
6/27/2005	0.0
6/28/2005	0.0
6/29/2005	0.0
6/30/2005	0.1
7/1/2005	2.1
7/2/2005	3.2
7/3/2005	3.9
7/4/2005	3.6
7/5/2005	3.8
7/6/2005	3.7
7/7/2005	3.1
7/8/2005	2.2
7/9/2005	1.4
7/10/2005	0.0
7/11/2005	0.0
7/12/2005	0.0
7/13/2005	0.0
7/14/2005	0.0
7/15/2005	1.1
7/16/2005	2.4
7/17/2005	3.5
7/18/2005	5.7
7/19/2005	6.9
7/20/2005	6.9
7/21/2005	6.4
7/22/2005	5.3
7/23/2005	2.5
7/24/2005	1.1
7/25/2005	0.0
7/26/2005	0.0
7/27/2005	1.6
7/28/2005	2.7
7/29/2005	2.8
7/30/2005	3.2
7/31/2005	2.9
8/1/2005	2.9
8/2/2005	2.4
8/3/2005	2.5
8/4/2005	2.8
8/5/2005	1.7
8/6/2005	1.0
8/7/2005	0.2
8/8/2005	0.0
8/9/2005	0.0
8/10/2005	0.0
8/11/2005	0.0
8/12/2005	2.0
8/13/2005	3.9
8/14/2005	5.0
8/15/2005	5.0
8/16/2005	4.0
8/17/2005	4.8
8/18/2005	5.1
8/19/2005	3.9
8/20/2005	2.3

Water Year 2005 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
8/21/2005	0.3
8/22/2005	0.0
8/23/2005	0.0
8/24/2005	1.7
8/25/2005	0.9
8/26/2005	0.9
8/27/2005	1.2
8/28/2005	1.3
8/29/2005	2.1
8/30/2005	0.8
8/31/2005	0.1
9/1/2005	1.0
9/2/2005	1.3
9/3/2005	0.1
9/4/2005	0.0
9/5/2005	0.0
9/6/2005	0.0
9/7/2005	0.0
9/8/2005	0.5
9/9/2005	1.4
9/10/2005	0.5
9/11/2005	1.6
9/12/2005	2.1
9/13/2005	2.1
9/14/2005	2.5
9/15/2005	1.3
9/16/2005	0.9
9/17/2005	0.0
9/18/2005	0.0
9/19/2005	0.0
9/20/2005	0.0
9/21/2005	0.0
9/22/2005	0.6
9/23/2005	1.4
9/24/2005	0.0
9/25/2005	0.0
9/26/2005	0.0
9/27/2005	0.0
9/28/2005	0.0
9/29/2005	0.0
9/30/2005	0.0

Water Year 2006

Water Year 2006
Number of Days Each Month that Gates Would be Closed for Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	9	4	4	1	0
Jan	22	20	14	4	0
Feb	3	1	0	0	0
Mar	16	12	5	0	0
Apr	30	30	25	4	0
May	25	17	11	0	0
Jun	16	9	3	0	0
Jul	17	7	0	0	0
Aug	17	6	3	0	0
Sep	9	2	0	0	0

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
10/1/2005	0.0
10/2/2005	0.0
10/3/2005	0.0
10/4/2005	0.0
10/5/2005	0.0
10/6/2005	0.0
10/7/2005	0.8
10/8/2005	1.4
10/9/2005	0.5
10/10/2005	0.0
10/11/2005	0.0
10/12/2005	0.0
10/13/2005	0.0
10/14/2005	0.0
10/15/2005	0.0
10/16/2005	0.0
10/17/2005	0.0
10/18/2005	1.3
10/19/2005	0.0
10/20/2005	0.0
10/21/2005	0.0
10/22/2005	0.0
10/23/2005	0.0
10/24/2005	0.0
10/25/2005	0.0
10/26/2005	0.0
10/27/2005	0.0
10/28/2005	0.0
10/29/2005	0.0
10/30/2005	0.0
10/31/2005	0.0
11/1/2005	0.0
11/2/2005	0.0
11/3/2005	0.0
11/4/2005	0.6
11/5/2005	0.0
11/6/2005	0.6
11/7/2005	0.6
11/8/2005	0.0
11/9/2005	0.0
11/10/2005	0.0
11/11/2005	0.0
11/12/2005	0.0
11/13/2005	0.0
11/14/2005	0.0
11/15/2005	0.0
11/16/2005	0.0
11/17/2005	0.0

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
11/18/2005	0.0
11/19/2005	0.0
11/20/2005	0.0
11/21/2005	0.0
11/22/2005	0.0
11/23/2005	0.0
11/24/2005	0.0
11/25/2005	0.0
11/26/2005	0.0
11/27/2005	0.0
11/28/2005	0.0
11/29/2005	0.0
11/30/2005	0.0
12/1/2005	4.0
12/2/2005	3.0
12/3/2005	0.0
12/4/2005	0.0
12/5/2005	0.0
12/6/2005	0.0
12/7/2005	0.0
12/8/2005	0.0
12/9/2005	0.0
12/10/2005	0.0
12/11/2005	0.0
12/12/2005	0.0
12/13/2005	0.0
12/14/2005	0.0
12/15/2005	0.5
12/16/2005	0.3
12/17/2005	0.0
12/18/2005	3.9
12/19/2005	0.6
12/20/2005	0.0
12/21/2005	0.0
12/22/2005	0.0
12/23/2005	0.0
12/24/2005	0.0
12/25/2005	0.0
12/26/2005	3.9
12/27/2005	3.5
12/28/2005	8.4
12/29/2005	6.6
12/30/2005	8.0
12/31/2005	14.0
1/1/2006	14.9
1/2/2006	19.1
1/3/2006	18.4
1/4/2006	14.1
1/5/2006	10.2
1/6/2006	10.0
1/7/2006	11.1
1/8/2006	8.0
1/9/2006	6.6
1/10/2006	6.6
1/11/2006	7.3
1/12/2006	6.2
1/13/2006	6.3
1/14/2006	8.9
1/15/2006	4.9
1/16/2006	1.1
1/17/2006	0.0
1/18/2006	0.0
1/19/2006	0.0
1/20/2006	0.0
1/21/2006	0.0
1/22/2006	0.0
1/23/2006	0.0
1/24/2006	0.5
1/25/2006	3.7
1/26/2006	4.2

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/27/2006	4.5
1/28/2006	4.3
1/29/2006	4.2
1/30/2006	4.4
1/31/2006	2.2
2/1/2006	0.4
2/2/2006	0.0
2/3/2006	0.4
2/4/2006	1.3
2/5/2006	0.0
2/6/2006	0.0
2/7/2006	1.9
2/8/2006	1.4
2/9/2006	1.8
2/10/2006	2.1
2/11/2006	1.7
2/12/2006	0.0
2/13/2006	0.0
2/14/2006	0.4
2/15/2006	0.0
2/16/2006	0.0
2/17/2006	0.0
2/18/2006	0.0
2/19/2006	0.0
2/20/2006	0.0
2/21/2006	0.0
2/22/2006	0.0
2/23/2006	0.0
2/24/2006	0.3
2/25/2006	1.0
2/26/2006	1.5
2/27/2006	3.5
2/28/2006	4.3
3/1/2006	0.9
3/2/2006	2.5
3/3/2006	4.4
3/4/2006	3.9
3/5/2006	5.3
3/6/2006	5.4
3/7/2006	3.1
3/8/2006	0.8
3/9/2006	4.7
3/10/2006	4.9
3/11/2006	4.6
3/12/2006	1.6
3/13/2006	0.0
3/14/2006	1.9
3/15/2006	0.0
3/16/2006	0.0
3/17/2006	1.5
3/18/2006	2.0
3/19/2006	1.8
3/20/2006	1.7
3/21/2006	1.3
3/22/2006	0.0
3/23/2006	0.0
3/24/2006	0.9
3/25/2006	7.1
3/26/2006	2.1
3/27/2006	4.6
3/28/2006	7.6
3/29/2006	6.9
3/30/2006	6.7
3/31/2006	7.8
4/1/2006	8.4
4/2/2006	7.4
4/3/2006	10.3
4/4/2006	8.4
4/5/2006	10.8
4/6/2006	5.9

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
4/7/2006	8.0
4/8/2006	9.6
4/9/2006	7.9
4/10/2006	9.2
4/11/2006	9.7
4/12/2006	12.8
4/13/2006	11.3
4/14/2006	12.5
4/15/2006	12.1
4/16/2006	12.7
4/17/2006	10.1
4/18/2006	7.7
4/19/2006	7.4
4/20/2006	6.5
4/21/2006	5.1
4/22/2006	4.3
4/23/2006	5.0
4/24/2006	5.0
4/25/2006	7.0
4/26/2006	8.6
4/27/2006	9.7
4/28/2006	10.1
4/29/2006	10.4
4/30/2006	8.8
5/1/2006	7.6
5/2/2006	6.3
5/3/2006	6.2
5/4/2006	3.5
5/5/2006	2.9
5/6/2006	1.5
5/7/2006	0.8
5/8/2006	1.6
5/9/2006	2.3
5/10/2006	3.1
5/11/2006	3.9
5/12/2006	5.3
5/13/2006	6.5
5/14/2006	6.1
5/15/2006	6.8
5/16/2006	8.1
5/17/2006	6.6
5/18/2006	5.3
5/19/2006	3.1
5/20/2006	0.0
5/21/2006	1.0
5/22/2006	4.2
5/23/2006	5.3
5/24/2006	5.1
5/25/2006	6.5
5/26/2006	8.2
5/27/2006	7.7
5/28/2006	5.0
5/29/2006	4.0
5/30/2006	3.2
5/31/2006	1.4
6/1/2006	0.0
6/2/2006	0.0
6/3/2006	0.0
6/4/2006	0.0
6/5/2006	0.0
6/6/2006	0.0
6/7/2006	1.4
6/8/2006	2.8
6/9/2006	3.4
6/10/2006	4.7
6/11/2006	6.4
6/12/2006	7.7
6/13/2006	5.2
6/14/2006	3.6
6/15/2006	3.6

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
6/16/2006	0.8
6/17/2006	0.0
6/18/2006	0.0
6/19/2006	0.0
6/20/2006	1.0
6/21/2006	2.6
6/22/2006	3.0
6/23/2006	4.4
6/24/2006	6.3
6/25/2006	5.9
6/26/2006	5.3
6/27/2006	4.7
6/28/2006	3.8
6/29/2006	1.9
6/30/2006	0.0
7/1/2006	0.0
7/2/2006	0.0
7/3/2006	0.0
7/4/2006	0.0
7/5/2006	0.0
7/6/2006	1.1
7/7/2006	1.3
7/8/2006	2.3
7/9/2006	4.1
7/10/2006	5.8
7/11/2006	5.5
7/12/2006	4.2
7/13/2006	2.4
7/14/2006	1.2
7/15/2006	0.0
7/16/2006	0.0
7/17/2006	0.0
7/18/2006	2.8
7/19/2006	2.8
7/20/2006	3.7
7/21/2006	3.9
7/22/2006	3.9
7/23/2006	4.0
7/24/2006	4.9
7/25/2006	5.1
7/26/2006	4.8
7/27/2006	4.0
7/28/2006	2.4
7/29/2006	1.6
7/30/2006	0.0
7/31/2006	0.2
8/1/2006	0.0
8/2/2006	1.8
8/3/2006	4.3
8/4/2006	6.2
8/5/2006	6.6
8/6/2006	5.9
8/7/2006	7.0
8/8/2006	5.0
8/9/2006	3.4
8/10/2006	3.0
8/11/2006	2.1
8/12/2006	0.0
8/13/2006	1.9
8/14/2006	2.8
8/15/2006	2.9
8/16/2006	2.9
8/17/2006	2.7
8/18/2006	2.9
8/19/2006	3.5
8/20/2006	3.6
8/21/2006	2.9
8/22/2006	0.9
8/23/2006	0.4
8/24/2006	0.0

Water Year 2006 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/25/2006	0.0
8/26/2006	0.0
8/27/2006	0.0
8/28/2006	0.0
8/29/2006	0.0
8/30/2006	0.0
8/31/2006	1.1
9/1/2006	3.2
9/2/2006	4.0
9/3/2006	4.0
9/4/2006	3.8
9/5/2006	2.9
9/6/2006	1.5
9/7/2006	1.1
9/8/2006	1.6
9/9/2006	0.0
9/10/2006	0.0
9/11/2006	0.3
9/12/2006	1.0
9/13/2006	2.9
9/14/2006	4.6
9/15/2006	2.0
9/16/2006	1.8
9/17/2006	0.0
9/18/2006	0.0
9/19/2006	0.0
9/20/2006	0.0
9/21/2006	0.0
9/22/2006	0.0
9/23/2006	0.0
9/24/2006	0.0
9/25/2006	0.0
9/26/2006	0.9
9/27/2006	1.3
9/28/2006	1.2
9/29/2006	2.5
9/30/2006	1.8

Water Year 2014

Water Year 2014
Number of Days Each Month that Gates Would be Closed for X Hours or Longer.

Month	2 hours	4 hours	6 hours	12 hours	24 hours
Oct	0	0	0	0	0
Nov	0	0	0	0	0
Dec	1	0	0	0	0
Jan	0	0	0	0	0
Feb	1	0	0	0	0
Mar	0	0	0	0	0
Apr	0	0	0	0	0
May	0	0	0	0	0
Jun	5	0	0	0	0
Jul	9	0	0	0	0
Aug	5	0	0	0	0
Sep	7	0	0	0	0

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
10/1/2013	0.0
10/2/2013	0.0
10/3/2013	0.0
10/4/2013	0.0
10/5/2013	0.0
10/6/2013	0.0
10/7/2013	0.0
10/8/2013	0.0
10/9/2013	0.8
10/10/2013	0.0
10/11/2013	0.0
10/12/2013	0.0
10/13/2013	0.0
10/14/2013	0.0
10/15/2013	0.0
10/16/2013	0.0
10/17/2013	0.0
10/18/2013	0.0
10/19/2013	0.0
10/20/2013	0.0
10/21/2013	0.0
10/22/2013	0.0
10/23/2013	0.0
10/24/2013	0.0
10/25/2013	0.0
10/26/2013	0.0
10/27/2013	0.0
10/28/2013	0.0
10/29/2013	0.0
10/30/2013	0.0
10/31/2013	0.0
11/1/2013	0.0
11/2/2013	0.0
11/3/2013	0.0
11/4/2013	0.0
11/5/2013	0.0
11/6/2013	0.0
11/7/2013	0.0
11/8/2013	0.0
11/9/2013	0.0
11/10/2013	0.0
11/11/2013	0.0
11/12/2013	0.0
11/13/2013	0.0
11/14/2013	0.0
11/15/2013	0.0

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
11/16/2013	0.0
11/17/2013	0.0
11/18/2013	0.0
11/19/2013	0.0
11/20/2013	0.0
11/21/2013	0.0
11/22/2013	0.0
11/23/2013	0.0
11/24/2013	0.0
11/25/2013	0.0
11/26/2013	0.0
11/27/2013	0.0
11/28/2013	0.0
11/29/2013	0.0
11/30/2013	0.0
12/1/2013	0.0
12/2/2013	0.0
12/3/2013	2.3
12/4/2013	0.0
12/5/2013	0.0
12/6/2013	0.0
12/7/2013	0.0
12/8/2013	0.0
12/9/2013	0.0
12/10/2013	0.0
12/11/2013	0.0
12/12/2013	0.0
12/13/2013	0.0
12/14/2013	0.0
12/15/2013	0.0
12/16/2013	0.0
12/17/2013	0.0
12/18/2013	0.0
12/19/2013	0.0
12/20/2013	0.0
12/21/2013	0.0
12/22/2013	0.0
12/23/2013	0.0
12/24/2013	0.0
12/25/2013	0.0
12/26/2013	0.0
12/27/2013	0.0
12/28/2013	0.0
12/29/2013	0.0
12/30/2013	0.3
12/31/2013	1.1
1/1/2014	1.1
1/2/2014	0.0
1/3/2014	0.0
1/4/2014	0.0
1/5/2014	0.0
1/6/2014	0.0
1/7/2014	0.0
1/8/2014	0.0
1/9/2014	0.0
1/10/2014	0.0
1/11/2014	0.0
1/12/2014	0.0
1/13/2014	0.0
1/14/2014	0.0
1/15/2014	0.0
1/16/2014	0.0
1/17/2014	0.0
1/18/2014	0.0
1/19/2014	0.0
1/20/2014	0.0
1/21/2014	0.0
1/22/2014	0.0
1/23/2014	0.0
1/24/2014	0.0

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
1/25/2014	0.0
1/26/2014	0.0
1/27/2014	0.0
1/28/2014	0.6
1/29/2014	0.4
1/30/2014	1.1
1/31/2014	0.0
2/1/2014	0.0
2/2/2014	0.0
2/3/2014	0.0
2/4/2014	0.0
2/5/2014	0.0
2/6/2014	0.0
2/7/2014	0.0
2/8/2014	0.0
2/9/2014	0.0
2/10/2014	0.0
2/11/2014	0.0
2/12/2014	0.0
2/13/2014	0.0
2/14/2014	0.0
2/15/2014	0.0
2/16/2014	0.0
2/17/2014	0.0
2/18/2014	0.0
2/19/2014	0.0
2/20/2014	0.0
2/21/2014	0.0
2/22/2014	0.0
2/23/2014	0.0
2/24/2014	0.0
2/25/2014	0.0
2/26/2014	0.0
2/27/2014	0.4
2/28/2014	2.5
3/1/2014	0.0
3/2/2014	0.0
3/3/2014	0.0
3/4/2014	0.0
3/5/2014	0.0
3/6/2014	0.0
3/7/2014	0.0
3/8/2014	0.0
3/9/2014	0.0
3/10/2014	0.0
3/11/2014	0.0
3/12/2014	0.0
3/13/2014	0.0
3/14/2014	0.0
3/15/2014	0.0
3/16/2014	0.0
3/17/2014	0.0
3/18/2014	0.0
3/19/2014	0.0
3/20/2014	0.0
3/21/2014	0.0
3/22/2014	0.0
3/23/2014	0.0
3/24/2014	0.0
3/25/2014	0.0
3/26/2014	0.0
3/27/2014	0.0
3/28/2014	0.0
3/29/2014	0.0
3/30/2014	0.0
3/31/2014	0.0
4/1/2014	0.0
4/2/2014	0.0
4/3/2014	0.0
4/4/2014	0.0

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	Hours Gates Closed Each Day
4/5/2014	0.0
4/6/2014	0.0
4/7/2014	0.0
4/8/2014	0.0
4/9/2014	0.0
4/10/2014	0.0
4/11/2014	0.0
4/12/2014	0.0
4/13/2014	0.0
4/14/2014	0.0
4/15/2014	0.0
4/16/2014	0.0
4/17/2014	0.0
4/18/2014	0.4
4/19/2014	0.4
4/20/2014	0.0
4/21/2014	0.0
4/22/2014	0.0
4/23/2014	0.0
4/24/2014	0.0
4/25/2014	0.0
4/26/2014	0.0
4/27/2014	0.0
4/28/2014	0.0
4/29/2014	0.0
4/30/2014	0.0
5/1/2014	0.0
5/2/2014	0.0
5/3/2014	0.0
5/4/2014	0.0
5/5/2014	0.0
5/6/2014	0.0
5/7/2014	0.0
5/8/2014	0.0
5/9/2014	0.0
5/10/2014	0.0
5/11/2014	0.0
5/12/2014	0.0
5/13/2014	0.0
5/14/2014	0.0
5/15/2014	0.0
5/16/2014	0.8
5/17/2014	1.2
5/18/2014	1.5
5/19/2014	0.2
5/20/2014	0.0
5/21/2014	0.0
5/22/2014	0.0
5/23/2014	0.0
5/24/2014	0.0
5/25/2014	0.0
5/26/2014	0.6
5/27/2014	0.3
5/28/2014	0.6
5/29/2014	0.0
5/30/2014	0.2
5/31/2014	0.0
6/1/2014	0.0
6/2/2014	0.0
6/3/2014	0.0
6/4/2014	0.0
6/5/2014	0.0
6/6/2014	0.0
6/7/2014	0.0
6/8/2014	0.0
6/9/2014	0.0
6/10/2014	1.9
6/11/2014	5.7
6/12/2014	4.6
6/13/2014	3.0

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
6/14/2014	1.8
6/15/2014	1.8
6/16/2014	1.5
6/17/2014	0.0
6/18/2014	0.0
6/19/2014	0.0
6/20/2014	0.0
6/21/2014	0.0
6/22/2014	0.1
6/23/2014	0.7
6/24/2014	1.8
6/25/2014	2.2
6/26/2014	2.3
6/27/2014	1.7
6/28/2014	1.9
6/29/2014	0.0
6/30/2014	0.0
7/1/2014	1.7
7/2/2014	0.0
7/3/2014	0.0
7/4/2014	0.0
7/5/2014	0.0
7/6/2014	0.0
7/7/2014	0.1
7/8/2014	1.9
7/9/2014	4.2
7/10/2014	5.6
7/11/2014	6.1
7/12/2014	4.8
7/13/2014	3.8
7/14/2014	2.8
7/15/2014	2.7
7/16/2014	1.0
7/17/2014	0.8
7/18/2014	0.5
7/19/2014	1.0
7/20/2014	1.1
7/21/2014	2.1
7/22/2014	1.8
7/23/2014	2.1
7/24/2014	1.1
7/25/2014	0.7
7/26/2014	1.0
7/27/2014	0.8
7/28/2014	0.8
7/29/2014	0.0
7/30/2014	0.0
7/31/2014	0.0
8/1/2014	0.0
8/2/2014	0.0
8/3/2014	0.0
8/4/2014	1.0
8/5/2014	0.9
8/6/2014	0.0
8/7/2014	2.2
8/8/2014	3.0
8/9/2014	3.0
8/10/2014	2.6
8/11/2014	1.7
8/12/2014	1.4
8/13/2014	0.0
8/14/2014	0.0
8/15/2014	0.0
8/16/2014	0.0
8/17/2014	0.8
8/18/2014	1.6
8/19/2014	1.9
8/20/2014	2.6
8/21/2014	1.6
8/22/2014	1.1

Water Year 2014 Number of Hours Gates Closed Each Day	
Date	**Hours Gates Closed Each Day**
8/23/2014	1.2
8/24/2014	1.4
8/25/2014	1.3
8/26/2014	0.0
8/27/2014	0.0
8/28/2014	0.0
8/29/2014	0.0
8/30/2014	0.0
8/31/2014	0.0
9/1/2014	0.0
9/2/2014	2.1
9/3/2014	2.9
9/4/2014	3.2
9/5/2014	4.4
9/6/2014	3.5
9/7/2014	2.7
9/8/2014	2.4
9/9/2014	0.9
9/10/2014	0.0
9/11/2014	0.4
9/12/2014	1.1
9/13/2014	1.8
9/14/2014	1.5
9/15/2014	1.3
9/16/2014	0.5
9/17/2014	0.4
9/18/2014	1.0
9/19/2014	0.0
9/20/2014	0.0
9/21/2014	0.4
9/22/2014	0.0
9/23/2014	0.0
9/24/2014	0.0
9/25/2014	0.0
9/26/2014	0.0
9/27/2014	0.0
9/28/2014	0.0
9/29/2014	0.0
9/30/2014	0.0

ENVIRONMENTAL ADDENDUM I

USFWS AND NMFS BIOLOGICAL OPINONS

LOWER SAN JOAQUIN FEASIBILITY STUDY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer To:
08ESMF00-2015-F-0206

JUN 13 2016

Ms. Alicia Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Formal consultation on the Lower San Joaquin River Feasibility Study, San Joaquin County, California

Dear: Ms. Kirchner:

This is in response to your November 6, 2015, letter requesting formal consultation with the U.S. Fish and Wildlife Service (Service) on the Lower San Joaquin River Feasibility Study Recommended Plan (LSJRFS), San Joaquin County, California. The LSJRFS is a Federal project with the U.S. Army Corps of Engineers (Corps) as the Federal lead agency and the Central Valley Flood Protection Board and the San Joaquin Area Flood Control Agency (SJAFCA) as the non-Federal local sponsors partnering with the Corps. The LSJRFS consists of improvements to about 24 miles of levees in the Central and North Stockton areas to address seepage, slope stability, overtopping, and erosion concerns. At issue are effects of the LSJRFS on the federally-listed as threatened valley elderberry longhorn beetle (*Desmocerus californicus*) (beetle), giant garter snake (*Thamnophis gigas*) (snake), delta smelt (*Hypomesus transpacificus*), and delta smelt critical habitat. Your request was received on November 10, 2015. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). The findings in this consultation are based on the November 2015 Biological Assessment (BA) included with your letter, the February 2015 Draft Integrated Interim Feasibility Report/Environmental Impact Statement/Environmental Impact Report, site visits to the project area, discussions with Corps staff, consultation with species experts, and other information in our files.

CONSULTATION HISTORY

February 27, 2015: Corps transmits letter and BA requesting formal consultation.

June 8, 2015: Service transmits letter requesting additional information.

November 6, 2015: Corps transmits revised BA.

December 9, 2015: Following review of the BA, Service requests Tables E1, E2, and E3, discussed in the BA, and verification that the Corps is consulting on effects of the project construction, ETL (i.e., Engineering Technical Letter ETL 1110-2-583, dated April 30, 2014, entitled "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures") compliance, and operation and maintenance.

December 10, 2015: Corps transmits email with attachment "Table E: Pre-project vegetation and vegetation lost from project implementation." Corps (Tanis Toland) confirms by follow up telephone call that it is consulting on ETL compliance and operation and maintenance, to the extent known, as well as project construction. Service transmits email requesting information on how snake habitat was determined. Corps responds by email with explanation of determination of snake habitat.

December 16, 2015: Service responds to December 10, 2015, Corps emails regarding scope of consultation and determination of snake habitat, questioning that determination and requesting a site visit.

December 18, 2015: Corps transmits email providing additional elements of operations and maintenance expected with the future condition.

January 7, 2016: Service staff (Steve Schoenberg) attends site visit to project area with the Corps (Tanis Toland, Ryan Larson) and SJAFCA (Eric Ambriz, Matthew Ward). The descriptions of future maintenance in the project description of this biological opinion are based in part on discussions at this site visit.

January 21, 2016: Service requests, and Corps transmits, an attached shapefile of the project footprint with areas, work types, and other information by email.

January 22, 2016: Corps staff (Tanis Toland) informs Service via telephone call of project changes, namely, the Dad's Point floodwall may be a berm, and the setback mitigation area will be modified (i.e., extended south, still within reach FM_30_L).

February 9, 2016: Corps transmits email to Service stating that erosion protection for Duck Creek element has been deleted.

February 23, 2016: Service requests a description of ongoing and future channel maintenance between levees by email to Corps.

February 26, 2016: Corps transmits email attachment to Service of revised BA Table C-1 with all cost reach lengths (used in Appendix A of this biological opinion). Corps transmits email and attachment describing channel maintenance between levees.

March 7, 2016: Corps transmits email clarifying that it previously considered, but no longer intends, to seek a "SWIF" (System Wide Improvement Framework) for the LSJRFS.

March 9, 2016: Service transmits its analysis of snake habitat impacts and a request for the Corps to revise its snake habitat estimates via email.

March 10, 2016: Corps transmits email and attachment with updated impacts to snake habitat.

March 18, 2016: Service transmits emails to the Corps: (a) a request for an accounting of beetle habitat (elderberry shrubs) within project footprint and (b) a draft biological opinion to the Corps with a request for comment or otherwise concurrence with the project description, including revised conservation measures. Corps responds with emails describing locations of shrubs within the project footprint (includes easements) and 100 feet of that footprint.

March 30, 2016: Corps transmits consolidated team comments on draft biological opinion.

April 7, 2016: Service transmits email requesting updated vegetation loss estimates reflecting the Corps' March 30, 2016, comments (i.e., comment T4), and verifying the footprint of elderberry shrub effects.

April 12, 2016: Service transmits emails with (a) its analysis of footprint elderberry shrub losses, and (b) inconsistencies between the BA Table and subsequent Table E (see December 10, 2015, above) regarding vegetation loss estimates.

April 13, 2016: Corps transmits example response explanation of vegetation loss estimates and tabular inconsistencies. Service responds with emails (a) requesting a conference to resolve these inconsistencies, and (b) proposed edits to Table E to correct possible errors.

April 14, 2016: Corps sends email response to Service stating: (a) it has no information on Smith Canal water quality, (b) guidance language on limiting mitigation duration to when success criteria are met, (c) concurrence that channel maintenance practices are not part of this consultation, (d) request that the Service recheck snake conservation measures, specifically - whether the alternative use of fencing or continuous monitoring can be applied to reaches other than those specified in the draft biological opinion, and (e) concurrence with the Service's suggested grouting conservation measure. With respect to the snake conservation measures, Service staff (Steve Schoenberg) explained by phone call to Corps staff (Josh Garcia) that we had limited the use of fencing to those reaches where we deemed it reasonable to install fencing due to site conditions and would not agree to apply this option to other reaches for which continuous monitoring only is prescribed. The Service explained that the "no effect" language for certain reaches with limited conservation measures was intended to mean the effect after implementation of those conservation measures.

April 14, 2016: Service sends email with attachments showing revisions to Table E (see Appendix B), separating out the impacts of elderberry shrubs in the footprint only (see Table 1), and requests Corps concurrence. Corps (Josh Garcia, Anne Baker) sends emails concurring with these revisions.

April 18, 2016: Service transmits second draft biological opinion to the Corps with additional and/or revised conservation measures, mostly discussed previously. Among other changes, this includes revising (reducing) proposed beetle habitat impacts to those in the footprint only, and avoiding impacts to habitat within 100 feet of the footprint with measures, and confirming the effectiveness of such avoidance measures by post-construction monitoring.

April 22, 2016: Corps responds with review comments on the second draft biological opinion.

May 2, 2016: Service transmits third draft biological opinion to the Corps with a request for concurrence with the project description including conservation measures.

May 3, 2016: Corps responds that it concurs with the project description and conservation measure language and requests a small change in the placement of the compensation measure and language for effects on animal burrows of construction and grouting. Service and Corps staff confer by telephone and reach agreement on this language.

May 24, 2016: Service and Corps staff participate in teleconference to clarify closure gate description in the revised BA.

June 2, 2016: Corps provides updated analysis of closure gate operations including operating criteria, frequency, and duration.

June 3, 2016: Corps provides projected closure gate durations under an intermediate sea level rise scenario for 10 representative water years.

BIOLOGICAL OPINION

Description of the Action

The action covered by this consultation includes construction of the project, activities concurrent with construction to bring the project elements into compliance with Corps vegetation policies as described in the ETL, and operation and maintenance activities after construction.

Construction Activities:

The construction work consists of flood protection improvements involving 24 miles of levees in the Stockton area. The purpose of this work is to address seepage, slope stability, overtopping, and erosion concerns of levees adjacent to urban areas. Construction will occur on Mosher, Tenmile, Fivemile, Fourteenmile, and French Camp Sloughs, the San Joaquin and Lower Calaveras Rivers, Duck Creek, and Shima Tract. A variety of treatments and combination of flood control measures will be done to improve levees depending on specific location, including 20.1 miles of cutoff walls, 6.1 miles of geometric improvement (slope and crown reshaping), 3.5 miles of levee raises, 3 miles of seismic protection, 4.9 miles of erosion protection, and 0.95 mile of new levee[1]. The project also includes construction of two new in-water closure structures.

Cutoff Wall

The predominant measure proposed to improve levee performance will be installation of a vertical wall of low hydraulic conductivity material through the middle of the levee known as a slurry cutoff wall. The depth of the wall extends through and beyond the embankment and foundation and is usually tied into an impervious sub-layer. The methods used will be either the conventional open trench method for depths 70-80 feet (ft) or less, or the deep soil mixing

[1] Quantities are approximate linear distances; work width and total area of work vary with location and depend on levee height and other factors. The floodwall now to be substituted with a berm is considered new levee.

method for depths >80 ft. For either method, construction sites will be cleared, grubbed, and stripped of all vegetation, and the levee will be degraded to about half its height in order to provide sufficient working surface (~30 ft). After the slurry has hardened it will be capped, and the levee embankment reconstructed (or raised) as specified with impervious or semi-impervious soil. The levee soil surfaces will be hydroseeded after construction unless specified as crown roads or for erosion protection (see below). Equipment used for this type of feature will include heavy equipment such as haul trucks, front end loaders, bulldozers, cranes, backhoes and/or a long-trench excavator, scrapers, and various machinery for an on-site batch plant (where needed). This measure will be applied to Mosher Creek, Shima Tract, the lower Calaveras River, French Camp Slough, and portions of the San Joaquin River and Duck Creek.

In some areas which cannot be easily accessed such as around utilities and at bridges along levees, a jet grouting method will be used to install the cutoff wall. This involves rotary/rotary percussive methods to drill and fill interconnected columns with impermeable grout. Equipment consists of a drill rig and string, a high pressure/flow pump, batch plant, and associated generators, compressors, tanks, and silos.

Levee Reshaping (“geometric fix” or slope reshaping)

This measure involves grading high areas, and/or placing additional soil fill and compacting it to meet Corps design criteria for side slope (2 or 3:1) and crown width (12 or 20 ft). This requires clearing and grubbing the waterside crest edge, and stripping the landsides slope to remove 0.5-1 ft of material, and occasionally up to 2 ft of material. Material needed to correct levee geometry will be placed only on the land side, but reshaping may occur on both land and water sides. If this reshaping requires removal of rock revetment, the rock will be replaced. Relocation of land side toe drains and ditches will be done where required. The equipment needed is similar to levee raising (see below). This measure will be applied to portions of Tenmile Slough, the Calaveras and San Joaquin Rivers, and a portion of Duck Creek.

Seismic Remediation (Seismic Fix)

This measure involves a deep soil mixing technique to prevent liquefaction during a seismic event and also reduces seepage and increases landside slope stability. This technique is used to install a drilled grid of soil-cement mixture columns. There will be a series of overlapping such columns aligned longitudinally with and transverse to the levee alignment and which will extend beyond the levee prism. This measure will be applied to Fivemile, Fourteenmile, and a portion of Tenmile Sloughs.

For construction of this measure, areas will be cleared and grubbed. Except for Fourteenmile Slough, levees will be degraded to half their height, and the degrade material placed landward to form an extension of the existing levee. Deep soil mixing augers will be used to construct the columns, which will be filled with cement-bentonite slurry during the auguring. The levee crest will be topped with a 6-inch-thick aggregate road and the levee slopes reseeded.

In the portion of the project along Fourteenmile Slough where a setback is proposed as part of a conservation measure, seismic remediation measures will be constructed landward (west) of the setback from the slough, and a new levee will be constructed there. The old levee will be partially degraded. The land between the new and old levees will become a mitigation area for project impacts. The setback width will be 60-90 ft, and will occur within reach FM_30_L.

Levee Raise

This measure is prescribed where either the levee crown has slumped or to raise the existing levee height to maximize benefits. It is proposed for portions of Mosher Creek, Fourteenmile Slough, and the San Joaquin River. All of these areas also will have either a cutoff wall or seismic fix specified as well as erosion protection for Fourteenmile Slough only. Borrow material will be added to the land side after cutoff walls and levee reshaping improvements are completed. Any crown roads will be resurfaced with aggregate and the slopes reseeded (except for erosion protection areas). Construction requires that the waterside crest edge be cleared grubbed, and stripped of 0.5-2 ft of material. The landside slope and crown will be scraped or ripped and the raise material will then be placed and compacted. Heavy equipment such as a hitched scraper, disc, or ripper will be used to loosen material. Other typical equipment will involve a water truck, grader, dump trucks, bulldozer, and compaction equipment.

Floodwall

This measure will consist of a sheetpile floodwall from the southern portion of Dad's Point to Louise Park, about 3-4 ft high, possibly with a metal cap or encased in concrete, and 12-18 inches wide. The extent will be 825 ft in length. The improvement at this location may be a berm instead of a floodwall.

New Levee

This measure involves constructing a new levee to reduce risk to some areas or prevent outflanking the existing levee system. A new levee is planned for a portion of Duck Creek to tie into existing levee. Construction will involve clearing and grubbing the footprint area, and excavating a new foundation 3-6 ft deep. Material will be placed and compacted in short lifts. A gravel road will be constructed on the crown and slopes will be reseeded. The BA states that cutoff wall and erosion protection will be placed if needed, however, erosion protection at Duck Creek has since been deleted (see Consultation History). Equipment for new levee will be similar to that for levee raise.

A short earthen berm, which will be constructed and function similar to a new levee, may be constructed in lieu of the floodwall proposed near Dad's Point to high ground at Louise Park as part of the Smith Canal improvements. No construction details of this berm are currently available. The linear extent will also be about 825 ft, but the footprint width may be wider.

Closure Structure

This measure will involve construction of structures across Smith Canal and Fourteenmile Slough to prevent flooding from the San Joaquin River and Delta; for Fourteenmile Slough, it also will limit the level and duration of water saturation due to higher tides on private levees to the east to reduce the risk of their failure. Each structure will consist of a fixed sheet pile wall structure with an opening gate structure to allow tidal flows and boats to pass when open. A small building has been specified for the Smith Canal structure but since the Fourteenmile

Slough structure is a separate, scalable version, it may also require a building. The structure will tie into high ground, either the new berm for the Smith Canal structure or the levee for the Fourteenmile Slough structure. The structures will be routinely closed during any water stage equal to or greater than 8 ft North American Vertical Datum of 1988 (NAVD88) caused by high tides or high tide in combination with rain on snow flood events, as well as during emergency (e.g., failure along Smith Canal and Fourteenmile Slough levees to the east) (see Operation and Maintenance, below). The frequency and duration of gate closure operation is expected to increase during wetter water years, and over the life of the project due to sea level rise.

For portions of the sheetpile to be installed on land, vegetation will be cleared and grubbed for a 35-ft-wide footprint. For the portions of the sheetpile to be installed in water, installation will be done in water using a barge and tug boat. The structure will consist of two parallel sheetpile walls 20 ft apart. The space between the walls will be dewatered and filled with granular fill. Installation of the gate structure and its foundation will be done in the dry by constructing a metal sheet cofferdam for a 70 x 70 ft area. This area will be dewatered. Concrete cylinder piles (24 inch) will be driven inside the cofferdam, then concrete walls and floor, and then the metal miter gate. The gate for each structure will be 50 ft long. Equipment will include a barge, tugboat, vibratory hammer, crane, and vehicles for transporting equipment, material, and personnel.

Erosion Protection

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History).

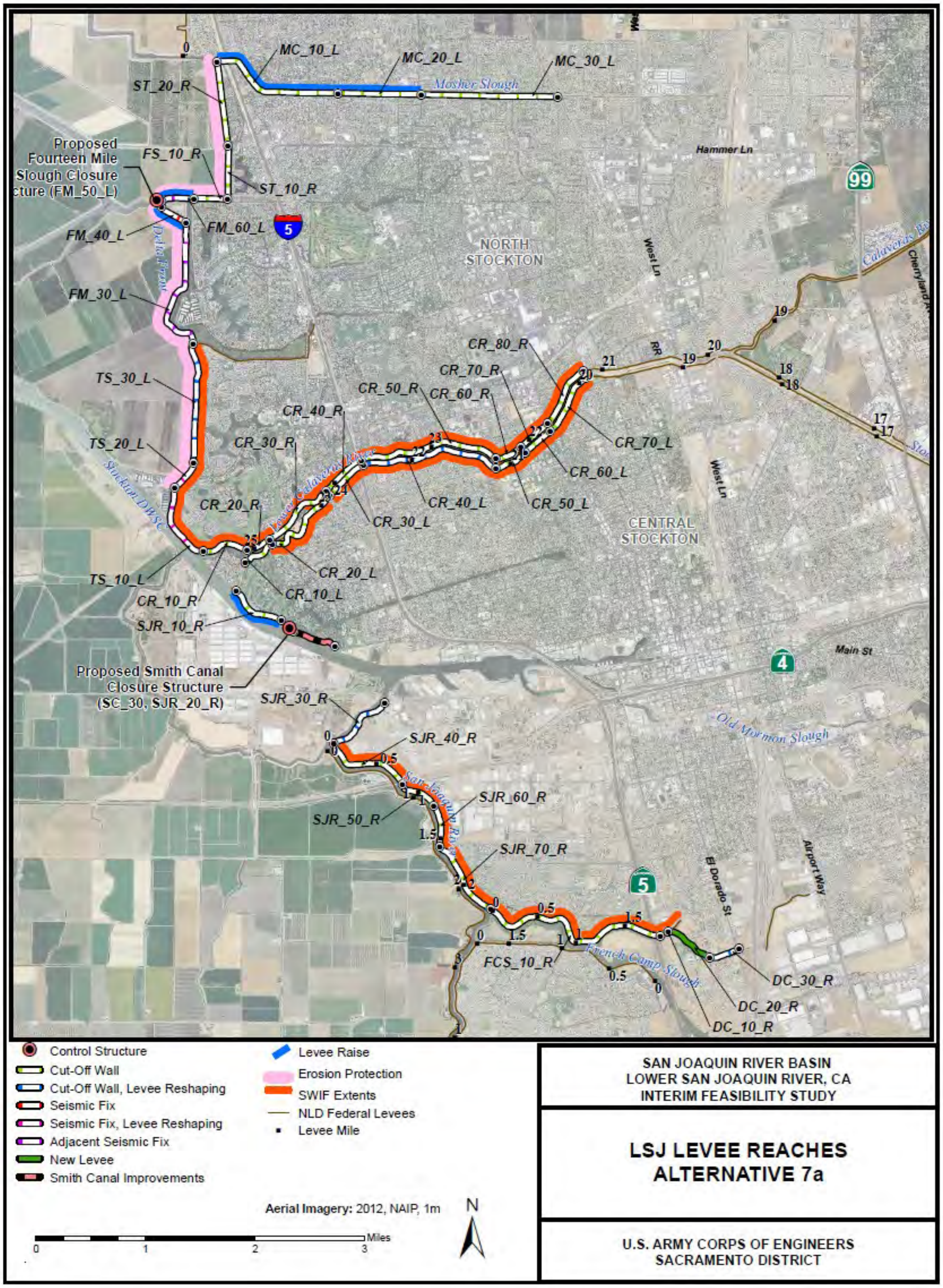
Conventional quarry stone riprap is proposed. A sand filter will be installed prior to riprap placement. Equipment used will be dump or belly dump truck, dozer, and hydraulic excavator. The riprap will be placed in a two-foot-thick layer along the full face of the levee from toe to crown.

A summary of the construction measures in each reach under the proposed plan (alternative 7a in the Feasibility Study) is provided in Appendix A and is depicted in Figure 1.

ETL Compliance Activities:

Additionally, the project includes treating encroachments either by removal, relocation, or otherwise bringing them into compliance with Corps policy. This includes structures, certain vegetation, power poles, pumps, and penetrations. The project also includes establishment of ETL compliant levees. ETL standard compliance is achieved by removal and maintaining free of woody vegetation the entire levees, floodwalls, and easements 15 ft landward and waterward beyond the levee toe or floodwall footing. A variance from the ETL standard may be considered after detailed engineering analysis which may allow some vegetation to remain if the analysis demonstrates that such vegetation does not imperil the levee. This analysis has not yet been done. However, based on the information available at the time of initiation of this formal consultation, the Corps expects that all vegetation shall be required to be removed from the entire

Figure 1. Lower San Joaquin River Feasibility Study Recommended Plan



landside slope and easement, and from the upper half of the water side slope. For the lower half of the water side slope and easement, the Corps expects that with an approved variance, up to 75% of the current vegetation cover shall be removed and at least 25% of this current vegetation will remain. Up to 50% of the vegetation on the lower waterside slope may be allowed to remain depending on the future project refinement and analysis. The amounts of removed and retained vegetation by reach have been estimated (see Consultation History: April 13, 2016 and Appendix B). These estimates of vegetation removal are based on projected canopy area.

The Corps anticipates it will formulate additional specificity in the vegetation maintenance prior to construction, as part of its variance request process and development of an operation and maintenance manual consistent with any approved variance. These will include necessary limitations in the basal diameter of woody vegetation, spacing between vegetation for purposes of inspection sight lines and flood fighting, and plant species. This variance will be requested and obtained prior to construction. Although the Corps expects that some vegetation will be allowed, it will likely differ in stature from the existing vegetation in some locations. Non-native trees, including nut trees, will probably be removed, as will large diameter trees generally, and not allowed to regrow. Stem or basal diameter sizes of remaining trees, and those which will be allowed in the future, will likely be limited to 8 inches or less. Vines and brambles will probably be removed entirely. The initial treatment of encroachments and vegetation will be done (and in some cases must be done) concurrent with construction, and is therefore considered part of the construction phase.

Operation and maintenance activities:

The project includes the continued operation and maintenance of the facilities after construction. Activities performed for operation and maintenance and their effects on listed species are covered by this consultation. The Corps is responsible for amending the operation and maintenance manual for levees and other facilities affected or created by the project, also referred to as the Operation, Maintenance, Repair, Replacement and Rehabilitation manual (OMRRR). The local sponsor to whom the project will be transferred will be required to implement the OMRRR. Generally, the levees will be required to be maintained to the as-built condition in perpetuity. This will require regular inspection, identification of any deficiencies, and implementation of actions. The type of actions will include: geometric adjustment due to any settlement (irregular, as needed); vegetation maintenance up to four times a year including mowing, removal or trimming of vegetation, and/or application of herbicide; patrol road maintenance; visual inspections; trash and debris removal as needed; invasive aquatic weed control and application of herbicide and mechanical removal; grouting of animal burrows; monitoring and protection of interior features (cutoff walls, jet grouting, seismic remediation) from encroachments or other ground disturbing activities; inspection and repair of floodwalls; and routine maintenance and repair as needed of the two closure structures. Only those activities within the footprint and easements of the improvements described in the LSJRFS are covered in this biological opinion. Activities in the channel such as silt removal, aquatic weed control, and/or removal of vegetation or other materials will require separate consultation.

There are also existing operation and maintenance requirements for the channels associated with the proposed improvements which could affect the snake. Specifically, the Calaveras River from the San Joaquin River upstream to McAllen Road, which includes a number of reaches of this proposed project, is part of the Mormon Slough Project. The existing OMRRR for that project requires inspections and maintenance of any shoaling or debris that affects floodway capacity, including (p. 22, Mormon Slough Project OMRRR) "weeds and other vegetal growth in the channel shall be cut in advance of flood season and together with all debris, removed from the channel" and (p. 23) "during periods of high water...Appropriate measures shall be taken to prevent the formation of jams of debris." Portions of the project channels appear to be at least partially maintained (e.g., Calaveras River, North Pershing Ave. to El Dorado Street), while others appear in a more natural state (e.g., Calaveras River west of North Pershing Avenue; French Camp Slough).

There is insufficient description of channel maintenance to evaluate effects on listed species at this time. Accordingly, channel maintenance and effects thereof on listed species are not considered nor authorized in this biological opinion. Only those OMRRR activities within the footprint and easements of the improvements described in the LSJRFS are covered in this biological opinion. As necessary, the Corps will consult separately or re-initiate consultation for effects of channel maintenance such as silt removal, aquatic weed control, and/or removal of vegetation or other materials.

Conservation Measures:

The following general, avoidance and minimization, and compensation measures shall be implemented:

General Measure

- Overall construction affecting habitat of any listed species will be scheduled and sequenced to the minimum period necessary to complete the work, generally, 3 years for the Central Stockton area reaches (2018-2020) and 8 years for the North Stockton area reaches (2021-2028). Should the work period differ in either timing or duration by more than 5 years from these periods, the Corps shall re-initiate consultation.

Delta Smelt

Construction Phase:

Avoidance and Minimization Measures

- Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Implement erosion control measures (BMPs) including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. Install and monitor BMPs for effectiveness, and

maintain BMPs throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.

- Schedule construction when smelt will be least likely to occur in the project area. Complete avoidance will be assumed if in-water work is completed between August 1 and November 30. However, the Corps anticipates the need to begin in-water work on the gates for the two closure structures as early as July. Since construction needs to extend into the timeframe when smelt may be present, the Corps will develop and submit to the Service prior to construction, a fisheries protection plan that includes measures and monitoring, and/or additional compensation, to offset the effect of this in-water work on smelt.
- Limit site access to the smallest area possible in order to minimize disturbance.
- Remove litter, debris, unused materials, equipment, and supplies from the project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
- Immediately (within 24 hours) clean up and report any spills of hazardous materials to the resource agencies. Report any such spills, and the success of the efforts to clean them up, in post-construction compliance reports.
- Designate a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped, threatened or endangered species. Identify this representative to the employees and contractors during an all employee education program conducted by the Corps.
- For work between December 1 and July 31 that involves pumping, screen any water pump intakes as specified by Service screening specifications. Water pumps will maintain flows to keep approach velocity at the pump screens at 0.2 ft per second or less when working in areas that may support delta smelt or juvenile salmonids.

Compensation Measures

- The Corps proposes to offset the permanent open water impact of an estimated 1 acre, due to construction of the two closures structures by purchase of 3 credits (acres) at a Service-approved conservation bank.

- The Corps proposes to offset the effect of operation of the closure structures on tidal action in an estimated 233 acres combined in Fourteenmile Slough and Smith Canal by purchase of 120 credits (acres) at a Service-approved conservation bank.

Giant Garter Snake

Construction Phase:

Avoidance and Minimization Measures

- For each discrete reach affecting snake habitat, construction will be initiated during the snake active period (May 1–October 1) and prior to September 15, but may continue beyond the active period provided that work is continuous (lapses shall be no greater than 24 hours).

- All construction personnel, including workers and contractors, will participate in a worker environmental awareness training program conducted by a Service-approved biologist prior to commencement of construction activities.
- Reach specific monitoring and inspection will be conducted appropriate to the potential for snake presence as indicated by the proximity to and quality of habitat. This will include one or more of the following measures as specified in Appendix A: (a) a pre-work inspection sufficient to detect active snakes before any construction, to occur no sooner than 24 hours prior to initial construction in potential habitat; (b) a morning inspection before each work day, including the work site, and any parked equipment; (c) an additional second inspection of habitat during construction for each work day; (d) continuous[2] monitoring during all work; and/or (e) a choice of either exclusionary fencing in those reaches where it is possible (i.e., Calaveras River from North Pershing to El Dorado St.; Duck Creek work) or continuous monitoring. Should there be any interruption in work for greater than two weeks, a biologist will survey the project area again no later than 24 hours prior to the restart of work.
- If the Corps elects to use exclusionary fencing in lieu of continuous monitoring, it will be buried at least six inches below the ground to prevent snakes from burrowing and moving under the fence, and will be inspected daily.
- Snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas; where possible, these will be located more than 200 ft away from snake aquatic habitat.
- Snake habitat within 200 ft of construction activities will be designated as an environmentally sensitive area and delineated with signs and high visibility fencing. Fencing will be inspected and maintained as needed daily until completion of each work section of the project. This area will be avoided by all construction personnel.
- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- The Service, National Marine Fisheries Service, California Department of Fish and Wildlife, and the Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be onsite and used if a frac-out occurs. Containment materials, such as straw bales, also will be onsite prior to and during all operations, and a vacuum truck will be on retainer and available to be operational onsite within notice of 2 hours. The site

[2] "Continuous monitoring" means that an approved monitor is conducting continuous visual examination for snake presence throughout the workday within and immediately adjacent to work sites. Monitoring protocols are not specified at this time and are subject to Service approval.

supervisor will take anynecessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks) as needed.

- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1ft, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- Project-related vehicles will observe a 20-mile-per-hour speed limit within construction areas, except on existing paved roads where they will adhere to the posted speed limits.
- Aquatic habitat for the snake which will be affected by construction will be inspected for the snake, then dewatered, and maintained dry and absent of aquatic prey for 5 days prior to the initiation of construction activities. This measure applies primarily to the ditches to be relocated west of the Delta front levee sections. If complete dewatering is not possible, the Service will be contacted to determine if any additional measures may be necessary to minimize effects to the snake.

Compensation Measures

- Habitat (primarily upland) temporarily impacted for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants. This includes 111.5 acres of upland snake habitat primarily between the edge of the levee crown to the waterside easement of work locations (excludes hard surfaces) impacted by cutoff wall, seismic fix, levee raise, and/or reshaping actions; all temporary fill and construction debris shall be removed prior to such restoration work. Landside aquatic habitat consisting of ditches on the Delta Front reaches are considered temporarily impacted because they will be re-created west of the new setback levee there.
- Aquatic habitat permanently impacted will be replaced at a 3:1ratio. This includes the portion of the permanent closure structure at Fourteenmile Slough. The estimated area of permanent impact is considered to be no more than 0.5 acre, for which the Corps will provide no more than 1.5 acres of compensation at an approved mitigation bank.
- Upland habitat permanently impacted will be replaced at a 1:1ratio. This includes an estimated 12.5 acres (footprints of the permanent closure structure at Fourteenmile Slough, new road surfaces on the Duck Creek levee, and landside armoring along Fourteenmile Slough). The Corps will provide up to 12.5 acres of compensation at a Service- and Corps-approved mitigation bank.
- Animal burrows exist throughout the project footprint (includes easements). These burrows are a special element of upland habitat used by the snake as refugia. Animal burrows in the footprint will be removed or filled as part of construction activities and new animal burrows will be subject to grouting throughout the project life as part of operation and maintenance. To offset the effect on the snake of construction and grouting of animal burrows for all reaches of the project considered potential snake habitat, there will be a one-time purchase of 22.62 snake credits at an approved snake

conservation bank before any project construction[3].

- The Corps will ensure that mitigation is acquired prior to any disturbance of snake habitat. Habitat will be protected, managed, and maintained, in perpetuity.
- Quantify alternative snake refugia (i.e., alternatives to animal burrows, consisting of upland features within 30 ft of snake aquatic habitat, including but not limited to brush piles; riprap with voids sufficient to allow snake use; animal burrows in uplands outside of maintenance zones but within levees, including islands). This assessment will be done within one year prior to the initial onset of project work, and repeated at five year intervals until completion of all project work in the LSJRFS.

Operation and Maintenance Phase:

Avoidance and Minimization Measures

- Snake-impacting OMRRR activities will be planned so that they occur between May 1 and October 1 during the snake's active season so as to minimize impacts to the species.
- Grouting of animal burrows on upland within 30 water side ft of snake aquatic habitat will only be done between May 1 and September 1, and during times of day when air temperatures are between 13 and 34 degrees Centigrade (55.4 and 93.2 Fahrenheit). Grouting will be permitted without restriction on levee road and ramp road surfaces, on the land side of the levee, and on upland farther than 30 ft from the water side.
- Construction personnel will participate in Service-approved worker environmental awareness program.
- A snake survey will be conducted 24 hours prior to beginning OMRRR activities in potential habitat. Should there be any interruption in work for greater than two weeks; a biologist will survey the project area again within 24 hours of restarting work.
- Snakes encountered during OMRRR activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from construction associated with OMRRR will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 ft away from snake aquatic habitat.

Valley Elderberry Longhorn Beetle

Construction Phase:

[3] 22.62 credits = Length sum of 54,750 ft (reaches Calaveras reaches CR_30_R, CR_40_R, CR_50_R, CR_60_R, CR_70_R, CR_80_R, CR_10_L, CR_20_L, CR_30_L, CR_40_L, CR_50_L, CR_60_L, CR_70_L; French Camp Slough reach FCS_10_R; and Duck Creek reaches DC_10_R, DC_20_R, and DC_30_R) X 30 ft X 0.2 (factor of 20% reduction in snake upland quality due to summer grouting assumes that some non-burrow refugia habitat, or ephemeral burrows between maintenance inspection/actions, will remain, and that a variance is approved)/43,560 square ft per acre x 3 (3:1 ratio of compensation:effects).

Avoidance and Minimization Measures

The following measures based in part on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999; hereafter "Conservation Guidelines") will be implemented to minimize any potential effects on beetles or their habitat, including restoration and maintenance activities, long-term protection, and compensation if shrubs cannot be avoided:

- When a 100 ft (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-ft buffer has been approved by the Service, a setback of 20 ft from the dripline of each elderberry shrub will be maintained whenever possible.
- Shrubs that are closer than 100 ft to any work, but outside the construction footprint (construction, ETL compliance, OMRRR) are assumed to be avoided by the application of other avoidance measures such as signage, fencing, worker education, and post-construction monitoring that demonstrates no effect on health and viability (see compensation measures, below), and will not be subject to transplantation or the need for offset compensation.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors and work crews will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 ft along the edge of the avoidance area identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction from adverse effects of the project, such as during maintenance actions.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Trimming of elderberry plants is subject to mitigation measures.
- Elderberry shrubs that cannot be avoided will be transplanted to an appropriate riparian area at least 100 ft from construction activities or to an approved conservation bank.
- Elderberry shrubs to be removed will be transplanted during their dormant season (November 1-February 14).
- Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity.
- The Corps will work to develop and identify on- and off-site compensation areas prior to any take of beetles.
- The Corps will submit its site suitability study to the Service for review and comment prior to implementation; and request and receive written concurrence from the Service that the site(s) is suitable for compensation for this project prior to construction.

- Management of compensation areas will include all measures specified in the Conservation Guidelines related to weed and litter control, fencing, and the placement of signs.
- Monitoring of compensation areas will occur for five consecutive years. Annual monitoring reports will be submitted to the Service.
- Dust control measures shall be implemented when construction activities take place within 100 ft of elderberry shrubs.
- Off-site compensation areas will be protected in perpetuity and have a funding source for maintenance.

Compensation Measures

Compensation for landside and waterside effects to the beetle will be addressed in accordance with the Conservation Guidelines under the presumption that effects on shrubs outside of the footprint (construction and easement areas) will be avoided by application of conservation measures. Removal of elderberry shrubs in the footprint to be transplanted would occur prior to construction during dormancy. Transplants and compensatory seedlings and associated native plants would be planted at a Service and Corps approved site, which could include the compensation area described below, or other suitable sites not yet identified. If another site other than that described is proposed, the Corps will coordinate with the Service through reinitiation of formal consultation.

The proposed compensation area for the beetle is within the seismic remediation area with setback located on Fourteenmile Slough cost reach FM_30_L (Figure 1). The plantable area will include land from the degraded levee (i.e., including the degraded levee as plantable) to the edge of the new levee easement. Based on the affected number of stems, the Corps proposes to plant 196 plantings (Table 1). This is based on the continued survival of the 18 shrubs which are near (but not within) the footprint area. To document that avoidance measures are effective in protecting these shrubs, the Corps will assess their health and condition no sooner than the season prior to construction at that location, and for 2 years following completion of the construction. Shrubs which die or show a major decline in condition during this period will be compensated offsite in accordance with the Conservation Guidelines.

Operation and Maintenance Phase:

The avoidance, minimization, and compensation measures described here are examples of the types of measures that may be appropriate during the operation and maintenance phase of the project.

Avoidance and Minimization Measures

When a 100-ft (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.

- Where encroachment on the 100-ft buffer has been approved by the Service, a setback of 20 ft from the dripline of each elderberry shrub will be maintained whenever possible.

- During maintenance activities, all areas to be avoided will be fenced and flagged.
- Maintenance personnel will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Dust control measures shall be implemented when OMRRR activities take place.
- Maintenance workers will be trained on identification of elderberry plants.
- No restrictions or measures are required for areas which are to be maintained free of any woody vegetation; it is assumed these areas will be maintained on an interval such that any elderberry plants will not achieve the minimum 1 inch necessary for potential beetle occupation.

Table 1: Elderberry Compensation Worksheet for the Lower San Joaquin River Feasibility Study.

Affected elderberry plant compensation ratios based on location, stem diameter, and presence of exit holes

Worksheet			No. of Stems	elderberry ratios	elderberry planting	associated native planting	native ratios
Location	**stems**	**Holes present?**		**multiplier (ratio)**			
non-riparian	greater than or = 1" & less than or = 3"	No	**27**	1	27	**27**	**1**
non-riparian	greater than 3" & less than 5"	yes	**0**	2	0	**0**	2
	greater than 3" & less than 5"	No	**7**	2	14	**14**	1
non-riparian	greater than or = 5"	yes	**0**	4	0	**0**	2
	greater than or = 5"	No	**6**	3	18	**18**	1
riparian	greater than or = 1" & less than or = 3"	yes	**0**	6	0	**0**	2
	greater than or = 1" & less than or = 3"	No	**39**	2	78	**78**	1
riparian	greater than 3" & less than 5"	yes	**0**	4	0	**0**	2
	greater than 3" & less than 5"	No	**9**	3	27	**27**	1
riparian	greater than or = 5"	yes	**0**	6	0	**0**	2
	greater than or = 5"	No	**8**	4	32	**32**	1
Totals			**96**		**196**	196	

- For reach areas with approved vegetation variances and planned for maintenance, elderberry bush surveys will be done prior to and in the same season as maintenance, identifying the number of elderberry bushes and stems by diameter size class, and noting any exit holes or live beetles observed (see Table 1 for information format).

After construction, elderberry plants may establish or re-establish in project reach areas that will be subject to routine OMRRR activities (i.e., other than compensation area(s)). Areas with approved variances could support elderberries with stem sizes larger than the minimum 1 inch considered potentially occupied by the beetle. These may require removal and/or trimming of elderberry plants. The proposed measures for these types of OMRRR activities are as follows:

- Trimming of an elderberry bush will be allowed without compensation provided it removes no more than one-third of either the total stem diameter of stems >1 inch, or the projected canopy area of that bush.
- Removal of entire bushes will be allowed without compensation provided the action removes no more than one-half of the number of bushes in a reach with equivalent or lessor combined canopy area than those remaining.
- Trimming of bushes will be allowed no more frequently than every third year.
- Trimming or removal of bushes will be done between July 1 and February 28.

Compensation Measures

- Trimming in excess of the one-third allowance will involve compensation at a Service-approved site of two elderberries and one associated planting for every bush excessively trimmed, provided that the over trimmed bush is determined to have survived to the following season.
- Excessively trimmed bushes will be inspected for vitality the season following; if the over trimmed bush is dead, it will be assessed for stem diameter losses and compensated in accordance with the Conservation Guidelines.
- Removal of entire bushes in excess of the one-half allowance will be compensated in accordance with the Conservation Guidelines.

Additional Minimization and Conservation Measures (all listed species)

To further avoid and minimize project effects on listed species and their critical habitat the Corps will conduct the following additional measures during the Preconstruction Engineering and Design (PED) phase, and prior to construction:

- Evaluate the suitability of the levees for an ETL 1110-2-583 vegetation variance. Where suitable, pursue a vegetation variance that would allow woody vegetation to remain on the lower waterside portion of the levee and within the 15ft waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements. It is anticipated that a vegetation variance, if approved, will allow at least 25% of the woody vegetation, as measured by projected area, to remain on the lower waterside portion of the levee and within the 15ft waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements, floodwall, or closure structures), in each reach. This consultation request applies solely to the circumstance in which a variance is approved in advance of construction. If a variance is not sought, or not approved, the Corps will reinitiate consultation.

- Develop the information necessary to evaluate the feasibility of establishing Shaded Riverine Aquatic (SRA) and shallow water habitat compensatory mitigation outside of the vegetation-free zone (or within it where a vegetation variance is approved) along the Lower Calaveras River.
- Minimize vegetation removal to the extent feasible.
- Minimize, to the extent possible, grubbing and contouring activities.
- Identify all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporate sensitive habitat information into project bid specifications.
- Incorporate requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service, a pre-construction accounting of the actual amount of listed species habitat expected to be temporarily and permanently affected by the project, and proof of the acquisition or completed construction of any required compensation habitat needed to offset these effects.
- The Corps will reinitiate consultation during the Preliminary Engineering and Design (PED) phase if there are changes in effects to listed species due to design refinements.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area includes all areas where any type of construction, ETL compliance action, or operation and maintenance action will occur; staging areas and transportation routes used for this construction (not specified at this time); areas to the east of the two closure structures where tidal exchange will be limited by operation of such structures (i.e., Fourteenmile Slough and Smith Canal); the portion of Fourteenmile Slough to the west of the proposed closure structure, where local tidal exchange will also be affected; and the setback area in reach FM_30_L designated for mitigation plantings; and any other mitigation bank sites deemed necessary to offset impacts (i.e., approved conservation banks, not specified at this time).

Analytical Framework for the Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components for the snake, beetle, and smelt: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of these species and the role of the action area in the survival and recovery of these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework for the Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of critical habitat for the delta smelt in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the delta smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide will remain functional (or will retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the delta smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species and Environmental Baseline

Delta Smelt Status of the Species

For information on the status of delta smelt, please see our most recent 5 year review and 12 month finding for delta smelt (Service 2010a, b). We found that the status of the species warrants reclassification from threatened to endangered, but that this reclassification is precluded by higher priority actions.

Status of the Delta Smelt Critical Habitat

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code). The Primary Constituent Elements (PCEs) are physical habitat (PCE#1), water (PCE#2), and river flow (PCE#3).

Delta Smelt and Critical Habitat Environmental Baseline

The action area of the proposed project includes tidal waterways of the Delta that are wholly within critical habitat for the species. Adult delta smelt will be expected to migrate from the western Delta into these waterways in the winter and spring months, with typical spawning occurring during April through mid-May, but the species may be present as early as December. Larval smelt will move west in the spring and summer and rear in the low salinity zone. The action area includes shallow subtidal waters that can be used by the species. The project area also includes adjacent levees and vegetation; however, the quality of that habitat for smelt varies with location within the project area and the immediate vicinity. Some portions of the project area include heavily armored channels with limited vegetation on levee slopes or in adjacent shallow water. Other parts of the project area have less armoring and more vegetation growing on the levee slopes. Portions of the action area consist of shallow subtidal waters interspersed with emergent marsh vegetation adjacent to the proposed work; this includes fragments throughout the project area, as well as larger habitat blocks on Fourteenmile Slough both east and west of the proposed closure structure, on the lower Calaveras River, and on French Camp Slough.

The overall numbers of delta smelt have dramatically declined in the last 10 to 15 years, and the species population has fallen to very low numbers during the most recent drought period (2011-2015). The Fall Midwater Trawl index (FMWT) fell to a record low of 7 for 2015 after a previous record low of 9 in 2014 (CDFW 2016). By comparison, the prior historical low of the FMWT was 17 in 2009, down from a recent increase in the FMWT to 343 in 2011.

Delta smelt observations have been recorded in the California Natural Diversity Database (CNDDB) along the mainstem San Joaquin River within the project area as recently as 2004, and more recent records are known to the north and west on waterways contiguous to the project area including Little Potato Slough, the Mokelumne River, Frank's Tract, and Empire Cut. Adult and larval delta smelt have also been captured in the near vicinity of the project area. Because of the presence of the primary constituent elements needed for delta smelt spawning, the location of the project area within critical habitat, and the existence of known records, we conclude that delta smelt are present in the action area.

Giant Garter Snake Status of the Species

For the most recent Service assessment of the species' range-wide status, please refer to the *Giant Garter Snake (Thamnophis gigas) 5-year Review: Summary and Evaluation* (Service 2012). It is the largest garter snake species and endemic to the Central Valley. Ongoing threats to giant garter snake include habitat loss from urbanization, the resultant fragmentation and population isolation, flood channel maintenance, agricultural practices (e.g., rice fallowing due to drought conditions, habitat disturbance and loss from irrigation and drainage ditch maintenance), climate change, water transfers, and invasive species. Our review emphasizes urbanization as one of the greatest threats to the species, particularly where associated with rice agriculture. While these threats continue to affect the giant garter snake throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the giant garter snake.

According to Halstead et al. (2015a), habitat quality plays a central role in the population ecology of this species, depending on factors like refuge and prey availability, vegetation type and density, and scouring floods. Our revised draft recovery plan outlines actions needed to protect and enhance the species sufficiently to remove it from the list of endangered species (USFWS 2015). This includes but is not limited to, the protection, connection, and improvement of the quality and presence of habitat through various management actions aimed at water quality and presence of summer water.

More recent studies examining the use of uplands have bearing on the effects of the proposed project (Halstead et al. 2015b). It has been known for some time that the giant garter snake spends half of the year, roughly November through April, hibernating in uplands. However, it is now known that the snake also spends more than half the time in terrestrial environments during the active period during summer. While in such terrestrial habitats in summer, the snake is often underground, especially during extreme temperatures. Animal burrows are believed to be an important component of upland refugia, although other elements such as brush piles and even riprap may be used (e.g., Wylie and Amarello 2008). Although snakes can venture as much as 500 ft or more from the water edge, the overwhelming majority of both the summer and winter upland captures are within the first 10 meters from the water edge.

Giant Garter Snake Environmental Baseline

Most information on the status of the snake comes from work on agricultural and managed refuge lands; much less is known about the snake outside of these areas in other habitats. Nevertheless, scattered records documented on the CNDDB indicate a wider distribution that includes marshes and waterways of the Delta, which includes and is hydrologically connected to the proposed project area. Other than historic records, the nearest post-development sightings to the project area are both from 1976: the Stockton Diverting Canal, about 2.7 miles away, which connects to the Calaveras River, and Pixley Slough, about 2 miles away. More recent (i.e., up to 2010) and frequent sightings have been recorded in the White Slough Wildlife Area, about 4-6 miles to the north of the project area. A few snakes have also been documented on lands near major waterways in the western Delta as recently as 2016, including the Sacramento River (Sherman Island), Frank's Tract (Webb Island), Twitchell, Jersey and Bradford Islands, and the San Joaquin River (Little Venice Island). In the Little Venice Island sighting in 1996, several snakes were seen, including one which moved into riprap. The project area includes permanent waters with varying amounts of aquatic vegetation and adjacent uplands which could potentially support the snake (Appendix A). The distribution of the snake and range of habitat types in which it has been observed, lead us to conclude that the snake is present in the project area.

Valley Elderberry Longhorn Beetle Status of the Species

The Service designated the beetle as threatened and proposed critical habitat on August 8, 1980 (45 FR 52803) and approved a final Recovery Plan on June 28, 1984. A 5-year review was completed on September 26, 2006, which determined that the beetle had recovered and therefore recommended delisting. A proposed rule to delist the beetle was published on October 12, 2012 (77 FR 60237). After public comment and peer review, that proposal was withdrawn on September 17, 2014 (79 FR 55879).

This wood boring beetle is a subspecies of the California elderberry longhorn beetle which persists in small isolated populations in the California Central Valley in riparian areas which have a component of elderberry savannah. The listed subspecies is typified by sexual dimorphism, in which the male shows a predominantly red elytra. The primary threat to the species is habitat loss, particularly along major river systems that are known to have supported the species, often as a result of urban or agricultural development and flood control actions (both construction and operation and maintenance). Additional major threats are that of extinction due to small population size, predation from alien species such as the Argentine ant, inadequate protections (other than the Endangered Species Act), pesticides, non-native plants of various types that compete with native riparian vegetation including elderberries, and other factors. The beetle itself is rarely seen, and the vast majority of its detection reported in the CNDDB have been inferred from the presence of exit holes in plant stems.

The period since listing to the present has witnessed considerable population and urban growth in California at the expense of remaining riparian habitat and adjacent upland habitat near river systems that supported elderberry. Elderberry plants can colonize and persist on levees and nearby lands as well, and some beetle and exit hole records have been reported in this type of habitat. This form of habitat is often the result of deferred maintenance. However, Federal flood control improvements including the currently proposed project, as well as State-wide initiatives to improve the standard of flood control in urban systems generally, have resulted in levee improvements and more rigorous maintenance that has eliminated this habitat. Mitigation is typically done off-site in banks, and habitat enhancement has been almost entirely limited to Federal and State refuge lands in the north Central Valley. In sum, since listing, there has been a progressive further decline in beetle habitat amount and distribution with increasing discontinuity between remaining habitat fragments, reduced frequency of sightings, and likely curtailment of the range of this species.

Valley Elderberry Longhorn Beetle Environmental Baseline

Most of the records of adult beetles date from the 1980s and 1990s or earlier. With the exception of recent pheromone trials on a Service refuge that yielded ~20+ captures in 2014, only about a dozen other beetle specimens have been seen anywhere in the last 15 years, and the majority of these were in conservation areas on Federal or State lands or conservation banks in the North Central Valley. In the proposed project vicinity, a sighting of adult beetles (including a male) in 1984 has been reported near Middle River, about 4.5 miles west of the nearest proposed project feature. In the region, there were several beetle exit holes detected along the Calaveras River near Linden, roughly 8 miles east of the project area, and along Bear Creek near Lockeford, about 15 miles north of the project area, all in 1984. Upon re-examination in 1989 by Barr (1991), these particular vicinity locations no longer supported beetles nor live elderberry plants. Other studies of formerly occupied areas of both South and North Central Valleys have shown complete loss of elderberry plants, negative surveys for beetle holes, or very low occupancy (Collinge et al. 2001; Kucera et al. 2006; River Partners 2007; Holyoak and Graves 2010).

The project area includes potential habitat for the species which will be affected by the proposed action. Woody vegetation of variable densities is present throughout the project area, depending on the extent and intensity of maintenance of the current levees. Based on surveys conducted in 2015 (BA pp. 72-74), the Corps estimates that up to 44 elderberry shrubs could be affected by the proposed project (i.e., in the footprint or within 100 ft of the project footprint boundary). These elderberry shrubs are located along certain project reaches of Tenmile Slough, the Calaveras River, and the San Joaquin River. The plants include stems larger than 1 inch and some greater than 5 inches, indicating a size sufficient to support the beetle. Because of the presence of shrubs, location in or near riparian habitats, and documented records of beetles and exit holes in the region, we conclude that the beetle is present in the project area.

Effects of the Action

Delta Smelt

For the purposes of this consultation, Shallow Water Habitat (SWH) - that habitat which is assumed to be usable by delta smelt and for which direct effects may occur - is bounded by an upper limit at mean high water, and a lower limit 3 meters below mean lower low water.

Construction along portions of the project subject to levee reshaping may require removal and replacement of water side revetment. Such levee reshaping is specified for mainstem San Joaquin River reach SJR_30_R (3,500 lineal ft) and the south (left) bank of the lower Calaveras River at reach CR_40_L (6,900 lineal ft). BA Figure 5 shows the corrective method to involve placing additional material on the land side, while BA text (p. 17) states that some existing levees with slopes as steep as 2:1 "may be acceptable if slope performance has been good and if the slope stability analyses determined that factors of safety to be adequate." No such analyses are yet available. It is undetermined at this time what if any waterside revetment may be placed (or replaced). For the purpose of this consultation, we have assumed that no direct construction impact, either temporary or permanent will occur within SWH due to levee reshaping. If this assumption is later determined to not apply and impacts to SWH become known, the Corps will need to reinitiate consultation.

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in a combined permanent loss of 1 acre of SWH and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance. Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of 233 acres of SWH in waters isolated by the structures (66 acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[4]).

Based on updated information provided by the Corps since the BA was issued, gate closure operations are expected to increase over the 50 year project life due to sea level rise. Just after project completion, around 2025, the closure structures would be operated rarely, generally during the wettest of year types such as 1983 and 1997. Under such extremely wet conditions, the gates may close for a full tidal cycle each day for several weeks during the January-March period. Under other water year types, the gates would be rarely operated. However, after several decades and certainly by the end of the project life, sea level rise will require much more frequent gate closure operations and for longer periods during the January-March period when delta smelt may be present. The frequency of gate closure of 6 hours or more would still be greatest in wet years but could occur every day for a full tidal cycle for several months. Additionally, sea level rise will require moderately frequent short term gate closure on the order of 2-4 hours per day for several days to weeks in all months, including summer months, in all year types. Even with sea level rise, the gates would not be continuously closed for a full day or more except during major events during the wettest water years (1-2 times per century).

As sea level rises, the timing of this operation will overlap an increasing proportion of the delta smelt spawning season. Adult smelt seeking areas to spawn could be prevented from entering the area isolated by the closure structure, or could be trapped behind the closure structure. Trapped adults may spawn behind the structure and the eggs or newly-hatched larvae would likely be adversely affected by isolation from tidal flows. Because of the current rarity of smelt and variability in spawning timing, it is not possible to predict the magnitude of such impacts nor avoid them. However, smelt upstream movements may be cued by the same tide and precipitation events that require gate closure. If this is the case, the effect on smelt could be greater than that predicted from the relative proportion of time that the gates are closed.

Long term monitoring of the delta smelt indicates that its distribution within the Delta varies between years and, while it has not been seen in the project area recently, the species was

[4] Service rough estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion it is assumed that all surface water in these eastern channel areas falls within the SWH limits discussed in this section.

detected in prior years when the population was somewhat more abundant. For example, adult smelt were noted in Spring Kodiak trawls in 2003 and 2004 slightly to the north and west of the project area. A small numbers of larval smelt were captured in April 1999 on the San Joaquin River near the confluence with the Calaveras River, within the project area. Records of beach seining at Dad's Point, which is at the mouth of Smith Canal where one of the closure structures is proposed, include captures of small numbers of adult smelt from 1979 to 2000. Taken as a whole, we believe it is likely that delta smelt do occur in the project area and would be affected by gate closure operations on Smith Canal and Fourteenmile Slough. To assess this conclusion, we have developed a Term and Condition for limited pre- and post-project sampling for smelt and other representative information in the sloughs affected by the closure structures. However, the ability to detect smelt from such sampling is limited by the extremely low populations. Additionally, sampling results cannot be used to manage gate operations because gate closure operations is strictly based on water stage to avoid the risks of levee damage and failure.

The effect of this expected gate closure on the species is difficult to estimate, but is potentially significant. Tidal flows have a wide range of benefits, including the transport of nutrients, organic matter, animals, and food organisms, and the establishment and maintenance of a salinity gradient. The tidal prism (i.e., the volume of water exchanged between low and high tide) would be incrementally reduced by gate operations. The timing of the longer gate closures, in January-March, overlaps the period of smelt potential occurrence and spawning in the project area and has the obvious potential to impact the species. The more frequent short term gate closures, which would eventually occur in all months, may have adverse impacts on fish behavior and interactions. For example, many smaller fish species school and predators feed during and around slack tides, including the highest tides which would be affected by gate closure. The manner in which gate closure operations affect these interactions cannot be easily estimated or measured.

Throughout the project, the proposed removal of vegetation and maintenance of portions of levees free of vegetation along channels will reduce these inputs and incrementally affect the quality and productivity of connected tidal waterways. Inputs of wood, leaves, terrestrial insects, and organic matter generally are a function of the presence of riparian vegetation. These inputs can provide a resource base supporting food organisms and a spawning substrate used by a variety of fishes including delta smelt.

Benefits to delta smelt will accrue from the purchase of 123 credits from a Service-approved conservation bank. The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. For this reason, we believe that the 123 credits proposed are appropriate compensation for the effects on the 233 acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

Delta Smelt Critical Habitat

This opinion on the critical habitat for the delta smelt does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U. S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to critical habitat.

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about 1 acre and temporarily affect 3 acres. These effects will be offset through the purchase of 3 credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on 233 acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of 120 credits at a delta smelt conservation bank.

Giant Garter Snake

Much of the proposed project construction occurs in uplands within 30 feet to aquatic habitat that could be considered potentially occupied by the snake during the active season. Although the quality of this potential snake habitat varies, the extent of this habitat is beyond the reaches identified in the BA. BA Plate 2 identified as snake habitat only the project work reaches along Fourteenmile Slough and portions of the north and south banks of the Calaveras River east of I-5. Based on our review of the BA and site visits to the project area, the Service considers portions of Mosher Slough, Shima Tract, and Tenmile Slough, and all of French Camp Slough and Duck Creek to be potential snake habitat as well.

Several of the construction methods proposed (cutoff wall, levee reshaping, seismic fix, levee raise, new levee) will involve upland disturbance that will at least temporarily affect snake upland habitat. Where levees are modified, clearing and degrading the top half of the levee to provide a platform of at least 30 ft wide is needed. Much of the work is designed so that most, but not all, of the disturbance is on the land side of the levee. Nevertheless, most of the upland work is within 200 ft of aquatic habitat that is considered snake habitat. Snakes will not be able to use this area for refugia, and any burrowing snakes present before construction begins could be killed. Snakes might enter the site and be crushed by heavy equipment. These effects will be minimized by the proposed inspection before construction, and monitoring during work, and exclusionary fencing where possible and appropriate. Most of this upland habitat will be restored within one season or less after construction. However, there will be some permanent impact in the form of new erosion protection on the Delta front work (Shima Tract, Fourteenmile Slough, Tenmile Slough). The effect of this new erosion protection on the snake is likely to be limited because of the relatively low quality of the ditches that constitute the nearest aquatic habitat to these locations. Some better upland snake habitat is on the east side of these levees, and those levee faces will remain unarmored. Overall, we estimate there to be about 111.5 acres of temporary impact on upland snake habitat.

Some of the work will affect snake aquatic habitat. Permanent losses will be limited to the footprint area of the Fourteenmile Slough closure structure and are estimated at 1 acre or less. Temporary disturbances of aquatic habitat includes removal and relocation of land (west) side ditches bordering Shima Tract and Fivemile, Tenmile and Fourteenmile Sloughs. We estimate the area of such aquatic temporary disturbance to be not more than 3 acres (assuming a 5-ft bottom width of ditch) and up to 3 acres of temporary disturbance of Fourteenmile Slough for the construction of the closure structure.

There will also be some permanent effects on snake upland habitat. These include landside (i.e., west) levee slope armoring of the delta front levee improvements in certain reaches of Shima Tract (ST_20_R) and Fourteenmile Slough (FM_30_L, FM_40_L, FM_60_L), and top of levee road construction for Duck Creek (all reaches). The total estimated impact for this work is 12.52 acres (permanent conversions of upland within 200 feet of snake aquatic impact; see consultation history, Corps email dated March 10, 2016). The Corps has committed to offset these impacts by purchase of credits at a 1:1 ratio. Based on the Service's initial evaluation of site conditions, this is to be considered a maximum and subject to confirmation or adjustment downward with further study of habitat suitability.

The ETL compliance work may directly kill snakes during removal of non-compliant vegetation and encroachments. This can be minimized by monitoring and inspection, and by disposing and inspecting waste vegetation in a manner which best detects any snakes present in the material. When this compliance work is complete, the thickness of woody vegetation will be substantially reduced from current conditions in a number of project reaches (Mosher Slough, Shima Tract, Calaveras River, French Camp Slough). This may allow some additional herbaceous upland and near shore aquatic vegetation to establish where it was otherwise shaded out by woody vegetation, and could modestly benefit the snake.

Operations and maintenance activities following construction will also affect the snake. Activities such as grouting, mowing, and maintenance to ETL standards (including a variance, if approved), will result in adverse effects on the snake and will continue for the life of the project. Grouting could entomb any snakes in animal burrows, and reduce the availability of refugia. The effect of the project on refugia availability is believed to be limited due to the presence of alternative forms of refugia, including riprap of a size sufficient to provide open voids, fallen wood and brush, and animal burrows which are formed and used by the snake between inspection/maintenance cycles. Monitoring information on the extent and frequency of grouting, and on alternative refugia will be useful to assess the expected continued availability, albeit reduced, of such refugia (i.e., reformed animal burrows or alternative forms) with the LSJRFS and its operation. Mowing could also kill snakes, or expose them to predators such as hawks and raccoons. Channel maintenance to maintain channel capacity may remove sediment bars and associated emergent vegetation and brush that is habitat to the snake.

Based on our evaluation, we consider the proposed 22.62 credits for the effect of grouting on snakes is also to be a maximum, subject to confirmation or adjustment downward with further evaluation of site conditions on some of the reaches. Specifically, a portion of Calaveras Reach CR_20_L is beyond the 200 foot criterion for snake upland habitat. A portion of Calaveras Reach CR_30_R appears to be currently armored, and if so would not function as upland habitat. Finally, a significant portion of the Calaveras River reaches to the east (CR_60_R, CR_70_R, CR_80_R, CR_40_L, CR_50_L, CR_60_L, CR_70_L) are within 200 feet, but substantially more than 30 feet, from the aquatic habitat. While the levee slope uplands in these reaches would be subject to grouting, they would rarely be used by snakes during the active season because of the distance from water. Rather, these reaches have uplands within the flood channel well outside of the levee profile that would not be subject to grouting activity and are adjacent to water that are more likely to be used for summer refugia. Any future adjustment to either the 12.5 credit offset for permanent snake upland effects or 22.26 credit offset for upland grouting effects on the snake, is not part of this biological opinion, and will require reinitiation of consultation with the Service.

The conservation measures will limit effects on the snake. Monitoring will be done to limit direct effects on snakes during construction. Bank credits will be purchased to offset permanent losses of snake habitat and unavoidable effects of grouting near potential snake habitat. This will help maintain the geographic distribution of the species and contribute to recovery by augmenting the extent of habitat secure from threats. Seasonal restrictions, training, and other measures will further reduce effects on the snake. The Corps will consult separately on any effects of channel maintenance.

Valley Elderberry Longhorn Beetle

Habitat for the beetle will be adversely affected by direct removal of elderberry bushes during construction and maintenance of the project. Up to 44 bushes with 151 stems are within or near enough (i.e., closer than 100 ft) to the footprint or maintenance easements that they could be affected by the project. However, this is a maximum amount and it is anticipated that the 18 bushes that are closer than 100 ft from the footprint or maintenance easements will be avoided through compensation measures. To ensure that these 18 shrubs are not affected by construction, the Corps will monitor their condition and viability for two years after construction. If mortality or reduction in condition of these shrubs is observed, additional mitigation will be performed. There are 26 shrubs within the footprint of the project that will require removal, either for construction or to bring existing or new maintenance easements into compliance with the ETL. Some of these will be lost while others could be transplanted. Some mortality or reduction in health of the transplanted shrubs may occur. There is adequate area within the setback compensation area to accommodate the maximum 297 elderberry plantings and associated native plantings needed to be in accordance with the Conservation Guidelines if all 44 bushes and 151 stems within the footprint and within 100 ft of the footprint were found to be impacted. The Corps has also proposed to conduct additional study to evaluate the compensation site to ensure that it will support elderberries.

Elderberry plants, as well as other native and non-native vegetation, will be removed to establish ETL compliance and regularly maintain the project per the Corps' OMRRR manual thereafter. This could result in locally restricting the distribution of the beetle if maintenance precluded elderberry shrub from these waterways. Such effects will be reduced if elderberries re-establish within portions of the project where vegetation is allowed by variance. Such re-establishment is uncertain because elderberry plants usually grow on higher terraces, and the area to be considered for a variance is the lower half of the waterside slope. If elderberry plants did grow back in variance areas, they will likely still be affected by trimming or the need for removal. These effects of maintenance will be subject to measures to avoid impacts, and where it must occur it will be limited in extent and/or offset by additional plantings. The overall effect of the conservation measures will be to sustain beetle habitat to the extent allowable and consistent with project operation and maintenance, while compensating for unavoidable losses near the project area. This is consistent with the need to augment and enhance habitat in or near managed waterways that could otherwise be subject to complete loss of beetle habitat.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed LSJRFS are not considered in this section; they require separate consultation pursuant to Section 7 of the Act. The Service is not aware of specific projects that might affect the smelt, snake, or beetle in the action area that are currently under review by State, county, or federal authorities.

Conclusion

After reviewing the current status of delta smelt, giant garter snake, and valley elderberry longhorn beetle, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects on these species, it is the Service's biological opinion that the proposed LSJRFS is not likely to jeopardize the continued existence of these species. The Service reached this conclusion because the project-related effects when added to the environmental baseline and considering cumulative effects, will not rise to levels that preclude recovery or reduce the likelihood of survival of the species. This is based on implementation of the conservation measures proposed by the Corps including: measures to avoid, limit, and monitor effects of construction and operation and maintenance; measures to restore temporarily affected habitat; and measures to provide compensation habitat for the smelt and snake to offset permanent impacts and effects of maintenance grouting through purchase of credits; and development of a setback compensation area which will provide habitat for the beetle.

Based on review of these same factors, it is the Service's biological opinion that the proposed LSJRFS is not likely to destroy or adversely modify designated critical habitat for delta smelt. This is because the effects on the critical habitat are discrete and relatively small in area compared to the total area designated and will be minimized through compensatory mitigation, and as such are not expected to appreciably reduce the value of the critical habitat or prevent it from sustaining the species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require SJAFCA to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the OMRRR or any permit or grant document related to the LSJRFS, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Delta Smelt

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in 4 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (1 acre of fill in the footprints of the closure structures; 3 acres of temporary loss in the construction area of the closure structures).

As for the effect of tidal gate operations on the 233 acres of SWH east of the closure structures that would be seasonally and diurnally affected by gate operation, incidental take of delta smelt will be difficult to evaluate directly. Because of the extremely low population of the species, sampling is unlikely to detect smelt even if they were present. Any such detections will mean that take is occurring and our analysis requires re-evaluation. Initially, the Corps will develop and conduct a fixed term of focused pre- and post-project sampling within the affected sloughs required as a term and condition of this biological opinion. We acknowledge that the effects are partial, and would be offset by purchase of credits. We anticipate incidental take of two (2) adult or juvenile delta smelt for the area affected by the closure structures. Detection of two adult or juvenile delta smelt in Smith Canal or Fourteenmile Slough during the focused sampling by the Corps, or within these waters by other independent sampling after the project has been completed, will mean that the smelt is being or could be affected by the project in excess of the expected effects in these locations.

Giant Garter Snake

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed undisturbed at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed during construction activities, including in staging areas and roads carrying vehicular traffic. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action as a surrogate measure for quantifying individuals. The Service anticipates no more than 2 giant garter snakes total in the 128 acres of aquatic and upland habitat affected during construction and maintenance (101.5 upland temporary, 12.5 upland permanent, 0.5 aquatic temporary, and 0.5 acre aquatic permanent habitats) will be harmed or killed due to the proposed project and its maintenance over the 50-year project life. The cumulative detection of two (2) snakes over the combined periods of construction and maintenance is to be used to determine when take is exceeded. Detection of 2 snakes will indicate that the snake is being affected by the project at a level where avoidance and minimization measures and project implementation need to be re-evaluated and possibly modified.

Valley Elderberry Longhorn Beetle

The Service anticipates that incidental take of valley elderberry longhorn beetle will be difficult to detect due to its life history and ecology. Specifically, valley elderberry longhorn beetles can be difficult to locate due to the fact that a majority of their life cycle is spent in the elderberry shrub and finding a dead or injured individual is unlikely due to their relatively small size. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities; therefore, the Service is authorizing take incidental to the proposed action as harm, harassment, injury, and mortality of all valley elderberry longhorn beetles within a maximum of 21 shrubs which will be removed due to project construction and vegetation removal for ETL compliance. Subject to the proposed compensation measure limitations on trimming, the Service authorizes incidental take of all beetles in bushes which are trimmed for maintenance purposes over the project’s 50 year life. Subject to the proposed compensation measure limitations on removal, the Service also authorizes incidental take of all beetles in bushes that will be completely removed due to maintenance, up to a maximum of 75 bushes over the project's 50 year life. The cumulative detection of two adult beetles (i.e., live or dead specimens, not exit holes) over the combined periods of construction and maintenance is to be used to determine when take is exceeded. Detection of two beetles will indicate that the beetle is being affected by the project at a level where avoidance and minimization measures and project implementation need to be re-evaluated and possibly modified.

Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the delta smelt, giant garter snake, or valley elderberry longhorn beetle.

Reasonable and Prudent Measures

The necessary measures needed to avoid and minimize impacts on listed species due to the project have been incorporated into the project description. Therefore, the Service has determined that the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the smelt, snake, and beetle:

1. All conservation measures as stated in the Project Description section of this biological opinion shall be fully implemented and adhered to. This reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with, or ensure compliance with, the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These Terms and Conditions are nondiscretionary.

The following Terms and Conditions implement the Reasonable and Prudent Measure:

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: (a) a pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically (i) areas of upland and aquatic habitat for the snake, (ii) numbers of elderberry shrubs and stems in the diameter classes considered habitat for the beetle in accordance with the Conservation Guidelines, and (iii) areas of Shallow Water Habitat as habitat for the smelt affected by the project including the footprint of proposed gate structures, the operational periods of such gates, and the area(s) isolated by such gates; (b) a cumulative accounting of the effects on listed species habitat of all phases constructed to date; (c) a narrative describing how the already constructed plus additional proposed work effects fall within the take limits described in this biological opinion; (d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction; (e) its approved ETL variance for that phase, with a narrative explaining how it is consistent with the project description of this biological opinion, and a determination that the effects are within the parameters of allowable take; (f) detailed survey protocols for implementing those measures shown in Appendix A of this biological opinion; and (g) a request to the Service for written concurrence with items 1(c) ,1(e), and 1(f). If the Service concurs, we shall issue a letter of concurrence and the Corps may proceed with construction and OMRRR under this biological opinion. If we do not concur, we will specify our reasons and the Corps must re-initiate formal consultation.

   In order to accurately estimate take, the Corps shall resurvey areas with pending construction for elderberry shrubs no sooner than one year prior to the onset of that construction.

2. The Corps will conduct adequate preliminary study of the proposed beetle compensation area to assess suitability to support elderberry plants and beetle. This study shall include but is not limited to; evaluation of soil texture, chemistry, and composition; soil water and chemistry; potential effects of adjacent uses and factors that may adversely affect elderberry (pesticides, herbicides); management needs; and a proposed monitoring plan. The Corps will prepare a report of this study and submit it to the Service with a request for written finding from us concurring that the site is suitable for compensation for effects of the project on beetle. If the Service concurs, the Corps may proceed with development of that compensation site. If we do not concur, the Corps will need to develop alternative means of compensation before project construction, and reinitiation will be required.

3. The Corps will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work.

4. The Corps will prepare and submit to the Service for approval, a sampling plan designed to detect any delta smelt that may be using Smith Canal or Fourteenmile Slough. The general parameters of this sampling are that it should be limited to three seasons, of which at least two seasons will be before project construction, and the post-construction sampling is to be conducted no later than three years after construction. This plan must be approved by the Service in writing prior to the onset of monitoring.

5. The Corps will prepare and submit to the Service for approval, a monitoring plan designed to quantify the extent and distribution of alternative snake refugia. The general parameters of this monitoring are that it will be done pre-project and then at five year intervals thereafter until the project is completed, encompass all snake habitat as identified in this biological opinion during each monitoring year (both constructed and to-be-constructed reaches), and differentiate the forms of alternative refugia. Due to construction duration, the last monitoring year may be several years after all project work is complete. This plan must be approved by the Service in writing prior to the onset of monitoring.

6. The Corps will prepare and submit to the Service for approval, a monitoring plan which details the protocols for implementing construction snake monitoring as described in this biological opinion (Conservation Measures; Appendix B). This plan must be approved by the Service at least 90 days in advance of construction.

7. The Corps will conduct five years of monitoring of beetle compensation areas.

The Service believes that no more than the quantities specified in the Incidental Take Statement will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to the following monitoring requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-5604, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps (during construction) or the local sponsor (during maintenance) shall follow the steps outlined in the Disposition of Individuals Taken section below. The Corps shall incorporate this notification information as a requirement in the OMRRR.

2. The Corps will document, monitor, and report the actual amount of take of listed species and listed species habitat for project construction of each discrete phase or contract of the project, and submit a post-construction monitoring report within 180 days of completion. This document will include: (a) photo-documentation immediately before construction, and after completion of construction; (b) a comparison of the as-built effects on listed species habitat with that described in Term and Condition No. 1; and (c) a summary table of construction monitoring to verify that the monitoring extent and frequency are consistent with that proposed, the sightings of any listed species, and any observed effect on habitat beyond that described in the design.

3. The Corps will develop a requirement in its OMRRR manual for the local sponsor to maintain a record of operations and maintenance activities as they affect listed species and reporting of such in an annual report to the Service. The report will cover calendar year activities, and be submitted to the Service by March 1 of the year following. This requirement will include a record of the dates, types, locations, areas, and frequencies of maintenance activities, extent of compliance with conservation measures in this biological opinion associated with maintenance, and the take of any listed species or lack thereof. Example parameters may include areas mowed within 30 ft of snake habitat, a tally of the number of rodent holes grouted within 30 ft of snake habitat in particular areas, the number of elderberry shrubs present, avoided, trimmed, or removed, and so on. The Corps will provide a draft of this requirement to the Service for review and concurrence that it adequately documents the effect of maintenance on listed species. If the Service concurs, the Corps may proceed with finalizing its OMRRR manual. If we do not concur, we will specify our reasons and alternative language that fulfills this need.

4. Additional Reporting: Within 90 days of completion of the last data collection of the year for each monitoring requirement, the Corps will submit (a) baseline and annual reports of the health and condition of elderberry shrubs not directly affected, but within 100 ft of project work (one baseline and two post-construction reports per construction phase); and any associated additional mitigation; (b) preconstruction and, at 5-year intervals until construction is complete, reports documenting quantities of alternative snake refugia; and (c) pre- and post-construction reports of delta smelt sampling in Fourteenmile Slough and Smith Canal.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen must be frozen in a freezer located in a secure site, until instruction s are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-5604; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement, 5622 Price Way, McClellan, California 95562, at (916) 569-8444.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Service recommends the Corps develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996) the Giant Garter Snake Recovery Plan (Service 2015) and the Valley Elderberry Longhorn Beetle Recovery Plan (Service1984).

2. The Corps and SAFCA should develop and implement projects that support DWR's Central Valley Flood System Conservation Strategy. This document provides goals and measurable objectives and potential projects which could be implemented in a manner that while improving the riverine ecosystem also will improve the flood system.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION—CLOSING STATEMENT

This concludes formal consultation on the Lower San Joaquin River Feasibility Study. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary

Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this biological opinion on the proposed Lower San Joaquin River Feasibility Study, please contact Steven Schoenberg of my staff at (916) 414-6564.

Sincerely,

Kaylee Allen
Field Supervisor

cc:

Tanis Toland, Corps of Engineers, Sacramento, CA
Howard Brown, National Marine Fisheries Service, Sacramento, CA
Jeff Drongesen, Region II, California Department of Fish and Wildlife, Sacramento, CA
Jim Starr, Region III, California Department of Fish and Wildlife, Stockton, CA
Ruth Darling, Department of Water Resources, Sacramento, CA
Roger Churchwell, San Joaquin Area Flood Control Agency, Stockton, CA

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Appendix A. Lower San Joaquin River Feasibility Study: reach-specific construction measures, Service assessment of giant garter snake habitat suitability,and Corps/Service agreed to avoidance/minimization measures.

Reach[1]	Waterway	Reach Boundaries	Construction Measure(s)[2]	Suitability as snake Habitat	Proposed avoidance/minimization measures and effect determination
MC_30L (6,600 ft)	Mosher Slough	Thornton Road to railroad tracks	Cutoff wall	Wetted channel after storms but no emergent vegetation; believed to be dry in this reach in summer; only urban adjacent; non-tidal; minimal forage/lack of water means presence unlikely.***	Training of workstaff as to identification and what to do if there is an incidental suspected observation of snakes. Not considered snake habitat.
MC_10L, MC_20L, 10,700 ft	Mosher Slough	Shima Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)	Begins to show evidence of permanent water near little Bear Creek. Heavy shade and small patches of emergents but mostly open surface. Snake forage probably improved. Likelihood of snake presence low but possible.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Reduction of woody plants from project actions may enhance basking for snake. Maintenance effects of grouting, mowing, etc., apply.
ST_10R, ST_20R, (6,700 ft)	Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)[3]	ST_20R only: Substantial emergent vegetation; summer open water; possible snake forage from amphibians and/or introduced vector control (mosquito fish). Small patch size; interrupted hydrologic continuity to other snake habitat. ST_10R: No adjacent snake habitat.	ST_20R only: Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Reduction of woody plants here may enhance basking for snake. Maintenance effects of grouting, mowing, etc. ST_10R only: Insignificant effects on snakes due to lack of habitat (no inspections required).
FS_10R (1,700 ft)	Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)[3]	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Minimal maintenance effects due to heavily rocked waterside slope requires no grouting, infrequent maintenance.
FM_60_L (1,600 ft)	Fourteenmile Slough	Fivemile Slough to Proposed Closure Structure	Seismic Fix; Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)[3]	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Minimal maintenance effects due to heavily rocked waterside slope requires no grouting, infrequent maintenance.
FM_50_L, (300 ft)	Fourteenmile Slough	Approximately 1,500 ft west of Fivemile Slough	Closure Structure	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site travel routes within 200 ft of work only to declare them snake free. No/minimal maintenance effect or operational effects on snakes. Small direct loss of upland/aquatic in footprint.**
FM_40_L, (1,500 ft)	Fourteenmile Slough	Approximately 1,250 ft southeast setback out from proposed closure structure	Seismic Fix Levee height fix (sea level rise) Erosion protection (landside)[3]	Within 200 ft of potential habitat, but does not constitute snake habitat. No permanent/seasonal wetland vegetation; no ditches seen.***	Training, pre-work inspection, and daily morning inspection of work site travel routes within 200 ft of work to declare them snake free. No other effects anticipated.
FM_30_L (7,000 ft),	Fourteenmile Slough	From setback cut south to Tenmile Slough	Seismic Fix (adjacent levee) Erosion protection (landside)[3] Setback levee	West: low-value potential snake habitat in form of small ditch with temporary intermittent water if any. East: much higher value potential snake habitat in portions of 14-mile slough within 200 ft of work.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap removes burrow potential but effect deemed discountable (no offset). Dewater ditch and reinspect before grading/removal. Low value ditch habitat to be lost, but might be expected to be replaced by a new ditch to west of setback levee
TS_30_L (5,900 ft)	Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope Reshaping Erosion protection (waterside)[3]	West: low value potential snake habitat in ditch with some emergent vegetation. East: developed. Levee slopes compacted with granular armor.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap removes burrow potential but effect deemed discountable. If ditch habitat is to be affected, dewater ditch and reinspect before grading/removal. Ditch may be replaced if affected, as it appears to be part of agricultural operations.

TS_20_L (1,600 ft),	Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic Fix; Slope Reshaping Erosion protection (waterside)	Some floating vegetation, patches of emergent vegetation, and close proximity to other habitat in Bulkley Cove, but low value snake habitat due to major river location.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap replaces compacted granular rock surface with no burrowing seen due to maintenance.
TS_10_L (4,000 ft)	Tenmile Slough/Buckley Cove	West March Lane/Buckley Cove Way to Calaveras River	Seismic Fix; Slope Reshaping	Larger patches of emergents on-site, slightly off major river, proximity to other (upstream) habitat), but low value snake habitat due to predominant shoreline development.	Training, pre-work inspection, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during maintenance. *
CR_10_R (2,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Fairway Dr.	Cutoff wall	Similar condition to TS_10_L, but slightly better in terms of proximity to natural island habitat.	Training, pre-work inspection, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during/for maintenance.*
CR_20_R (1,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Fairway Ave.	Cutoff wall	Similar to CR_10_R, but less intense shoreline development (on south bank), and closer proximity to islands.	Training, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during/for maintenance.*
CR_30_R (3,800 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Kirk St.	Cutoff wall	Better quality habitat than CR_20_R, due to adjacent side channel, shallow water emergent wetland	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_40_R (2,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite I-5.	Cutoff wall	Better quality snake habitat nearby, but not immediately adjacent to this reach, includes side channel and shallow water emergent wetland.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_50_R (6,900 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit N. Pershing Ave.	Cutoff wall	Increasing quality snake habitat includes adjacent shallow water side channels with floating and/or emergent wetland, herbaceous cover on banks and (near N. Pershing) grasslands within channel, islands, and open water.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_60_R, (1,400 ft) CR_70_R, (1,800 ft)	Calaveras River – Right/North Bank	Calaveras River, N. Pershing to Pacific Aves.	Cutoff wall	Increased snake habitat quality and potential for occurrence with shallow water side and main channels with maintained grassy levee slopes and bench areas between levees. Some Arundo.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_80_R (3,200 ft)	Calaveras River – Right/North Bank	Calaveras River, Pacific Ave. to El Dorado Street	Cutoff wall	Increased snake habitat quality and potential for occurrence with shallow water, primarily in main channel, with maintained grassy levee slopes and bench areas between levees. Limited marginal vegetation; channel may be maintained/cleared.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*

CR_10_L, (1,700 ft)	Calaveras River – Left/South Bank	From about Fairway Dr to Rainer Ave	Cutoff wall	Better quality potential snake habitat than at river mouth due to proximity to islands, much less riprap on south bank, and less dock development.	Training, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance to preclude any burrows which occur (increase over existing maintenance based on observed condition). Monitor plus measures during/for maintenance.*
CR_20_L, (4,300 ft)	Calaveras River – Left/South Bank	From about Rainer Ave to Kirk Street	Cutoff wall	Varies; better quality upland than elsewhere, owing to larger habitat width, thus less urban disturbance; portions >400 ft from water, therefore not encroached into proposed levee profile, but this varies. Water edge steep, across from wetland on north bank.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_30_L (1,600 ft)	Calaveras River – Left/South Bank	From about Kirk Street to I5	Cutoff wall	Riparian/upland with gaps. The adjacent river is a uniform single thread in this reach, lacking islands, backwaters, or side channels that are present upstream and downstream. A few docks are present.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_40_L (6,900 ft)	Calaveras River – Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping	Riparian, more or less continuous but of younger stands; some riprap; some steeper slopes and some open gaps; mid-channel islands; floating vegetation prominent in upper end.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_50_L, (1,700)	Calaveras River – Left/South Bank	Approximately North Pershing Avenue to unnamed narrow bridge by University of the Pacific campus.	Cutoff wall	Riparian, sparse trees with gaps, grassland between levees, and island vegetation. Shallow water, arundo islands; no rock toe observed. Increasing snake habitat quality.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_60_L (1,600 ft)	Calaveras River – Left/South Bank	Approximately unnamed narrow bridge by University of the Pacific campus to North Pacific Avenue.	Cutoff wall	Similar to CR_50_L, and with more herbaceous upland between levees than elsewhere; variable channel (open, narrow, and/or scrub islands)	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_70_L (3,200 ft)	Calaveras River – Left/South Bank	Approximately North Pacific Avenue to El Dorado Street	Cutoff wall	Continuation of CR_60_L; similar conditions.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
SC_30 (800 ft)	Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure Structure	Deep water work , near SJR, minimal edge cover nearby; snake presence unlikely***	Worker training only.
SJR_10_ R, (8,600 ft)	San Joaquin River	From approximately 2,100 ft upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)	Work adjacent to SJR; riparian and golf course with ponds nearby; snake presence unlikely. Not examined on ground.***	Worker training only.
SJR_20_ R (600 ft)	Smith Canal	Dad's Point from the Closure Structure to approximately 375 ft down Monte Diablo Avenue	Floodwall	Work adjacent to open deep waters of SJR and Smith Canal; lower stature riparian in managed park setting; snake presence discountable.***	Worker training only.
SJR_30_ R (3,500 ft)	San Joaquin River	Railroad bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping	Work adjacent to open deep waters of SJR and disturbed sewage treatment location. snake presence discountable.***	Worker training only.
SJR_40_ R, (4,400 ft) SJR_50_ R, (2,000 ft) SJR_60_ R, (2,100 ft)	San Joaquin River	Burns Cutoff to SR-4	Cutoff wall	As with SJR-30_R.***	Worker training only.

SJR_70_ R (4,100 ft)	San Joaquin River	SR 4 to French Camp Slough	Cutoff wall	Work adjacent to open deep waters of SJR and golf course; some marsh fragments and floating vegetation near French Camp Slough confluence. Slight potential for snakes.	Training and, for work within the first 400 ft of north bank nearest to French Camp Slough, daily morning inspection of work site to declare it snake free.
FCS_10_ R (9,000 ft)	French Camp Slough	Part of CS-E-9 "a" and "b" NEPA Reaches	Cutoff wall	Increased habitat quality for snakes and potential for presence due to location off of main river, presence of larger marsh blocks, shallower waters. Some toe rock. Some riparian habitat on lower slope.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
DC_10_R (450 ft)	Duck Creek ("a" only)	French Camp Slough to 500 ft past I-5 crossing	Cutoff wall	Increased snake habitat quality and presence potential; shallow water, high coverage of floating plants and emergents; some open water visible on aerial photos; semi-rural to suburban adjacent land use.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*
DC_20_R (2,450 ft)	Duck Creek	500 ft past I-5 crossing to approximately Odell Avenue	New Levee	Increased snake habitat quality and presence potential; shallow water, high coverage of floating plants and emergent vegetation; some open water visible on aerial photos; semi-rural to suburban adjacent land use.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects much more significant due to higher quality of habitat and construction of new levee. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*
DC_30_R (2,450 ft)	Duck Creek	Approximately Odell Avenue to McKinley Avenue	Fix in-place Cutoff wall Levee Reshaping Levee height fix	Not observed; aerial images suggest similar to adjacent downstream sections. Assume similar habitat quality.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat and reshaping work specified. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*

* single asterisk denotes this site included in determination of maintenance offset compensation determination.
** double asterisks denote inclusion in direct loss offset compensation determination.
*** triple asterisks denote determination of "no effect" on snake with application of the proposed conservation measures (i.e., insignificant, discountable, and/or wholly beneficial).

[1] Equivalent to "cost reach" in Appendix C of the Corps' BA.

[2] The term "waterside" refers to the ecological waterside (i.e., towards any proximate canal, slough, river or stream channel) and "landside" opposite the waterside. Toe drains and agricultural ditches are not considered waterside.

[3] The new erosion protection included in the Recommended Plan will be placed either on the waterside of the levee or on the landside of the levee. All of this new erosion protection is placed above the waterline. The purpose of the North Stockton erosion protection is protect the project levee from wind and wave run-up erosion which could occur if Delta levees to the west of the project levee were to fail allowing flooding of land immediately west of the project levee. Erosion protection on Duck Creek is no longer proposed (see Consultation History).

Note: New levees = 20 ft OMRRR easement (each side); existing non-Federal levees newly brought into the Federal system = 10 to 15 ft OMRRR easements.

Appendix B: verbatim attachment to April 13, 2016 email from Service to Corps (reformatted for this biological opinion)

Table E: Pre-Project Vegetation and Vegetation Lost from Project Implementation. Original from Corps (Toland) dated December 10, 2015, as corrected by FWS (SCHOENBERG) per 4/13/16 teleconference w/ CORPS Colby/Garcia. Edits are shown in **enlarged boldface.**
This table shows pre-project (i.e., existing) vegetation, vegetation lost due to construction of the structural flood risk management features, and vegetation lost due to implementation of vegetation free zones that removes 75% of the vegetation **from the waterside, and 100% of the vegetation from the landside,** that remain after construction of the structural flood risk management features.

A	B	C	D	E	F	G	H
MOSHER SLOUGH	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss After ETL (lower levee) E-F	Total Project Veg Loss D+G
Waterside Slope							
	Woody Riparian	3	1	2	0.5	1.5	2.5
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	0	0	0	0	0	0
	Woody Riparian	1	1	0	0	0	1
	Wetlands	3	3	0	0	0	3
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	3	3	0	0	0	3
Landside Slope							
	Woody Riparian	8	2	6	**0**	**6**	**8**
	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	7	4	3	**0**	**3**	**7**
	Grass (Park)	0	0	0	0	0	0
DELTA FRONT	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	2	1	1	0.25	0.75	1.75
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	0	0	0	0	0	0
	Woody Riparian	1	1	0	0	0	1

	Wetlands	4	4	0	0	0	4
	Grass	0.5	0	0.5	0.125	0.375	0.375
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	25	13	12	**0**	**12**	**25**
	Grass (Park)	2	2	0	0	0	2
Landside Easement							
	Woody Riparian	3	0	3	**0**	**3**	**3**
	Grass (Park)	1	1	0	0	0	1
Setback Levee							
As proposed mitigation	**TBD**	NA					
Calaveras River	Cover type	Overall	Construction	Veg on Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	7	4	3	0.75	2.25	6.25
	Wetlands	1	0	1	0.25	0.75	0.75
Waterside Easement							
	SRA (***LINEAR FEET***)	10406	0	10406	2601.5	7804.5	7804.5
	Woody Riparian	5	4	1	0.25	0.75	4.75
	Wetlands	1	1	0	0	0	1
	Grass	0.5	0.5	0	0	0	0.5
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	35	16	19	**0**	**19**	**35**
	Grass (Park)	3	3	0	0	0	3
Landside Easement							
	Woody Riparian	6	5	1	**0**	**1**	**6**
	Grass (Park)	2	2	0	0	0	2

San Joaquin DS of FCS	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	5	2	3	0.75	2.25	4.25
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	7949	1423	6526	1631.5	4894.5	6317.5
	Woody Riparian	5	4	1	0.25	0.75	4.75
	Wetlands	0	0	0	0	0	0
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	5	4	1	**0**	**1**	**5**
	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	3	1	2	**0**	**2**	**3**
	Grass (Park)	1	1	0	0	0	1

French Camp Slough & Duck Creek	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	2	1	1	0.25	0.75	1.75
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	7153	576	6577	1644.25	4932.75	5508.75
	Woody Riparian	3	3	0	0	0	3
	Wetlands	0	0	0	0	0	0
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	11	10	1	**0**	**1**	**11**

	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	0	0	0	0	0	0
	Grass (Park)	0	0	0	0	0	0
New Levee							
	Woody Riparian	2	2	NA	NA	NA	2
	Wetlands	2	2	NA	NA	NA	2
	Row/Field Crops	1	1	NA	NA	NA	1

NOTE: All values in acres, except for SRA (in linear feet)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

JUN - 7 2016

Refer to NMFS No: WCR-2015-3809

Ms. Alicia Kirchner
Acting Regional Resources Manager
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Lower San Joaquin River Feasibility Study in the area surrounding the City of Stockton, San Joaquin County.

Dear Ms. Kirchner:

Thank you for your letter of November 6, 2015, and accompanying biological assessment, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Lower San Joaquin River Feasibility Study (Project).

Based on the best available science and commercial information, the Biological Opinion (Opinion) concludes that the Lower San Joaquin River Feasibility Study is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncoryhnchus tshawytscha*), threatened California CV steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify the designated critical habitats for California CV steelhead or sDPS green sturgeon. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the Project.

This letter also transmits NMFS' essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*).

The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to Pacific salmon EFH in the action area as described in Amendment 18 of the Pacific Coast Salmon Plan.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the Project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Lower San Joaquin River Feasibility Study and the measures needed to avoid, minimize, or mitigate such effects.

Please contact Jeffrey Stuart at the NMFS California Central Valley Office, 916-930-3607, or at J.Stuart@noaa.gov, if you have any questions concerning these consultations, or if you require additional information.

Sincerely,

for William W. Stelle, Jr.
Regional Administrator

cc: Division Chron File: 151422WCR2015SA00098

Ms. Janet Whitlock, U.S. Fish and Wildlife Service, 2800 Cottage Way, Sacramento, CA 95825

Mr. Steven Schoenberg, U.S. Fish and Wildlife Service, 2800 Cottage Way, Sacramento, CA 95825

Mr. Daniel Welsh, Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814

Ms. Krystal Spur, California Department of Fish and Wildlife, 2109 Arch Airport Road, Suite 100, Stockton, CA 95206

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Lower San Joaquin River Feasibility Study

NMFS Consultation Number: 2015-SA00098

Action Agency: U.S. Army Corps of Engineers (Corps)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon (*Oncoryhnchus tshawytscha*)	Threatened	Yes	No	NA
California CV steelhead (*O. mykiss*)	Threatened	Yes	No	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: for [signature]
William W. Stelle, Jr.
Regional Administrator

Date: JUN - 7 2016

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into sections 2 and 3 below. The U.S. Army Corps of Engineers (Corps) proposes to implement flood risk management measures under the Lower San Joaquin River Feasibility Study. The purpose of this Biological Opinion (Opinion) is to analyze the potential effects of repairing levees in the greater Stockton metropolitan area and constructing two flood control gate structures on listed threatened and endangered species and on designated critical habitat, within the Project's area of effects (action area) under the Endangered Species Act (ESA).

1.1.1 Background, Authority, and Policy

The National Marine Fisheries Service (NMFS) prepared the Opinion and incidental take statement portions of this document in accordance with section 7(b) of the ESA of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

NMFS also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

NMFS completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). A complete record of this consultation is on file at the NMFS California Central Valley Area Office.

1.1.2 Background

The Corps and its non-Federal sponsors, the San Joaquin Area Flood Control Agency (SJAFCA) and the State of California Central Valley Flood Protection Board (CVFPB), represented by the California Department of Water Resources (DWR), are conducting the Lower San Joaquin River Interim Feasibility Study (LSJRFS or Project hereafter).

The purpose of the LSJRFS is to investigate and determine the extent of Federal interest in a range of alternative plans designed to reduce the risk of flooding in the cities of Stockton, Lathrop, Manteca, and surrounding urbanizing areas. These areas have experienced multiple flooding events since records have been maintained. The existing levee system within the study area protects over 71,000 acres of mixed-use land with a current population estimated at 264,000 residents and an estimated $21 billion in damageable property.

The general authority for flood control investigations in the San Joaquin River Basin arises under the Flood Control Act of 1936 (Public Law [PL] 74-738), sections 2 and 6 and amended by the Flood Control Act of 1938 (PL 75-761). The Flood Control Act of 1936, section 6 permits further reports to be authorized by congressional resolutions. Further studies of this river system were directed in the May 8, 1964, resolution adopted by the Committee on Public Works of the House of Representatives.

The LSJRFS is being accomplished in accordance with the section 905(b) Analysis (Water Resources Development Act (WRDA) 1986) dated September 23, 2004. The section 905(b) Analysis was approved by the Commander, South Pacific Division (SPD) on June 10, 2005. The section 905(b) Analysis was prepared with funds identified in House Report 108- 357 (Conference Report to accompany H.R. 2745 for the Energy and Water Development Appropriations Act of 2004) for use under the Sacramento-San Joaquin River Basins Comprehensive Study (Comprehensive Study) for a reconnaissance study to evaluate environmental restoration, flood protection, and related purposes for the Lower San Joaquin River. House Report 105-190, which accompanied the Energy and Water Development Appropriations Act of 1998 (PL 105-62) authorized the Comprehensive Study.

The section 905(b) Analysis determined that there was Federal interest in pursuing feasibility level investigations for potential flood risk reduction and ecosystem restoration projects in the Lower San Joaquin River area. This study has been focused on flood risk reduction through additional scoping and coordination with the non-Federal sponsors, resource agencies, and local stakeholders and does not include environmental restoration.

This study will only partially address the Comprehensive Study authority. Therefore, the LSJRFS will be called an "Interim Feasibility Report" which indicates that the study is addressing the flood risk issues of a specific area within the authority, rather than the entire area authorized for study.

1.1.3 Authority and Policy

Non-Discretionary Actions

The Corps has indicated in its biological assessment (BA) (Corps 2015) that they have no discretion in regards to the continuing existence and operation of the flood control structures of the Lower San Joaquin River and Tributaries Project (LSJRTP). They assert to have responsibility to ensure Civil Works structures are maintained to appropriate standards such that they continue to serve the congressionally authorized purposes inherent in the authority to construct them and their responsibility to ensure that these structures are maintained, is non-discretionary. The Corps claims that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps declares in its BA that it has a non-discretionary duty to maintain the LSJRTP and the fact that the Corps perpetuates the Project's existence is not an action subject to this consultation. The Federal government maintains oversight but has no ownership of, or direct responsibilities for, performing maintenance activities on the Federal levee system, except for the few select features that continue to be owned and operated by the Corps. Considering these exceptions, the great majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps Operations and Maintenance (O&M) manuals. The 1959 Standard O&M manual for the LSJRTP is the primary O&M manual for this area. There are two supplemental O&M manuals that cover the Project area, the 1963 LSJRTP Unit 1 manual and the Mormon Slough Project manual. The levees of the Project are part of the LSJRTP and therefore covered in the 1959 O&M manual or one of the supplemental O&M manuals.

Discretionary Actions

The Corps has maintained in its BA that it has discretion in the application of construction methodologies and timing of construction activities in relation to discharging its non-discretionary duties to maintain the functionality of the levees within the LSJRTP and provide flood protection. Following completion of construction of the upgrades to the levees comprising the Project, the Corps will prepare a supplement to the 1959 O&M manual which will specify maintenance requirements for these improved levees. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance which are required to meet certain standards), maintenance activities are discretionary actions that are part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly. These activities are performed for approximately 20 days annually. Patrol road reconditioning activities would typically be performed once a year and would include placing, spreading, grading, and compacting aggregate base or substrate.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. DWR would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the CVFPB's Chief Engineer through DWR's Flood Project Integrity and Inspection Branch.

Each Federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat. Furthermore, under section 2 of the ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA. In regards to species and critical habitat compensation, the Corps has the authority to compensate prior to, or concurrent with, project construction impacts. This authority is given under WRDA 1986 (33 USC §§ 2201–2330).

1.2 Consultation History

The Corps has been informally consulting with the U.S. Fish and Wildlife Service (USFWS) and NMFS during the development of the feasibility of the Project. Meetings and phone calls with the Corps and NFMS have taken place to discuss the Project and the potential species affected within the study area. With the completion of the LSJRFS, the Corps has requested formal section 7 consultation with NMFS on this Project prior to receiving authorization for funding. If the Project is authorized and funded, it would move into the Preliminary Engineering Design (PED) phase.

During PED phase, coordination with the resource agencies would continue in order to ensure that the Project remains in compliance with the completed section 7 consultation. The Corps would coordinate potential design refinements with the Services to avoid, minimize, and off-set any adverse effects on listed species. Formal section 7 consultation would be reinitiated with NMFS if changes to the Project occurred that were noncompliant with this Opinion. The following list summarizes the consultation history to date:

- 2013 – Initial species list obtained for the study area of the LSJRFS.
- May 29-30, 2013 – USFWS, DWR, and the Corps environmental staff participated in a field tour of the Project area.
- 2014 – Updated species list obtained.
- On June, 24, 2014, the USFWS submitted a Draft Fish and Wildlife Coordination Act Report to the Corps.
- July 22, 2014 – The Corps, USFWS, and NMFS met to discuss the study status, the Project alternatives, draft impact assessment, and approaches to mitigation and conservation measures.
- February 5, 2015 – an updated species list for San Joaquin County and pertinent quads was obtained from the USFWS website.
- March 2, 2015 – The Corps transmitted the draft BA to NMFS and requested comments prior to initiating section 7 consultation with NMFS under the ESA.
- March 31, 2015 – NMFS sent correspondence to the Corps requesting additional information from the Corps to support the consultation.
- April 2, 2015– The Corps and NMFS met to discuss NMFS' letter advising the Corps of additional information needed to support the consultation.
- July 30, 2015 – The Corps and NMFS biologists had a phone conversation to discuss potential conservation measures for the Project. Discussion centered on potential areas where conservation measures would be most effective.
- September 17, 2015 – Meeting between the Corps and NMFS to discuss the Project and conservation measures for the LSJRFS.
- November 9, 2015 - NMFS receives the final biological assessment (BA)(Corps 2015) for the Project and a request for formal section 7 consultation under the ESA from the Corps for effects to threatened California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) and the threatened southern DPS (sDPS) of the North American green sturgeon (*Acipenser medirostris*), their

designated critical habitats, and Essential Fish Habitat (EFH) described for Pacific Salmon (*Oncorhynchus spp.*) in Amendment 18 of the Pacific Coast Salmon Fishery Management Plan.

- December 10, 2015 - NMFS responds to the Corps that sufficient information has been made available to initiate formal consultation under section 7 of the ESA for the LSJRFS. However, NMFS stated in its letter that it will also include effects to individuals of the threatened Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) evolutionary significant unit (ESU) in light of the reintroduction of this run of fish into the waters of the San Joaquin River basin. NMFS indicated that the Corps should expect that an Opinion will be furnished to the Corps on or before March 23, 2016.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

This section describes the Project, which consists of the following two broad elements:

- Construction of structural flood risk management features for levees within the action area;
- Establishment of Engineer Technical Letter (ETL) 1110-2-583 compliant levees.

1.3.1 Overview

The structural measures that comprise the plan, the measures used on each reach of waterway, and the conservation measures included in the Project are described in detail in the Corps' BA (Corps 2015), specifically section 3. The approach to establishing ETL compliant levees is described more broadly in the BA.

The Corps has identified a number of problems associated with the flood risk management system protecting the City of Stockton and surrounding areas. There is a high probability that flows in the lower San Joaquin River, Calaveras River, and the Sacramento-San Joaquin estuary (the Delta) or a seismic event would stress the network of levees protecting Stockton to the point that they could fail. The consequences of such a levee failure would be catastrophic, since the area that would be inundated by flood waters is densely urbanized and the flooding could be up to 18 feet deep. The existing levees that are included in the proposed Project are identified as "Federal" or "Non-Federal" in Figure 1. At the request of the levee owner, and by meeting specific standards, some Non-Federal levees are included in the Corps Rehabilitation and Inspection Program and are eligible for rehabilitation assistance under Public Law (PL) 84-99.

Most levees in the Project area require seepage and slope stability improvements in order to meet the Corps criteria. Some levees require slope reshaping, height improvements, and/or erosion protection. The northern portion of the Project area is vulnerable to flooding from the west (the Delta). Options to improve existing levees immediately adjacent to the City of Stockton to reduce risk from this threat are constrained due to urban development. Therefore, two in water flood control gates are also proposed to help alleviate flood risks. In the southern part of the Project area, a new levee extension is proposed on Duck Creek. The BA analyzed the effects of improving the flood risk management system in the vicinity of the City of Stockton. A summary of the flood safety remediation measures proposed for each Project reach is provided in Table 1 and Figure 2.

1.3.2. Project Features by Area

The main structural measures included in the Project are summarized in Table 1 by area and reach. The locations of the measures are shown in Figure 2. A summary of the lineal extent of each structural measure is shown in Table 2.

1.3.2.1 North Stockton

The North Stockton area includes improvements to the Mosher Slough south levee, Shima Tract east levee, Fivemile Slough/Fourteenmile Slough north levee, Fourteenmile Slough west levee, Tenmile slough east levee, and San Joaquin River east levee. The measures proposed to improve the levees in the North Stockton area include cutoff walls, levee height fixes, erosion protection, seismic (deep soil mixing) fixes, and slope reshaping. In addition, a closure structure would be installed across Fourteenmile Slough, approximately 1,600 feet west of Fivemile Slough. These measures are described in more detail in the BA, specifically section 3 (Corps 2015). The locations of each of the measures are shown on Figure 2.

1.3.2.2 Central Stockton Area

The Central Stockton area includes levee improvements to the Calaveras River, San Joaquin River, Smith Canal, and French Camp Slough. For the Calaveras River, approximately 4.25 miles of the north bank (to approximately El Dorado Street) and approximately 3.3 miles of the south bank (to approximately Pacific Street) would be improved with a combination of cutoff walls, slope reshaping, and levee height fixes. Levee improvements will be made on the San Joaquin River from approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure structure. Additional levee improvements will be made from approximately Channel Point on the San Joaquin River upstream to French Camp Slough, including portions of French Camp Slough upstream of the confluence with the San Joaquin River. The locations of each of these are shown on Figure 2.

In addition to the levee improvements, a closure structure would be installed across the mouth of Smith Canal from the San Joaquin River east levee at Brown's Island to the end of Dad's Point. A floodwall (5 to 10 feet high) would also be constructed on Dad's Point to tie the closure structure into the high ground on the shoreline. The average height of the wall would be 5 to 6 feet as measured from the waterside. The closure structure and floodwall design is described in more detail in section 3.3 of the BA (Corps 2015). The closure structure would be operated to prevent inflow into Smith Canal during high water levels in the Delta and San Joaquin River. This would limit the level and duration of water saturation and reduce the risk of levee damage or failure in Smith Canal upstream of the closure structure.

Finally, a new levee would also be constructed at Duck Creek. This levee would be an extension of the existing French Camp Slough north levee and would extend approximately three-fourths of a mile from French Camp Slough to the rail yard. The new Duck Creek levee would be constructed consistent with the Corps levee construction criteria.

1.3.3 Description of Structural Flood Risk Management Measures

Levees in the Project area require improvements to address seepage, slope stability, overtopping, and erosion concerns that make them vulnerable to floods. The recommended actions are composed of different structural measures that address these vulnerabilities. Overall, the recommended actions for the Project includes: (1) 19.4 miles of seepage cutoff walls; (2) 3.2 miles of geometric improvements consisting of levee slope and crown reshaping to meet Federal standards; (3) 3.5 miles of levee height raises mainly to reestablish the design levee height; (4) 0.5 miles of flood walls/sheet pile walls; (5) 3 miles of seismic improvements; (6) 0.75 miles of new levee; and (7) 5 miles of new erosion protection (a majority of the new protection would be on the landside only; however, existing erosion protection disturbed by construction would be replaced). Note that these features overlap one another and cannot be added up to describe the total lineal extent of the Project. The total amount of horizontal flood features (including closure structures) is approximately 24.5 miles.

These measures would be implemented primarily by fixing levees in place. In addition to levee improvements, the Project includes two in-water closure structures located on Smith Canal and Fourteenmile Slough. Once a levee is modified, regardless of the measure implemented, the levee would meet the Corps levee design criteria. This would include slope reshaping and/or crown widening, where required. The levee crowns are required to have 20 feet minimum width on the San Joaquin River and 12 feet minimum width on all other levees included in the Project. Both landside and waterside slopes would also be established at a 3:1 slope, where possible. If necessary, the existing levee centerline would be shifted landward in order to accommodate levee reshaping and height improvements.

For more details on the potential levee modifications listed above and in Table 1, refer to the Project BA, specifically section 3 (Corps 2015).

In addition to the proposed levee improvement measures, the following measures and policies will apply to all of the levee repair alternatives, and will be addressed during construction:

1. Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (*e.g.*, pipes, conduits, cables) will be brought into compliance with applicable Corps policy or removed depending on type and location. This measure will include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements will occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.

2. Private encroachments shall be removed by the non-federal sponsor or property owner prior to construction.

1.3.4 Schedule and timing of Construction Measures

Seasonal Construction Timing

In general, the Corps has indicated in its BA that construction measures for the Project will occur between the middle of July through the end of October for the San Joaquin River mainstem locations (river mile 37 to Smith Canal area, Channel Point upstream to French Camp Slough). For other rivers, sloughs, and streams, the Corps has indicated that work will occur from the middle of April through the end of October.

Overall Schedule and Project Sequencing

The Corps has described in its BA that construction measures are anticipated to begin in the Central Stockton area in 2018. Construction in that area is expected to last approximately 3 years, concluding in 2020. Construction in North Stockton is estimated to begin in 2021. Construction in this area would last 8 years, ending in 2028. Construction of the full Project would take 10 years. These are estimated schedules because Congress has not yet authorized or appropriated funds for detailed engineering designs or construction plans. Final design and construction schedules may be different.

Annual Work

For Central Stockton the annual average work progress is 3 miles of slurry cutoff wall, two-thirds of a mile of geometric improvements, and a half mile of new levee construction per year. During the 3 year span for the projected work in the Central Stockton area, the closure gate at Smith Canal will be constructed. However, the Corps anticipates that completion of this structure should only take two work seasons to accomplish. For the northern Stockton area, the annual construction work progress averages out to one and a quarter miles of slurry cutoff wall, half a mile of geometric improvements, three-eighths of a mile of seismic remediation, and three-fifth of a mile of rock revetment per year.

1.3.5 Establishment of Corps ETL Compliant Levees

The Corps "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures," (ETL 1110-2-583) dated April 30, 2014, provides the standards for vegetation on and adjacent to Corps facilities. To be in compliance with this standard, the levee and floodwall and 15 feet landward and waterward of the levee toe or floodwall face, must be maintained free of woody vegetation unless a variance to this requirement is granted by the Corps. A levee or floodwall may be considered for a variance to the ETL standard after in-depth engineering analysis by the Corps has been completed that demonstrates that the levee and/or floodwall is not imperiled by maintaining woody vegetation on or within 15 feet of the levee or floodwall.

In order to construct the structural flood risk management features of the Project, vegetation will need to be removed from at least the upper half of the levee (in conjunction with 50 percent levee elevation degradation to achieve the necessary construction site conditions), and perhaps as much as 50 percent of the remaining waterside levee. Constructing some features, like slope reshaping or height repairs, will also require removal of all vegetation from the landside levee face and the landside easement. Constructing the two closure structures and the floodwall on Dad's Point (at Smith Canal) will require removal of waterside vegetation from the waterside levee toe and waterside construction easement.

During the construction phase, the levees included in the Project will be brought into compliance with the ETL. To accomplish this, the levees will undergo intensive engineering evaluation by the Corps during the Project Engineering and Design (PED) phase to determine their suitability for a variance to the ETL. Based upon the information available at this time, and using their engineering judgment, the Corps estimates that 50 percent of the existing vegetation on the lower waterside slope and within the waterside easement may be allowed to remain, meaning that the levees will have upwards of 75 percent of the waterside vegetation removed from the face of the levee. The Corps further estimates that almost none of the vegetation on the landside levee slope or within the landside easement would be allowed to remain.

1.3.6 Post Construction Operation and Maintenance

Once Project construction is complete, the Project would be turned over to the non-Federal sponsor with an Operations and Maintenance (O&M) manual in accordance with the executed Project partnership agreement for construction. The Project partnership agreement is signed before construction begins. Following construction, the non-Federal sponsor would then be responsible for the continued O&M of the Project consistent with the new and/or amended O&M manuals which are also referred to as Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) Manuals. The O&M Manuals specify the requirements for operating and maintaining the Project.

The Corps has indicated in their BA that the portion of the O&M manual that has been amended will be shared with the USFWS and NMFS for review and comment prior to being finalized to ensure that the Corps is properly incorporating the terms and conditions of any Biological Opinions. The Corps will continue to coordinate and consult with the USFWS and NMFS to further develop endangered and threatened species avoidance measures for inclusion in the amended O&M manuals.

Typical levee O&M in the Project area includes the following actions:

1. Vegetation maintenance up to four times a year by mowing or applying herbicide.
2. Control of burrowing rodent activity monthly by baiting with pesticide.
3. Slope repair, site-specific and as needed, by re-sloping and compacting.
4. Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
5. Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

The Corps has proposed the following O&M procedures for the two closure gates included in the Project description. The gates will be open except during routine maintenance, flood events, and high tides. Typically, the gates would be operated (closed) under specific conditions during the rainy season and during times when high tides occur in the area. Generally the rainy season and high tides will be between November 1st and April 30th. Gates will typically only be closed for a few hours to a day for astronomical high tide conditions when tides exceed +8.0 ft (North American Vertical Datum 1988 [NAVD88]). During flood events, the gates may be closed for several days when water elevations exceed +8.0 ft (NAVD88). A more detailed description of the O&M procedures is given in section 3.8.3 of the BA (Corps 2015).

1.3.8 Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this case, there are no interrelated or interdependent actions for this Project.

1.3.9 Proposed Conservation Actions

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible, and will implement on-site, and off-site compensation actions as necessary. The Corps proposed measures are:

1. Implement best management practices (BMPs) to prevent any bentonite slurry mixture from seeping out into the adjacent waterways from levee work sites, and require that any slurry delivery piping system be located on the land side of the levee only.
2. Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas or on designated barges, exclusive of any riparian and wetlands areas.
3. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a complete containment system.
4. Implement erosion control measure BMPs including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. Install and monitor BMPs for effectiveness, and maintain BMPs throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.
5. Schedule construction to periods when listed terrestrial and aquatic species would least likely to be present in the Project area. If construction needs to extend into the timeframe that species are present, coordinate with the resource agencies.
6. Limit site access to the smallest area possible in order to minimize disturbance.
7. Remove litter, debris, unused materials, equipment, and supplies from the Project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
8. Immediately (within 24 hours) clean up and report any spills of hazardous materials to the resource agencies. Report any such spills, and the success of the cleanup efforts in post-construction compliance reports.

9. Designate a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped, threatened or endangered species. Identify this representative to the employees and contractors during an all employee education program conducted by the Corps.
10. Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain flows to keep approach velocity at the pump screens at 0.2 feet per second or less when working in areas that may support delta smelt or juvenile salmonids.

To further avoid and minimize Project effects on listed species and their critical habitat the Corps has proposed the following additional measures during the PED phase and prior to construction:

11. Evaluate the suitability of the levees for an ETL 1110-2-583 vegetation variance. Where suitable, pursue a vegetation variance that would allow woody vegetation to remain on the lower waterside portion of the levee and within the 15 foot wide waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements, floodwall, or closure structures).
12. Develop the information necessary to evaluate the feasibility of establishing shaded riparian area (SRA) and shallow water habitat compensatory mitigation outside of the vegetation-free zone (or within it if a vegetation variance is approved) along the Lower Calaveras River.
13. Minimize vegetation removal to the extent feasible.
14. Minimize, to the extent possible, grubbing and contouring activities.
15. Identify all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected Project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
16. Incorporate sensitive habitat information into project bid specifications.
17. Incorporate requirements for contractors to avoid identified sensitive habitats into project bid specifications.

<u>Compensation Measures</u>

Vegetation losses have been roughly estimated at 9 acres of woodland riparian and approximately 20,000 linear feet (lf) of SRA habitat along the water's edge of the levee (see Table 3). To mitigate for the losses of potential SRA and woodland riparian habitat, the Corps has indicated in their BA that they will purchase shaded-riverine credits and floodplain mosaic wetlands (riparian) credits from Cosumnes Floodplain Mitigation Bank. During the PED phase, Project designs will be refined and specific surveys will be conducted to more accurately quantify losses of habitat and determine appropriate mitigation for those losses.

To mitigate for one acre of permanent open water impact and three acres of temporary open water impact associated with construction of the closure structures on Fourteenmile Slough and Smith Canal, the Corps has stated that they will purchase 2 credits (acres) of floodplain mosaic wetland. The Cosumnes Floodplain Mitigation Bank is approved under the 2008 Compensatory Wetland Mitigation Rule and has the appropriate credits available for the Corps to purchase.

This mitigation bank is located in Sacramento County and has been approved by the Corps, United States Environmental Protection Agency (USEPA), NMFS, and the California Department of Fish and Wildlife (CDFW) to provide SRA habitat credits with a service area that includes the Project area.

Table 1: Actions proposed for the Lower San Joaquin River Feasibility Study.

Waterway	Reach	Proposed Measure
	North Stockton	
Mosher Slough	Thornton Road to UPRR railroad tracks	Cutoff wall
Mosher Slough	Shina Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)
Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)
Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)
Fourteenmile Slough	Fivemile Sough to proposed Closure Structure	Seismic Fix Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	Approximately 1,500 feet west of Fivemile Slough	Closure Structure
Fourteenmile Slough	Approximately 1,250 feet southeast setback out from proposed closure structure	Seismic fix Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	From setback cut south to Tenmile Slough	Seismic fix Adjacent levee slope reshaping Erosion protection (landward)
Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope reshaping Erosion protection (waterside)
Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic fix Slope Reshaping Erosion protection (waterside)
Tenmile Slough/ Buckley Cove Marina/ San Joaquin River	West March Lane/ Buckley Cove Way to Calaveras River	Seismic fix Slope Reshaping
Calaveras River – Right/ North Bank	San Joaquin River to North El Dorado Street	Cutoff wall

	Central Stockton	
Calaveras River – Left/South Bank	San Joaquin River to approximately I-5	Cutoff wall
Calaveras River- Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping
Calaveras River – Left/South Bank	Approximately North Pershing Avenue to approximately El Dorado Street	Cutoff wall
San Joaquin River	From approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)
Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure structure
Smith Canal	Dad's Point from the closure structure to approximately375 feet down Monte Diablo Avenue	Floodwall
San Joaquin River	Railroad Bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping
San Joaquin River	Burns Cutoff to French Camp Slough	Cutoff wall
French Camp Slough – Right/North Bank	French Camp slough confluence with the San Joaquin River to approximately 500 feet southwest of I-5[1]	Cutoff wall
Duck Creek	500 feet past I-5 crossing to approximately Odell Avenue	New Levee
Duck Creek	Approximately Odell Avenue to McKinley Avenue	Cutoff wall Levee Reshaping Levee height fix

1) Note that some specific sections of this reach have been repaired by RD 404 and will be excluded from the recommended Project.

Table 2: Summary of structural measures included in the proposed Project plan by length/ or quantity.

Structural Measure	Alternative 7a
Cutoff walls	20.1 miles
Levee Reshaping	6.1 miles
Floodwall	0.2 miles
New Levee	0.75 miles
Erosion Protection (landside)	4.9 miles
Seismic Remediation (about 1.3 miles will include a Setback and partial degrade of the existing level)	3 miles
Closure Structure- Smith Canal	1
Closure Structure Fourteenmile Slough	1

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). This includes the Project footprint and surrounding areas where covered species could be affected by Project-related impacts. The action area for the Project is shown in Figure 3 and includes: the portion of the San Joaquin River between French Camp Slough and the railroad bridge 0.25 miles south of the Stockton Deep Water Shipping Channel (Stockton DWSC); French Camp Slough from El Dorado Street to the San Joaquin River; the Calaveras River from N. El Dorado Street to the San Joaquin River; portions of the Stockton DWSC between Louis Park and approximately river mile 37 on the San Joaquin River; the west side of Fourteenmile, Tenmile Slough, and Fivemile Slough to Mosher Slough; and the south side of Mosher Slough 0.41 miles beyond N. Eldorado Street up to the railroad tracks.

The action area includes perennial waters of the San Joaquin River extending 200 feet perpendicular from the average summer-fall-shoreline and 1,000 feet downstream from the proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Central Valley along the Sacramento River during similar construction activities.

Central Valley (CV) spring-run Chinook salmon, California Central Valley steelhead (CCV steelhead), and the sDPS of North American green sturgeon have the potential to occur in the action area during the Project's period of construction and long term operations. Sacramento River winter-run Chinook salmon are not likely to occur in the action area and will not be discussed further in this Opinion. Designated critical habitats occur in the action area for CCV steelhead (Delta waters) and the sDPS of North American green sturgeon (Delta waters).

Designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon does not occur in the action area and will not be discussed further in this Opinion.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and an adverse modification analysis.
The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, NMFS have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

NMFS use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

The designation of critical habitat for certain ESUs and DPSs used the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this Opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The descriptions of the status of species and conditions of the designated critical habitats in this BO are a synopsis of the detailed information available on NMFS' West Coast Regional website. The following federally listed species ESUs or DPSs and designated critical habitat occur in the action area and may be affected by the proposed action.

CV spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (70 FR 37160, June 28, 2005)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/central_valley_spring_run/central_valley_spring_run_chinook.html

CCV steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

CCV steelhead designated critical habitat
(70 FR 52488, September 2, 2005)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/california_central_valley/california_central_valley_steelhead.html

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

Southern DPS of North American green sturgeon designated critical habitat
(74 FR 52300, October 9, 2009)

http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html

Critical habitat designations identify those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the LSJRFS action area this includes the river water, river bottom, and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488).

In 2016, NMFS completed a status review of 28 species of Pacific salmon, steelhead and eulachon, including CV spring-run Chinook salmon, and CCV steelhead, and concluded that the species' status should remain as previously listed (102 FR 33468; May 26, 2016). The 2016 status reviews for CV spring-run and CCV steelhead found that, although the listings should remain unchanged, the status of these populations have suffered in 2014 and 2016 from the unprecedented California drought. An updated status review for sDPS green sturgeon was issued recently (July 2015, NMFS 2015), concluding that the status of sDPS green sturgeon should remain as threatened.

2.2.1 Central Valley Spring-run Chinook salmon

Listing and Distribution

CV spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent CV spring-run Chinook salmon listing decision (70 FR 37160, June 28, 2005). Although FRFH spring-run Chinook salmon production is included in the ESU, these fish do not have a section 9 take prohibition under the ESA. The action area is not included in the area designated as critical habitat for the CV spring-run ESU and will not be discussed further in this Opinion. In addition to the potential natural population of CV spring-run in the Sacramento River basin described above, attempts to reintroduce an experimental population to the San Joaquin River basin is underway. A final rule was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the San Joaquin River Restoration Project (SJRRP) (78 FR 251; December 31, 2013). Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. However, the rule includes proposed protective regulations under ESA section 4(d) that would provide specific exceptions to prohibitions under ESA section 9 for taking CV spring-run Chinook salmon within the experimental population area (San Joaquin River from Friant Dam downstream to the confluence of the Merced River), and in specific instances elsewhere. The first release of CV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April 2014. A second release occurred in 2015, and future releases are planned to continue annually during the spring. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined, but is likely to include individuals present in the Project action area in future years.

Historically, spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). Of the 18 to 19 original independent populations existing in four distinct geographic areas in the Central Valley (*i.e.*, diversity groups), only 3 extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the Northern Sierra Nevada diversity group (Lindley et al. 2004). All other independent populations and diversity groups have been extirpated. The Northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the Northern Sierra Nevada diversity group populations for their continued existence (see Figure 4).

Construction of dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, was thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may still persist in the Stanislaus and Tuolumne rivers (Franks, personal communication, 2012), as well as in the Yuba River. Documented naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

Life History

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River beginning in March (Yoshiyama 1998). Spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.* Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid-to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley *et al.* 2004) (Table 4). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998). Spring-run Chinook salmon spawning occurs between September and October (Moyle 2002). Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins et al. 1940, Fisher 1994). It is expected that the progeny of the experimental population reintroduced to the San Joaquin River basin will have timing that is similar to the timing characteristics of their parental stock from the Sacramento Basin.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995a). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55ºF to 57ºF (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. A significant reduction in egg viability occurs at water temperatures above 57.5ºF and total embryo mortality can occur at temperatures above 62ºF (NMFS 1997). Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel. Fry typically range from 25 mm to 40 mm during this stage.

The post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on zooplankton, small insects, and small aquatic invertebrates (Healey 1991). Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the- year or as juveniles or yearlings. The modal size of fry migrants are approximately 40 millimeters (mm) between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley et al. 2004).

When juvenile Chinook salmon reach a length of 50 mm to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the channel margins and avoid the elevated water velocities found in the thalweg of the channel.

When the channel of the river is greater than 9 feet to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams may spur outmigration of juveniles when they have reached the appropriate stage of maturation (Kjelson *et al.* 1982, Brandes and McLain 2001).

Studies in Butte Creek, (Ward et al. 2003, McReynolds et al. 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which occurred primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley et al. 2004). CDFW (CDFG 1998) observed the emigration period for spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982, Levings 1982, Levings *et al.* 1986, Healey 1991).

Once in the ocean, juvenile Chinook salmon tend to stay along the California Coast. This is likely due to the high productivity caused by the upwelling of the California Current. These food-rich waters are important to ocean survival, as indicated by a decline in survival during years when the current does not flow as strongly and upwelling decreases (Moyle 2002, Lindley *et al*. 2009). After entering the ocean, juveniles become voracious predators on small fish and crustaceans, and invertebrates such as crab larvae and amphipods. As they grow larger, fish increasingly dominate their diet. They typically feed on whatever pelagic zooplankton is most abundant, usually herring, anchovies, juvenile rockfish, and sardines. The Ocean stage of the Chinook life cycle lasts one to five years.

Table 4. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River basin[a],[b]					M	M	M	M	H	H	H	H	M	M	M	M	M	M	L					
Sac. River Mainstem[b],[c]		L	L	L	M	M	M	M	M	M	M	M	M	M	L	L								
Mill Creek[d]					L	L	M	H	H	H	H	M	M	L	L									
Deer Creek[d]					L	L	M	H	H	H	H	M	M											
Butte Creekd,[g]			L	M	M	M	M	H	H	H	H	M	L											
(b) Adult Holding[a,b]				L	L	M	M	H	H	H	H	H	H	H	H	M	M	L	L					
(c) Adult Spawning[a,b,c]															L	M	H	H	M	L				
(d) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Tribs[e]	M	M	M	M	M	M													M	M	H	H	H	H
Upper Butte Creekf,[g]	H	H	H	H	M	M	M	M	M	M	L	L							L	L	L	L	H	H
Mill, Deer, Butte Creeks[d,g]	H	H	H	H	M	M	M	M	M	M	L	L							L	L	L	L	L	L
Sac. River at RBDD[c]	H	H	L	L	L	L	L	L	L												H	H	H	H
Sac. River at KL[h]	M	M	M	M	H	H	H	H	M	M											M	M	H	H

Relative Abundance: H = High M = Medium L = Low

Sources: [a]Yoshiyama et al. (1998); [b]Moyle (2002); [c]Myers et al. (1998); [d]Lindley et al. (2004); [e]CDFG (1998); [f]McReynolds et al. (2007); [g]Ward et al. (2003); [h]Snider and Titus (2000)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Summary of ESU Viability

Since the independent populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on Viable Salmonid Population (VSP) parameters in these watersheds. Lindley *et al*. (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 status review of the CV spring-run Chinook salmon ESU, the authors concluded that the ESU status had likely deteriorated on balance since the 2005 status review and the Lindley *et al.* (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Additionally, Butte Creek remained at low risk, although it was on the verge of moving towards high risk, due to the rate of population decline. In contrast, spring-run Chinook salmon in Battle and Clear creeks had increased in abundance since 1998, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have likely increased at least in part due to extensive habitat restoration. The Southwest Fisheries Science Center concluded in their viability report (Williams *et al*. 2011) that the status of CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased. The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

In the 2016 status review, the authors found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which has moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek has remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations have continued to show stable or increasing numbers the last five years, putting them at moderate risk of extinction based on abundance. Overall, the SWFSC concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased, however the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (Williams et al. 2016).

The 2015 adult CV spring-run Chinook salmon returns were very low. Those that did return experienced high pre-spawn mortality. Juvenile survival during the 2012 to 2015 drought has likely been impacted, and will be fully realized over the next several years.

<u>Critical Habitat and Physical and Biological Features for CV spring-run Chinook salmon</u>

Designated critical habitat for CV spring-run Chinook salmon does not occur in the action area for this Project. It will not be discussed further in this Opinion.

2.2.2 California Central Valley Steelhead

CCV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good *et al*. 2005) and after application of the agency's hatchery listing policy, NMFS reaffirmed its status as threatened and also listed the Feather River Hatchery and Coleman National Fish Hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs and DPSs, NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological, and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011b). Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488).

Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta (Figure 5). Currently the CCV steelhead DPS and critical habitat extends up the San Joaquin River to the confluence with the Merced River. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. Critical habitat for CCV steelhead is defined as specific areas that contain the PBFs and physical habitat elements essential to the conservation of the species. The PBFs for CCV steelhead include freshwater spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine areas. Within the action area, critical habitat PBFs that are present are freshwater rearing areas, freshwater migratory corridors, and estuarine areas. Although highly degraded from decades of human alterations, juvenile and adult life stages are dependent on the function of these PBFs for successful survival and recruitment and therefore even in degraded areas, these PBFs have a high conservation value.

Life History

Steelhead in the CV historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and either perished in the warm water downstream of Old Folsom Dam or hybridized with winter-run steelhead. Only winter-run (ocean maturing) steelhead currently are found in California CV rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of access to suitable holding and staging habitat, such as coldwater pools in the headwaters of CV streams, presently located upstream of impassible dams (Lindley et al. 2006).

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April with peaks from January though March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961, McEwan and Jackson 1996; see Table 5 in text). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches at river mouths, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Barnhart *et al.* 1986, Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo *et al*. 2011), but that most return to the ocean (Null *et al*. 2013).

The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Table 5. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1]Sacramento R. at Fremont Weir	Low/Low	Low/Low	Low/–	–/–	–/–	–/Low	Low/Low	Low/Medium	High/High	High/Medium	Low/Low	Low/Low
[2]Sacramento R. at RBDD	Low/Low	Low/Low	Low/Low	Low/Low	Low/Low	Low/Low	Low/Low	Low/Low	Medium/Medium	High/Medium	Low/Low	Low/Low
[3]Mill & Deer Creeks	Medium/Medium	High/Medium	Medium/Low	Low/Low	Low/Low	Low/Low	–/–	–/–	–/–	Medium/High	High/Low	Low/Low
[4]Mill Creek at Clough Dam	Low/Low	Medium/High	Medium/Medium	Low/Low	–/–	–/–	–/–	–/–	–/Low	Medium/High	High/High	Medium/Medium
[5]San Joaquin River	High/High	Medium/Medium	Low/Low	–/–	–/–	–/–	Low/Low	Low/Low	Medium/Medium	Medium/Medium	Medium/Medium	High/High

(b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento R. near Fremont Weir	Low/Low	Low/Low	Medium/Medium	Medium/Medium	Medium/Medium	Medium/Medium	Low/Low	Low/Low	Low/Low	Medium/Medium	Medium/Medium	Low/Low
[6]Sacramento R. at Knights Landing	High/High	High/High	Medium/Medium	Medium/Medium	Low/Low	Low/Low	–/–	–/–	–/–	–/–	Low/Low	Low/Low
[7]Mill & Deer Creeks (silvery parr/smolts)	Low/Low	Low/Low	Medium/High	High/High	High/High	Low/Low	–/–	–/–	–/–	Low/Low	Low/Low	Low/Low
[7]Mill & Deer Creeks (fry/parr)	Low/Low	Low/Low	Low/Low	Medium/Medium	High/High	High/High	–/–	–/–	–/–	Medium/Medium	Medium/Medium	Medium/Medium
[8]Chipps Island (clipped)	Medium/Medium	High/High	Medium/Medium	Low/Low	Low/Low	–/–	–/–	–/–	–/–	–/–	–/–	Low/Low
[8]ChippsIsland (unclipped)	Medium/Medium	Medium/Medium	High/High	High/High	High/High	Medium/Medium	Low/Low	–/–	–/–	–/–	–/–	Low/Low
[9]San Joaquin R. at Mossdale	–/–	Low/Low	Medium/Medium	High/High	High/High	Low/Low	–/–	–/–	–/–	Low/Low	–/–	–/–
[10]Mokelumne R. (silvery parr/smolts)	Low/Low	Medium/Medium	Medium/Medium	High/High	High/High	Medium/Medium	Medium/Medium	–/–	–/–	–/–	–/–	–/–
[10]Mokelumne R. (fry/parr)	–/–	Low/Low	Low/Low	Low/Low	Medium/Medium	High/High	Medium/Medium	–/–	–/–	–/–	–/–	–/–
[11]Stanislaus R. at Caswell	Low/Low	Medium/Medium	High/High	Medium/Medium	Medium/Medium	Low/Low	–/–	–/–	–/–	–/–	–/–	–/–
[12]Sacramento R. at Hood	Low/Low	High/High	High/High	High/High	High/High	High/–	–/–	–/–	–/–	–/–	Low/Low	Low/Low

Relative Abundance: = High = Medium = Low

Sources: [1](Hallock 1957); [2](McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson and Merrick 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by FishBio) summarized by John Hannon (Reclamation) ; [12](Schaffter 1980).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows, when juveniles have undergone a physiological transformation (smoltification) to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River, San Joaquin River, and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986).

Summary of ESU Viability

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of naturally spawned fish to hatchery produced fish over the past 25 years (Good *et al*. 2005, NMFS 2011b); the long-term abundance trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts captured in monitoring studies has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley *et al*. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley *et al*. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild CCV steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV steelhead populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011b). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The 2011 status review of the CCV steelhead DPS (NMFS 2011b) found that the status of the population appears to have worsened since the 2005 status review (Good *et al*. 2005), when it was considered to be in danger of extinction.

The 2016 status review concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration and dam removal efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

Critical Habitat and Physical and Biological Features for CCV steelhead

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PBFs and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PBFs for CCV steelhead. PBFs for CCV steelhead include:

1. Freshwater Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging woody material, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

2.2.3 Southern DPS of North American Green Sturgeon

Listing and Distribution

In June of 2001, NMFS received a petition to list green sturgeon under the ESA and to designate critical habitat. After completion of a status review (Adams *et al*. 2002), NMFS found that the species was comprised of two DPS's that qualify as species under the ESA, but that neither DPS warranted listing. In April of 2005, NMFS (2005) revised its "not warranted" decision and proposed to list the sDPS of North American green sturgeon as "threatened" in response to a court order that challenged the original determination. In its 2006 final decision to list sDPS North American green sturgeon (also referred to as sDPS green sturgeon in this document) as threatened, NMFS cited concentration of the only known spawning population into a single river (Sacramento River), loss of historical spawning habitat, mounting threats with regard to maintenance of habitat quality and quantity in the Delta and Sacramento River, and an indication of declining abundance based upon salvage data at the State and Federal salvage facilities (71 FR 17757). Since the original 2006 listing decision, new information has become available that reinforces the original reasons for listing and reaffirms NMFS concerns that sDPS green sturgeon face substantial threats, challenging their recovery. Critical habitat was designated for the Southern DPS of North American green sturgeon on October 9, 2009 (74 FR 52300). A new five-year review of the species was issued in August 2015 (NMFS 2015), and finds that the sDPS of North American green sturgeon should remain listed as threatened under the ESA and that many of the listing factors remain unchanged since the initial listing.

Green sturgeon (*Acipenser medirostris*) are broken into two distinct population segments (DPSs), a northern DPS (nDPS) and a southern DPS (sDPS), and while individuals from the two DPS's are visually indistinguishable and have significant geographical overlap, current information indicates that they do not interbreed, nor do they utilize the spawning areas of each other's natal rivers. The sDPS of North American green sturgeon presently contains only a single spawning population within the Sacramento River basin, primarily in the main stem Sacramento River below Keswick Dam but spawning has been documented to occur in the Feather River below Oroville Dam and potentially in the Yuba River where adults exhibiting spawning behavior have been observed. Adults and juveniles occur within the Delta and both life history stages may occur within the action area at any time of the year. Designated critical habitat includes the waters of the legal Delta which includes portions of the action area (mainstem San Joaquin River and portions of Fourteenmile Slough and French Camp Slough). Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. Critical habitat for sDPS of green sturgeon is defined as specific areas that contain the PBFs essential to the conservation of the species, and have been designated in freshwater riverine systems, estuarine habitats, and nearshore marine coastal areas along the west coast of the United States. Only the freshwater riverine systems and estuarine habitats occur in the action area. The PBFs for sDPS green sturgeon in riverine systems include food resources, substrate type or size, water flow, water quality, migratory corridors, water depth, and sediment quality. Within estuarine habitats the PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality. Although highly degraded from decades of human alterations, juvenile and adult life stages are dependent on the function of these PBFs for successful survival and recruitment and therefore even in degraded areas, these PBFs have a high conservation value.

Life History

Green sturgeon are long lived, iteroperous, anadromous fish. hey may live up to 60-70 years; green sturgeon captured in Oregon have been age-estimated using a fin-spine analysis up to 52 years (Farr and Kern 2005). The green sturgeon sDPS includes those that spawn south of the Eel River. Until recently, it was believed that the green sturgeon sDPS was composed of a single spawning population on the Sacramento River. However, recent research conducted by DWR has revealed spawning activity in the Feather River (Seesholtz *et al*. 2015). Additionally, there is some evidence that spawning in the Yuba River may occur based on observed congregations and behavior of adult fish downstream of Daguerre Point Dam (Cramer Fish Sciences 2013), but no physical evidence of successful spawning or fertilized eggs has been recovered to date.

Green sturgeon eggs are adhesive and are broadcast spawned in rivers, typically over hard rocky substrates, but can include cobbles, grave and sand. Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15º C (59º F) (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Studies conducted at the University of California, Davis by Van Eenennaam *et al.* (2005) using nDPS juveniles indicated that an optimum range of water temperature for egg development ranged between 14º C (57.2º F) and 17º C (62.6º F). Temperatures above or below this range resulted in substantially elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch (Van Eenennaam *et al.* 2005).

Larval green sturgeon hatch in the late spring or summer (peak in July). Newly hatched green sturgeon are approximately 12.5mm to 14.5 mm (0.5 to 0.57 inches) in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. These yolksac larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation. Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al*. 2002) and are approximately 75 mm (2.95 inches) in length. At this stage of development, the fish are considered juveniles and are no longer larvae.

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). Growth is rapid as juveniles can reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto *et al.* 1995). Juvenile green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and sampled in trawling studies by the CDFW during all months of the year (CDFG 2002). The majority of these fish that were captured in the Delta were between 200 and 500 mm indicating they were from 1+ to 3 years of age, based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile sDPS green sturgeon likely hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard *et al.* (2005). Both nDPS and sDPS green sturgeon juveniles tested under laboratory conditions, with either full or reduced rations, had optimal bioenergetic performance (*i.e.,* growth, food conversion, swimming ability) between 15º C (59º and 19º C (66.2º F), thus providing a temperature related habitat target for conservation of this rare species (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed.

Radtke (1966) inspected the stomach contents of juvenile green sturgeon in the Delta and found food items to include a mysid shrimp (*Neomysis awatschensis)*, amphipods (*Corophium* spp.*)*, and other unidentified shrimp. No additional information is available regarding the diet of sDPS green sturgeon in the wild, but they are presumed to be generalist, opportunistic benthic feeders.

There is a fair amount of variability (1.5 to 4 years) in the estimates of the time spent by juvenile green sturgeon in freshwater before making their first migration to sea. Nakamoto *et al.* (1995) found that nDPS green sturgeon on the Klamath River migrated to sea, on average, by age three and no later than by age four. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that both nDPS and sDPS green sturgeon juveniles may occupy fresh to brackish water at any age, but they are physiologically able to completely transition to saltwater at around 1.5 years in age (Allen and Cech 2007). In studying nDPS green sturgeon on the Klamath River, Allen *et al.* (2009) devised a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and analyzing the ratios of strontium and barium to calcium. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5 to 1.5 years and then move into seawater at ages 2.5 to 3.5 years. Table 6 shows the migration timing of various life stages throughout the CV, Delta, San Francisco Bay, and into the Pacific Ocean.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley *et al.* 2011). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay in all months of the year (Kelly *et al.* 2007, Heublein *et al.* 2009, Lindley *et al.* 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean habitats along the Pacific coast of North America, and why they aggregate episodically (Lindley *et al.* 2008, Lindley *et al.* 2011). Genetic studies on green sturgeon stocks indicate that almost all of the green sturgeon in the San Francisco Bay ecosystem belong to the sDPS (Israel and Klimley 2008).

Green sturgeon do not mature until they are at least 15 to 17 years of age (Beamesderfer *et al.* 2007). Therefore, it would not be expected that a green sturgeon returning to freshwater would be younger than this. However, once mature, green sturgeon appear to make spawning runs once every few years. Erickson and Hightower (2007) found that nDPS green sturgeon returned to the Rogue River 2 to 4 years after leaving it on their prior spawning run; it is presumed that sDPS green sturgeon display similar behavior and return to the Sacramento River or Feather River system to spawn every 2 to 5 years. Adult sDPS green sturgeon begin their upstream spawning migrations into freshwater as early as late February with spawning occurring between March and July (CDFG 2002, Heublein 2006, Heublein *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates featuring crevices and interstices (Van Eenennaam *et al.* 2001). Poytress *et al.* (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008 to 2012 and has identified a number of confirmed spawning locations (Figure 6). Green sturgeon fecundity is approximately 50,000 to 80,000 eggs per adult female (Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon species. The chorion of the eggs are adhesive, and are denser than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009).

Post spawning, green sturgeon may exhibit a variety of behaviors. Ultimately they will return to the ocean, but the timing and the behaviors exhibited are variable. Illustrating the spectrum of behavioral choices, Benson *et al.* (2007) conducted a study in which 49 nDPS green sturgeon were tagged with radio and/or sonic telemetry tags and tracked manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding.

Table 6. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c.i]	Low	Low	Medium	Medium/High	High	High/Medium	Medium	Medium	Medium	Low	Low	Low
SF Bay Estuary[d,h,i]	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Low

(b) Larval and juvenile (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]					Medium	High	High	Medium				
GCID, Sac River[e]					Medium	High	High	Medium	Low	Low		

(c) Older Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta[*f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[e]				Medium	Medium	Medium	Medium	Medium	Medium	Medium		
Suisun Bay[e]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Relative Abundance: ■ = High ■ = Medium ■ = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al.* (1992); [c]Adams *et al.* (2002) and NMFS (2005); [d]Kelly *et al.* (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al.* (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Cards (2011-2015)

Summary of DPS Viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany *et al*. 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS is not believed to be viable. To support this statement, the population viability analysis (PVA) that was done for sDPS green sturgeon in relation to stranding events (Thomas *et al*. 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley *et al*. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010) and in the most recent 5-year review (NMFS 2015) the listing under the ESA remains unchanged as threatened, as many of the threats cited in the original listing still exist.

Critical Habitat and Physical and Biological Features for sDPS Green Sturgeon

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR 226.219. Critical habitat (see Figure 7) includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

Critical habitat for sDPS green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PBFs for sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the California Central Valley, NMFS will limit our discussion to freshwater riverine systems and estuarine habitats contained in the Project's action area.

Freshwater Riverine Systems

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel and Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

2. Substrate Type or Size

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, larval development, subadults, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs are likely to adhere to substrates, or settle into crevices between substrates (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2006).

3. Water Flow

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11ºC – 19ºC) (Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs [average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown (2007)]. In Oregon's Rogue River, nDPS green sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10ºC and flows increased (Erickson *et al.* 2002). On the Klamath River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al* 2007). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11ºC – 17ºC (optimal range = 14ºC – 16ºC) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20ºC for larval development (Werner *et al.* 2007); and temperatures below 24ºC for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 parts per thousand [ppt]) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O^2 hr^{-1} kg^{-1} for juveniles, Allen and Cech [2007]). Suitable water quality would also include water with acceptably low levels of contaminants (*i.e.*, pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc*.) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on effect of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a, 2001b, Feist *et al.* 2005, Fairey *et al.* 1997, Kruse and Scarnecchia 2002). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, the San Joaquin River basin, and the Delta.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

6. Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of GCID. The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). Approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern throughout the watershed.

For Estuarine Habitats

1. Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Green sturgeon feed primarily on worms, mollusks, and crustaceans (Moyle 2002). Radtke (1966) studied the diet of juvenile sDPS green sturgeon and found their stomach contents to include mysid shrimp, amphipods, and other unidentified shrimp. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source.

Invasive species are a concern because they may replace the natural food items consumed by green sturgeon. The Asian overbite clam (*Corbula amurensis*) is one example of a prolific invasive clam species in the Delta. It has been observed to pass through the white sturgeon's digestive tract undigested (Kogut 2008).

2. Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. The specific quantity of flow required is a topic of ongoing research.

3. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24ºC (75ºF). At temperatures above 24ºC, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O^2/l (Kelly *et al.* 2007, Moser and Lindley 2007).

Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

4. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP, responsible for large volumes of water diversions, alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel (DCC) facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

5. Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥5 m) holding pools within bays, estuaries, and freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia (Benson *et al.* 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 meters, either swimming near the surface or foraging along the bottom (Kelly *et al.* 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are composed of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin river systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

6. Sediment Quality

Sediment quality (*i.e.*, chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g.*, elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *sediment quality* for riverine habitats above).

Summary of the Conservation Value of Green Sturgeon Critical Habitat

The current condition of critical habitat for the green sturgeon sDPS is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, especially in the upstream riverine habitat. In particular, passage and water flow PBFs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as described for other listed Chinook salmon and steelhead critical habitats. In addition, the alterations to the lower Sacramento River and delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes, which can ultimately impact the potential population structure for decades.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.3.1 Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley watersheds has depleted stream flows in the tributaries feeding the Delta and altered the natural cycles by which juvenile and adult salmonids and sDPS green sturgeon base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and large woody debris (LWD, also referred to as instream woody material or IWM). More uniform flows year round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation (Mount 1995).

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al*. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries as well as in the maze of Delta waterways surrounding the intensively farmed islands within the legal Delta boundaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids and green sturgeon. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

2.3.2 Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and freshwater riverine and estuarine habitat PBFs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watershed's supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects; including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al*. 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

2.3.3 Land Use Activities

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin River basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches. Engineered levees have isolated the rivers from their natural floodplains and have resulted in the loss of their ecological functions.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and bar segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban stormwater and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, PAHs, and other organics and nutrients (Regional Board 1998), which can destroy aquatic life necessary for salmonid survival (NMFS 1996a, b) and are also expected to negatively impact the different green sturgeon life stages also present. Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e*., concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids and green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

2.3.4 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids and sDPS green sturgeon. Some common pollutants include effluent from wastewater treatment plants and chemical discharges such as dioxin from San Francisco Bay petroleum refineries (McEwan and Jackson 1996). In addition, agricultural drain water, another possible source of contaminants, can contribute up to 30 percent of the total inflow into the Sacramento River during the low-flow period of a dry year. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides [aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene], mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001, 2010).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al*. 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids and green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (USEPA 1994). However, the more likely route of exposure to salmonids or green sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures once the contaminant has entered the body of the fish.

2.3.5 Hydrology in the Delta

Substantial changes have occurred in the hydrology of the Central Valley's watersheds over the past 150 years. Many of these changes are linked to the ongoing actions of the CVP and SWP in their pursuit of water storage and delivery of this water to their contractors.

Prior to the construction of dams on the tributaries surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snow melt in the surrounding watersheds. These reservoirs delayed and muted the transmission of floodwaters traveling down the length of the Sacramento and San Joaquin rivers. Historically, there were at least six distinct flood basins in the Sacramento Valley. These extensive flood basins created excellent shallow water habitat for fish such as juvenile Chinook salmon, steelhead, and sturgeon to grow and rear before moving downstream into the Delta (The Bay Institute 1998). The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead, and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches.

Prior to the construction of dams, there were distinct differences in the natural seasonal flow patterns between the northern Sacramento River watershed and the southern San Joaquin River watershed. Furthermore, the natural unimpaired runoff in the Central Valley watersheds historically showed substantial seasonal and inter-annual variability. Watersheds below 5,000 feet in elevation followed a hydrograph dominated by rainfall events with peak flows occurring in late fall or early winter (northern Sierra Nevada, Cascade Range, and most of the western coastal mountains). Conversely, those watersheds with catchment areas above 5,000 feet, such as the Central and Southern Sierras, had hydrographs dominated by the spring snowmelt runoff period and had their highest flows in the late spring/early summer period. Summertime flows on the valley floor were considerably reduced after the seasonal rain and snowmelt pulses were finished (see Figure 8), with base flows supported by the stored groundwater in the surrounding alluvial plains. Since the construction of the more than 600 dams in the mountains surrounding the Central Valley, the variability in seasonal and inter-annual runoff has been substantially reduced and the peak flows muted, except in exceptional runoff years. Currently, average winter/spring flows are typically reduced compared to natural conditions, while summer/fall flows have been artificially increased by reservoir releases. Wintertime releases are coordinated for preserving flood control space in the valley's large terminal storage dams, and typically do not reach the levels necessary for bed load transport and reshaping of the river channels below the dams. Summertime flows have been scheduled for meeting water quality goals and consumptive water demands downstream (see Figures 9 and 10). Mean outflow from the Sacramento River during the later portion of the 19th century has been reduced from nearly 50 percent of the annual discharge occurring in the period between April and June to only about 20 percent of the total mean annual outflow under current dam operations (The Bay Institute 1998). Currently, the highest mean flows occur in January, February, and March. The San Joaquin River has seen its snowmelt flood peak essentially eliminated, and the total discharge to the valley floor portion of the mainstem greatly reduced during the spring. Only in very wet years is there any marked late spring outflow peak (The Bay Institute 1998).

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. The operations of the dams and water transfer operations of the CVP and SWP have reduced the winter and spring flows into the Delta, while artificially maintaining elevated flows in the summer and late fall periods. The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. Releases of water to the Delta during the normally low flow summer period have had several impacts on Delta ecology and hydrology. Since the projects started transferring water through the Delta, the normal variability in the hydrology of the Delta has diminished. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989, see Figures 11 and 12). The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and “unstable” Delta environment.

Furthermore, Delta outflow has been reduced by approximately 14 percent from the pre-dam period (1921-1943) when compared to the modern state and federal water project operations period (1968-1994). When differences in the hydrologic year types are accounted for and the “wet” years are excluded, the comparison between similar year types indicates that outflow has been reduced by 30 to 60 percent (The Bay Institute 1998), with most of this “lost” water going to exports. Currently, the Sacramento River contributes roughly 75-80% of the Delta inflow in most years and the San Joaquin River contributes about 10-15%; the Mokelumne, Cosumnes, and Calaveras rivers, which enter into the eastern side of the Delta, contribute the remainder. The sum of the river contributions flow through the Delta and into Suisun Bay, San Pablo Bay, San Francisco Bay, and eventually empties into the Pacific Ocean. Historical annual Delta inflow between 1945 and 1995 (*i.e.*, the period of modern dam operations) averaged approximately 23 million acre-feet (MAF), with a minimum inflow of approximately 6 MAF in 1977 and a maximum of approximately 70 MAF in 1983 (Corps 2015).

Water movement in the Delta responds to four primary forcing mechanisms: (1) freshwater inflows draining to the ocean; (2) Delta exports and diversions; (3) operation of water control facilities such as dams, export pumps, and flow barriers; and (4) the regular tidal movement of seawater into and out of the Delta. In addition, winds and salinity behavior within the Delta can generate a number of secondary currents that, although of low velocity, can be of considerable significance with respect to transporting contaminants and mixing different sources of water. Changes in flow patterns within the Delta, whether caused by export pumping, winds, atmospheric pressure, flow barriers, tidal variations, inflows, or local diversions, can influence water quality at drinking water intakes (Corps 2015).

2.3.6 Vegetation

Historic native vegetation in the Project area has been highly altered and fragmented as a result of flood risk management, land reclamation, urbanization, agriculture, and navigation projects (Corps 2015). Flood risk management infrastructure in this area includes levees, river and tributary realignments, constructed channels, erosion protection, and control structures. Vegetation within the Project area maintains some remnants of what was historically present, including Great Valley cottonwood riparian forest, Great Valley oak riparian forest, coastal and valley freshwater marsh. It also includes nonnative woodlands, agricultural (row crops, orchards and vineyards), and developed lands like lawns, parks and golf courses. Non-native grasses, forbs, shrubs, trees, and vines are interwoven throughout the landscape. Open water habitat includes rivers, tributaries, canals, and ditches. Ditches may contain water seasonally or year-round (Corps 2015).

Once, the San Joaquin River and tributaries were framed by dense riparian forest. Today, riparian vegetation consists of narrow linear strips and occasional patches of riparian forest and riparian scrub growing on or adjacent to the levee. Larger areas of riparian forest are present in some areas where the levee is set back from the river or tributary leaving floodplain on the waterside of the levee (Corps 2015).

The Project area occurs within the Great Central Valley subdivision of the California floristic Province in San Joaquin County (Hickman, Ed. 1993:45). The topography of the portions of the Project area adjacent to the levees is relatively level, and elevations in the Project area range from less than 5 feet to approximately 38 feet above mean sea level. The northern portion of the Project area includes Mosher Slough, Fivemile Slough, Fourteenmile Slough, Tenmile Slough, and the Stockton Deep Water Ship Channel. The central and southern part of the Project area includes the San Joaquin River and its tributaries, including Calaveras River, Smith Canal, Mormon Slough, French Camp Slough, and Duck Creek. The following sections describe the vegetation found in the Project action area.

Mosher Slough

Mosher Slough runs through a highly urbanized area in north Stockton. Woody riparian vegetation is most robust near the confluence with Fourteenmile Slough. It is comprised of typical Great Valley riparian trees and shrubs. Emergent wetland vegetation occurs intermittently at the water's edge. Landside vegetation includes non-native landscape trees and shrubs as well as natives. Typical wetland vegetation lines some stretches of this reach (Corps 2015).

Fourteenmile, Fivemile, and Tenmile sloughs

These levees along these waterways protect the western edge of the City of Stockton. Westward of the waterways the region is predominantly agricultural lands. To the east of the waterways are highly urbanized areas consisting of housing subdivisions and light industry. On the waterside of the levees, some woody riparian trees and shrubs still remain. Within some of the sloughs and canals, native and non-native aquatic weeds cover much of the water surface. Along the edges of the waterways wetland vegetation is present intermittently. Within Fourteenmile Slough, intertidal vegetation is present on rocky substrate that is exposed during low tides. In Buckley Cove, near the confluence of Tenmile Slough with the Stockton DWSC, wetland and subtidal vegetation is present along with native and non-native aquatic weeds (Corps 2015). .

San Joaquin River

On the San Joaquin River, lands waterside of the levees are very narrow and support a remnant riparian forest. Trees and shrubs occur in small patches or by scattered individuals. Vegetation on the waterside of levee slopes in the Project area is highly varied, ranging from ruderal herbaceous vegetation and annual grasses with few shrubs, to dense shrubs with little overstory, to mature riparian forest. Potential SRA cover is found along much of the river in the Project area.

Dominant waterside tree species include cottonwood (*Populus fremontii*), willow (*Salix* spp.), oak (*Quercus* spp.), box elder (*Acer negundo*), and walnut trees (*Juglans* spp.). In the Project area, common shrub species include willow, wild Rose (*Rosa* spp.), and blackberry (*Rubus* spp.). Elderberry shrubs (*Sambucus* spp.) are also present in some locations. Ruderal herbaceous vegetation is commonly present on waterside levee slopes. Landside levee slopes are primarily barren or covered with ruderal vegetation.

Calaveras River

Levees and the lands adjacent to both the waterside and landside of the levees in the reach of the Calaveras River above, and just below, the Stockton Diverting Canal are largely devoid of trees and shrubs. Moving downstream, more trees and shrubs are present on and adjacent to the levees. In the highly urbanized reaches of the river channel, many of the landside trees and shrubs are associated with landscape plantings in yards, parks, and public rights of way. Wetland vegetation appears to line the channel in places. Within the river channel, between the levee faces, seasonally inundated lands exist with riparian and ruderal vegetation consisting of grasses, bushes, and shrubs.

Smith Canal

Smith canal is surrounded by urban residential areas, including hard-scaping (sidewalks) and some landscape plantings adjacent to the water's edge. Near the confluence of the canal with the San Joaquin River, there is a public park, including a picnic area, boat launch ramp and associated infrastructure. There is an irrigated lawn and a mixture of native and non-native trees and shrubs. Wetland vegetation is prevalent at the water's edge and non-native invasive water plants inhabit the canal near the boat launch ramp. Non-native invasive waterweeds occupy much of the inlet in the vicinity of the boat launch ramp.

French Camp Slough and Duck Creek

The Corps' BA (Corps 2015) describes the levees along Duck Creek as devoid of trees and shrubs. Adjacent lands are largely in agriculture with urban development beginning to encroach upon these lands. French Camp Slough upstream of the confluence with Duck Creek is very similar in character to Duck Creek. Levees are free of trees and shrubs and adjacent lands are in agriculture with urban lands extending towards the levee slough.

The lower reaches of French Camp Slough (between Duck Creek and the San Joaquin River) are surrounded on the landward side by urban development. The Weston Ranch residential development is immediately to the south of the slough. A municipal golf course occupies land adjacent to the northern bank/levee of French Camp Slough. Between the north and south French Camp Slough levees there exists an "island" of land that is in agriculture. The perimeter of this island contains a fairly thick margin of trees and shrubs adjacent to the slough's waters (Corps 2015).

In the lower French Camp Slough reach, the levee crown includes a paved road. The landside levee slope and toe are mostly devoid of vegetation. There are some annual grasses and herbs. These are largely non-native weedy plants. Where trees and shrubs are present within the landside easement, they are mainly landscape plantings associated with public rights of way and private yards. The waterside levee slope and easement have trees and shrubs throughout their length, being quite dense in some areas. Trees include native valley oak, box elder, cottonwood, California black walnut, and willows. Elderberry shrubs, poison oak (*Toxicodendron diversilobum*), patches of dead willow shrubs, and snags also are present. In the canal between the southern levee and the mid-channel island to the north, wetland plants are abundant. These include tules (*Scirpus* spp.), nut sedges (*Cyperus* spp.), and tule potato (*Sagittaria* spp.). Non-native English walnut trees, water hyacinth (*Eichhornia crassipes*), and mistletoe (order *santalales*) are also present (Corps 2015).

2.3.7 Status of Species in the Action Area

1. Presence of CV Spring-run in the Action Area

Currently there are no documented populations of CV spring-run in the San Joaquin River basin that would likely occur in the action area. However, there is anecdotal evidence of Chinook salmon occurring in the Stanislaus and Tuolumne Rivers that may represent residual populations of spring-run Chinook salmon or individuals that have strayed from other river basins and use the Stanislaus and Tuolumne rivers for spawning based on their run timing and the presence of fry and juveniles that show traits characteristic of spring-run populations such as hatching dates and seasonal sizes (Franks 2013). Furthermore, the SJRRP goal of re-establishing an experimental population of CV spring-run in the San Joaquin River basin will create the potential that spring-run Chinook salmon will be present in the action area over the Project's construction time frame through 2028 and continued presence of the flood control structures and levees in the action area into the future.

There are no spawning areas in the action area that could be used by adult spring-run, therefore the potential that eggs would be present in the action area is essentially nonexistent. Likewise, the potential for alevins to be present in the action area is also unlikely, since only extreme precipitation events in the fall and early winter resulting in high river flows in the San Joaquin River basin could flush alevins out of their natal tributaries into the action area. Fry and parr are more likely to be present in the action area in response to high river flows due to the timing of winter storms and the progressive maturation of the fish. This period would be from approximately November through March. By April, juvenile spring-run are reaching the size that smoltification occurs, and the smolts would be moving downriver to enter the Delta on their emigration to the ocean. Spring-run smolt outmigration is essentially over by mid-May and early June. There is the potential that some juvenile spring-run will remain in the tributaries through the summer and outmigrate the following fall and winter as yearlings, but until the experimental population has had time to establish itself, this behavior is uncertain to occur. Adult spring-run are expected to enter the action area starting in January. Low levels of adult migration is expected to continue through early March. The peak of adult migration through the action area is expected to occur between April and June, based on the migratory behavior of the Sacramento River basin stocks. Adult migration is also likely to be strongly influenced by the flow levels in the San Joaquin River basin that provides access to the upstream holding and spawning areas.

The proposed construction period for the Project's actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. There is very little likelihood that either adult or juvenile life history stages of CV spring-run would overlap with this timing. However, the long-term operations of the Project's flood control gates in Smith Canal would overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. This period would overlap with a portion of both the juvenile and adult salmon migration movements from April through June. It is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for salmonids. Large populations of non-native fish, such as centrarchids, are present and pose a predation threat to juveniles. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of non-natal rearing juvenile spring-run. Both adults and juveniles could easily access these waters during their migratory movements through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

2. <u>Presence of CCV Steelhead in the Action Area</u>

Small, but persistent populations of CCV steelhead are present in the Calaveras River and San Joaquin River basins and are part of the Southern Sierra Nevada Diversity group. Both adults and smolts are detected by monitoring efforts in these basins indicating spawning is occurring in the basin's tributaries. There are no spawning areas in the action area that could be used by adult

CCV steelhead, therefore the potential that eggs would be present in the action area is nonexistent. All adult CCV steelhead originating in the Calaveras River watershed will have to migrate through the action area to reach their spawning grounds and return to the ocean following spawning. Likewise it is believed that the majority of adult CCV steelhead originating in the San Joaquin River basin will pass through the action area to reach their spawning grounds in the Stanislaus, Tuolumne, and Merced rivers, and the tailwater section of the San Joaquin River below Friant Dam, and return to the ocean following spawning through these same waterways. Some adults may access the San Joaquin River basin through the south Delta waterways leading to the Head of Old River near Lathrop, and may return to the ocean via this route too. These fish would avoid the action area if they use this alternative route. Likewise all CCV steelhead smolts originating in the Calaveras River watershed will have to pass through the action area in the lower reaches of the river where it empties into the San Joaquin River during their emigration to the ocean. CCV steelhead smolts leaving the San Joaquin River basin during their emigration also have the potential to pass through the action area, particularly if a fish barrier is installed at the Head of Old River during their emigration period. The waterways in the action area are expected to be used primarily as migration corridors for adult steelhead and emigrating steelhead smolts, but may also provide some rearing benefits to the emigrating smolts.

CCV steelhead smolts are expected to appear in the action area waterways as early as January, based on observations in tributary monitoring studies on the Mokelumne, Calaveras, and Stanislaus rivers, but in very low numbers. The emigration out of the tributaries starts to increase in February and peaks in March, with fish continuing to be observed through late May and June. The peak emigration in the lower San Joaquin, as determined by the Mossdale trawls near the Head of Old River, occurs from April to May, but with presence of fish typically extending from late February to late June. It should be noted that emigration out of the Calaveras River can only occur if there is hydraulic continuity between the upper watershed below New Hogan Dam and the Delta. If the water year is dry with little rainfall in the Calaveras River watershed, the river may disconnect upstream of the Delta, and any steelhead smolts still within the lower reaches of the Calaveras River, Mormon Slough, and the Diverting Canal will be stranded and will perish.

Adult CCV steelhead are expected to start moving upstream through the action area into the lower San Joaquin River as early as September, with the peak migration period occurring later in the fall during the November through January period, based on Stanislaus River fish weir counts. Adult CCV steelhead will continue to migrate upriver through March, with post spawn fish, “kelts”, moving downstream potentially through spring and early summer, although most are expected to move back downstream earlier than later.

The proposed construction period for the Project’s actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. This will overlap with the adult CCV steelhead migration period in the San Joaquin River basin (*i.e.*, the months of September and October) but will avoid the peak of spawning migration from November through January. However, the long-term operations of the Project’s flood control gates in Smith Canal may overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. This period would overlap with a portion of both the juvenile and adult migration movements from April through June and in the months of September and October when adults are migrating. It is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for salmonids. Large populations of non-native fish, such as centrarchids, are present and pose a predation threat to smolts. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of both adult and juvenile CCV steelhead. Both adults and juveniles are likely to be present in the waters of the Calaveras River during their migratory movements in the period between mid-April and June, particularly if there is hydraulic connection between the Delta and the upper reaches of the river. Presence in the waters of French Camp Slough is likely in the fall (adults) and in the spring (adults and smolts) due to the open access between the mainstem San Joaquin River and the slough during the migratory movements of adults and smolts through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

3. <u>Presence of sDPS of North American Green Sturgeon in the Action Area</u>

Both adult and juvenile green sturgeon are expected to occur in the action area, but in low numbers. The Delta serves as an important migratory corridor for adults during their spawning migrations, and as year round rearing habitat for juveniles. Both non-spawning adults and sub-adults use the Delta and estuary for foraging during the summer. Since there are no physical barriers to sDPS green sturgeon moving into the action area from the waters of the Delta adjacent to the action area during their rearing or foraging behaviors, presence in the action area is seen as feasible and likely.

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of sDPS green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on one of the two main rivers feeding the Delta (the San Joaquin River) and there have been consistent reports of green sturgeon being caught by sport fisherman in the San Joaquin River from Sherman Island at the western edge of the Delta upstream to at least Highway 140 near the town of Newman (CDFW 2015, 2014, 2013, 2012, 2011), although in low numbers compared to other regions of the Delta and San Francisco estuary. At this time, no specimen has been examined by trained biologists to determine if these fish caught and recorded in the sturgeon report card database are actually green sturgeon. Up until recently, juvenile green sturgeon from the sDPS were routinely collected at the State Water Project (SWP) and Central Valley Project (CVP) salvage facilities throughout the entire year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. However, over the past few years, salvage of juvenile green sturgeon at the facilities has been rare (as well as for salvage of the more common white sturgeon); the reason for this decline in salvage is unknown. Adult green sturgeon begin to enter the Delta in February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn. It is also possible that some adult green sturgeon will be moving back downstream into the Delta in April and May, either as early post spawners or as unsuccessful spawners and may potentially enter the action area via the San Joaquin River. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall, moving downstream with changes in water temperature and flows due to fall storms.

Because the only known spawning areas for sDPS green sturgeon occur in the Sacramento River basin, there is very low potential for eggs or larval green sturgeon to occur in the action area. Spawning in the San Joaquin River has not been recorded, although there appears to be at least some presence of adult fish in the river upstream of the Delta based on the sturgeon report card data.

The proposed construction period for the Project's actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. Since both adult and juvenile sDPS green sturgeon may be present in the Delta year round, the construction period will overlap with their presence. Likewise, the long-term operations of the Project's flood control gates in Smith Canal will overlap with both adult and juvenile presence in the Delta during the winter when river levels are expected to rise in response to high astronomical tides or flood events occur and the gates are operated. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. Since both adult and juvenile presence is assumed to occur year round in the action area, the planned construction window for the sloughs and tributaries will overlap with their presence. However, it is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for native fish. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of both adult and juvenile sDPS green sturgeon. Both adults and juveniles could easily access these waters at the mouths of the Calaveras River or French Camp Slough during their movements through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

2.3.8 Status of Critical Habitat within the Action Area

The PBFs for steelhead critical habitat within the action area include freshwater rearing habitat and freshwater migration corridors. Estuarine areas occur farther downstream where mixing occurs and salinity is greater than 0.5 ppt. The features of the PBFs included in these different sites essential to the conservation of the CCV steelhead DPS include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead smolts and for adult freshwater migration. No spawning of CCV steelhead occurs within the action area.

In regards to the designated critical habitat for the sDPS of North American green sturgeon, the action area includes PBFs which provide: adequate food resources for all life stages utilizing the Delta; water flows sufficient to allow adults, sub-adults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages utilizing the Delta; a broad spectrum of water depths to satisfy the needs of the different life stages present in the Delta and estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in the *Rangewide Status of the Species and Critical Habitat* section of this Opinion. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the CCV steelhead DPS and the sDPS of North American green sturgeon. All juvenile CCV steelhead smolts originating in the Calaveras River basins must pass into and through the action area in the Central Delta to reach the lower Delta and the ocean. A large fraction of the CCV steelhead smolts originating in the San Joaquin River basin fish will likely pass downstream through the action area within the San Joaquin River mainstem channel, particularly if there is a fish barrier at the Head of Old River to prevent smolt entrance into that route. Likewise, adults migrating upstream to spawn are likely to pass through the action area within the main stem of the San Joaquin River to reach their upstream spawning areas in the Calaveras River basin or the San Joaquin River basin. Therefore, it is of critical importance to the long-term viability of the CCV steelhead to maintain a functional migratory corridor and freshwater rearing habitat through the action area to sustain the Southern Sierra Diversity Group, and provide the necessary spatial diversity to achieve recovery. Due to a deficit of monitoring data directed at this species, an unknown fraction of the sDPS population utilizes the middle and upper San Joaquin River reaches within the Delta, and even less is known about utilization of the San Joaquin River upstream of the Delta. However, designated critical habitat occurs in the action area and includes the San Joaquin River upstream to the limits of the legal Delta (Vernalis) on the San Joaquin River. Preservation of the functionality of the PBFs within this region is important to the long term viability of the sDPS green sturgeon population by providing suitable habitat for the rearing of juveniles, and the foraging and migratory movements of adults.

2.3.9 Factors Affecting the Species and Habitat in the Area

The action area encompasses a small portion of the area utilized by CCV steelhead as well as the sDPS of North American green sturgeon. Many of the factors affecting these species in the action area are considered the same as throughout their range, as discussed in the *Rangewide Status of the Species and Critical Habitat* and *Environmental Baseline* sections of this Opinion, specifically, levee armoring and channelization, alteration of river flows and timing, reduction of LWD in the waterways, reduction of riparian corridors and associated SRA vegetation and the introduction of point and non-point contaminants and are incorporated here by reference.

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To conduct this assessment, NMFS examined information from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, government and non-government reports, the BA for this project, and supplemental material provided by the applicant in response to questions asked by NMFS.

2.4.1 Assessment

The assessment of Project effects will first look at construction related effects and then effects related to the long term impacts of the levees, loss of riparian vegetation, and implementation of the Corps' ETL vegetation policy. NMFS review of construction related effects will examine impacts from terrestrial and aquatic construction activities including noise related and short term turbidity effects upon listed species. Secondly, NMFS assessed the effects of the long term operation of the flood control structures on listed species, including entrapment, water quality, and vulnerability to predation. Next, NMFS examined the role of the physical presence of levee structures and the armoring of the levee faces with riprap on the functioning of aquatic and riparian communities, food webs, and utilization of these altered habitats by listed salmonids and green sturgeon. Finally, NMFS evaluated the impacts of the Project's actions on designated critical habitat in the action area.

2.4.1.1 Construction Related Effects

The proposed Project has both terrestrial and aquatic habitat construction impacts. The construction related effects will be comprised of two main effects: noise related impacts and turbidity related impacts. Noise related impacts will occur contemporaneously with the construction activities, and will be associated primarily with the use of heavy construction equipment on the levees, the use of excavators or drilling equipment to modify the levees for flood protection, and the use of pile drivers to install sheet pile walls and concrete columns. When construction activities are halted, noise generation ceases. This is considered a direct effect of the construction process related to the Project. In contrast, the construction related impacts associated with turbidity have a more complex temporal pattern. During construction, soils and sediments may become disturbed and directly suspended in the surrounding waterways, creating turbidity events adjacent to the levees under construction and in the nearby waterways as the turbidity plume is disbursed by water movement. This is the immediate temporal exposure to turbidity events related to construction activities and is considered a direct effect of the Project. Long term exposure to turbidity events can occur due to the erosion of exposed soil surfaces during or following the completion of construction activities and can occur weeks to months after the completion of Project activities during precipitation events and is considered an indirect effect of the construction process of the Project.

1. Noise related effects

Terrestrial Construction Sources

Based on the description provided in the Corps BA regarding construction elements of the Project (Corps 2015), heavy equipment will be used throughout the action area to implement the different levee improvements considered in the Project description. Heavy earth moving equipment will be used to clear and grub the levee faces on both the waterside and landsides of the levees undergoing structural flood risk improvements. Following this, the crown of the levee will typically be degraded, removing up to 50 percent of the levee height to create the suitable width for construction actions. This will require equipment such as bulldozers, scrapers, front loaders, and dump trucks to haul away the soil from the levee site for offsite storage. Construction of cutoff walls will require the use of excavators to dig the cutoff wall trench or the excavation of soils using specialized drilling equipment to inject the bentonite slurry into the cutoff wall space using deep soil mixing techniques. A similar drilling technique will also be used in the seismic remediation elements where installation of a larger grid of soil-cement mixed columns laid out in a series of overlapping cells running longitudinally and perpendicular to the levee alignment will be created. Reconstruction of the modified levees to achieve the appropriate levee prism will require new fill to be brought in by haul trucks and spread on the levee surfaces. Various earth moving equipment, including scrapers and soil compactors will be used to complete the levee construction to Corps design criteria.

All of these construction elements and the associated construction equipment required to complete the action will create noise in the terrestrial environment, particularly when heavy earth moving equipment is used. The scraping and moving of earth will create noise as energy is being transferred from the hard blades or buckets of the equipment to the soil horizons. The noise generated by the earth moving actions is partially transferred through the soil to surrounding areas, including the adjacent aquatic environment. This is referred to as coupled transmission. A report by Burgess and Blackwell (2003) indicated that vibratory installation of a sheet pile wall in an upland position generated sound levels of approximately 140 dB (re: 1µPa) at a distance of 200 feet in the adjacent waterway, indicating that the noise was coupled through the soil to the water column. It is expected that the noise transferred through the soil horizons to the adjacent waterways will attenuate in strength relatively quickly. Thus, it is unlikely that the noise level received by the aquatic system will be of sufficient energy to cause mortality or injury, rather, it will more likely result in levels of sound energy that cause harassment or behavioral responses. It is anticipated that the resulting noise levels will initially "drive" fish away from the area affected, however they may return or stay in the area as they acclimate to the new acoustic environment. Still, noise coupled with increased human activity (*i.e.*, motion, noise, shadows, etc.) on the levee may be sufficient to "drive" fish away from the work area for longer periods. Therefore, it is expected that any fish within the areas adjacent to levees under construction will avoid the shoreline and the shallow water adjacent to the levee toe and move into deeper, open water to avoid the noise during construction activities. This has the potential to expose the fish to elevated predation pressures from a lack of access to hiding areas associated with the shoreline.

Construction of the levee modifications are anticipated to last the entire length of time available each year (mid-July through October 31 along the San Joaquin River sections and mid-April through October 31 on the tributaries and slough sections of the Project). This will last the projected 10 years it will take to complete the levee modifications proposed for the Project (2018 through 2028).

Aquatic Construction Sources

The BA describes the construction of two operable flood control gates; one in Smith Canal and the second in Fourteenmile Slough and a flood wall constructed adjacent to the Smith Canal flood control gates. The design of the two gate structures will require that a sheet pile wall be constructed across the width of the site specific waterway and tied into the adjacent levee banks. The sheet pile wall will consist of two parallel walls of sheet pile, approximately 20 feet apart, that will be tied together, braced, and filled with stone aggregate. In the center of the channel, a gate enclosure will be constructed in the sheet pile wall measuring approximately 70-feet by 70-feet which will subsequently be dewatered for the construction of the gate foundation, which includes several 24-inch diameter concrete pilings and a concrete slab floor. The concrete floor will be supported on a grid of 24-inch diameter concrete piles driven into the channel bottom (Corps 2015).

In order to drive the sheet pilings into the channel bottom, two types of pile driving hammers are proposed for the Project. The Corps proposes to use a vibratory hammer to initially drive the sheet piles to the approximate final depth required, then finish the installation of the sheet pile walls with an impact hammer to achieve final tip depth and load bearing strength required in the design specifications. The Corps also anticipates that the landside portions of the sheet pile wall that tie into the adjacent levees will require the use of an impact hammer to achieve the necessary depth and load bearing for these sections. The installation of the 24-inch diameter concrete piles will require that an impact hammer be used to drive them to depth and the load bearing resistance necessary to support the concrete floor foundation upon which the steel gate structure will be mounted. The Project's description in the BA indicates that each half of the channel will take one construction season to complete with pile driving occurring over a 2-month period. The installation of the sheet pile cofferdam surrounding the gate location will take approximately 3 weeks to install. The cofferdam will close off the area of the gate structure, allowing the workspace behind it to be dewatered. Following the installation and dewatering of the work area, concrete pilings will be driven into the exposed work area to support the floor of the gate foundation and the gate structure. Construction of the foundation and gate will take an additional 6 months. Complete construction of the sheet pile wall and operable gates will take approximately 2 years to complete, requiring pile driving actions for the two work seasons.

Sheet piles and the concrete pilings are driven into the substrate until a predetermined level of resistance is encountered by the hammer. This typically is measured as the number of hammer blows required to move the sheet pile (or concrete pile) a certain distance into the substrate (*e.g.* number of blows to move 1 foot in depth). Energy transferred to the pile by the hammer is partially redirected as acoustic energy and heat as the pile loses energy to the surrounding medium (*i.e.,* soil or rock). As sound propagates away from the source, several factors change its amplitude (Burgess and Blackwell 2003). These factors include the spreading of the sound wave over a wider area (spreading loss), losses to friction between water or sediment particles that vibrate with the passing sound wave (absorption), scattering and reflections from boundaries and objects in the sound's path and constructive and destructive interference with one or more reflections of the sound off "solid" surfaces such as the seafloor or water surface. The sound level measured at any given point along the path of the propagated sound wave includes all of these effects and is termed the received level. The sum of all of the propagation and loss effects on a signal is called the transmission loss and is the difference between the received level and the source level. The effects of this sound transmission are described in the following section on *Effects of sound on fish*.

The construction project location at Smith Canal has several factors which may alter the transmission of the propagated sound waves into the channel of the San Joaquin River during the pile driving activities. The channel width to Rough and Ready Island directly across the San Joaquin River from the Smith Canal gate location is approximately 500 to 800 feet in a direct line. The propagation of sound could continue up and down river from the construction site for 2 to 3 thousand feet, based on a straight line of sight from the gate structure and the configuration of the northern shoreline and levees. The channel depth varies over a wide range in the reach adjacent to the construction project site. Along the levee banks, the depth is only 9 feet deep (mean low water) and a shallow bench exists that extends out from the levee toe to the dredged ship channel. The dredged ship channel, which is approximately 35 feet in depth at low tide, passes to the south of the construction project site and drops off rapidly from the shallow bench. To the east of the gate alignment, the shallow bench continues into Smith Canal. These changes in bottom contours will create conditions that will attenuate the propagation of sound through the channel (null spots). In addition, ambient noise from river flow, boat traffic, and irregular surfaces such as the rip rapped surface of the levees may create additional acoustic signals that muffle or cancel out the acoustic signal from the pile driving actions (masking). Installation of the concrete support pilings for the gate structure is anticipated to take place in the dewatered work area behind the coffer dam. The acoustic noise derived from the pile driving of the concrete support piles is expected to primarily be propagated through the soil to the aquatic environment (coupled transmission), rather than through the air. The construction project location on Fourteenmile Slough has a more confined and uniform channel geometry. The channel is approximately 300 feet wide with an average depth of approximately 8 feet. The section of channel in which the gate will be located is fairly straight for about 1,300 to 1,500 feet in either direction along the alignment of the slough before the channel begins to bend. The specific impacts are described in the following section *Effects of sound on fish*.

Effects of sound on fish

The installation of sheet piles and concrete piles with either a vibratory pile driving hammer or impact hammer is expected to result in adverse effects to listed salmonids and green sturgeon due to high levels of underwater sound that will be produced. Although adverse effects to fish from elevated levels of underwater sound are well documented for explosives (Gaspin 1975, Keevin and Hempen 1997a) and air guns (Pearson *et al.* 1992, Engas *et al.* 1996, McCauley *et al.* 2003, Popper *et al.* 2005), there was initially little information regarding the effects on fish from underwater sound pressure waves generated during the installation of piles (Caltrans 2001, Vagle 2003). Laboratory research on the effects of sound on fish has used a variety of species and sounds (Hastings *et al.* 1996, Popper and Clarke 1976, Scholik and Yan 2002, Turnpenny *et al.* 1994). Experimental data found in the literature concerning the effects of sound on aquatic animals are not reported in a consistent manner, and most of these studies did not examine the type of sound generated by pile driving.

The degree to which an individual fish exposed to underwater sound will be affected (from a startle response to immediate mortality) is dependent on a number of variables such as the species of fish, size of the fish, presence of a swimbladder, sound pressure intensity and frequency, shape of the sound wave (rise time), depth of the water around the pile and the bottom substrate composition and texture. It has long been known that underwater explosives can cause injury and mortality to fish. The Department of the Navy conducted a series of experiments to determine the effects on fish from underwater explosions (Goertner *et al.* 1994, Gaspin 1975) which resulted in significant differences in effects to fish depending on whether or not they had swimbladders. Thus, it is the swimbladder, inflated with gas, which rapidly compresses under the overpressure wave and then expands as the pressure wave passes through the fish and is replaced by the underpressure wave that likely causes the observed injuries to internal organs (Keevin and Hempen 1997a). An important characteristic of the underwater sound that causes injury is the frequency. During pile installation, most energy is contained within the frequency range (100–1,000 Hertz) which results in reverberation of the swimbladder. Studies have shown that the most susceptible tissues that are injured during exposure to underwater sound produced from pile driving are the soft-tissue organs surrounding the swimbladder, such as the liver and kidney (Caltrans 2001, Abbott and Bing-Sawyer 2002, Caltrans 2003).

There are two types of swimbladders: physostomous, in which the organ is thin, membranous and connects to the esophagus through a pneumatic duct, and physoclistous, in which the organ is thick-walled and connected to the blood stream (Smith 1982). Both salmonids and sturgeon possess physostomous swimbladders (Smith 1982). As indicated by Keevin and Hempen (1997b) fish with physoclistous swimbladders are believed to be most sensitive to blast pressures, however, species with either type of swimbladder are more susceptible to injury than fish which lack swimbladders. In addition, sturgeon, which are considered to be primarily benthically oriented fish, are known to have large swimbladders (Nelson 1994). Large swim bladders make green sturgeon more susceptible to acoustic impacts than fish with smaller swimbladders.

Although underwater sound pressure waves generated during pile driving are different in several ways from those generated during explosions, the mechanism of injury (*i.e*., swimbladder expansion) may be similar. The most important differences between the two are the repetitive nature of pile driving and the overpressure-underpressure oscillations within the pile driving signal. When fish are exposed to multiple strikes, the repetitive oscillations and the resultant pressure waves will cause the swimbladder to act like a drum, and although any single pulse (depending on its magnitude) may not result in acute injury to the internal organs, the repetitive nature of the sound produced during pile driving is likely to result in injury due to the repetitive flexure of the organ membrane, particularly if the membrane experiences resonance.

NMFS uses the sound exposure level (SEL) metric, expressed as the square of the time integrated sound-pressure-level measured in decibels over the duration of the sound exposure (decibels are referenced to one micropascal (µPa) of pressure; one pascal is equivalent to 1 Newton of force per square meter[2]), to correlate physical injury to fish from underwater sound pressure produced during the installation of piles (Hastings and Popper 2005). This metric allows for the summation of energy over multiple pulses (strikes). Using SEL, the exposure of fish to a total amount of energy (*i.e.,* dose) can be used to determine a physical injury response.

NMFS must make some assumptions as to the behavior of the fish and the recovery time of tissue being affected in order to determine the response (*i.e*., avoidance, injury, death) of the fish. Sonalysts (1997) suggested that although fish (including Atlantic salmon) exhibit a startle response during the first few acoustic exposures, they do not move away from areas of very loud underwater sounds and can be expected to remain in the area unless they are carried away by currents or normal movement patterns. Therefore, NMFS will assume that fish will remain in the vicinity of a construction site unless currents or behavior patterns unrelated to loud underwater sound avoidance would indicate that salmonid movement is likely to occur. Although there may be some tissue recovery between the completion of one pile and the

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[2] In the remainder of this document, SELs are referenced to one micropascal squared-second.

beginning of pile driving at the next, given the level of uncertainty that exists, NMFS will sum the underwater sound energy produced during the installation of all piles on any given day to determine potential physical effects to listed salmonids and sturgeon. NMFS will assume that normal behavior patterns will move migrating salmonids and green sturgeon out of the affected area within one day, and therefore underwater sound energy will not be summed across separate days. This would not be the case if the construction site were located in an area where either adult salmonids or sturgeon were spawning or juveniles were rearing for extended periods of time in the action area.

The structure of the fish inner ear is similar to that of other vertebrates: each ear has three semicircular canals and three otolithic organs, the utricle, saccule, and lagena. The semicircular canals and otolithic chambers are interconnected and filled with endolymphatic fluid. The swimbladder may act somewhat as an eardrum by responding to the sound pressure waves, depending on the species of fish. The motion of the swimbladder radiates a secondary signal to the inner ear. This provides the necessary particle movement for otolithic/auditory nervous stimulation, especially in species having the shortest distance between the swimbladder and the auditory apparatus (pars inferior).

The literature indicates damage to hearing by intense sound depends on auditory threshold and will vary from species to species (Popper and Fay 1973). Damage to hearing is normally measured in sound pressure levels expressed as root mean squared (RMS) decibels re 1 micropascal[3]. Some fish have hearing thresholds as low as 50 decibels RMS (dB_{rms}) while others have thresholds as high as 150 dB_{rms}. Enger (1981) exposed 26 Atlantic cod (*Gadus morhua*) to continuous tones of 180 dB_{rms} at frequencies from 50 to 400 Hertz (Hz) for one to five hours and found destruction of auditory hair cells in the saccule. The cod has a hearing threshold of 75-80 dB_{rms} between 100 and 200 Hz (Chapman and Hawkins 1973), so 180 dB_{rms} is about 100 dB above threshold. For Atlantic salmon (*Salmo salar*), Hawkins and Johnstone (1978) reported best sensitivity of 95-100 dB_{rms} between 100 and 200 Hz. Since the 100-200 Hz is the bandwidth of best sensitivity for both cod and Atlantic salmon, Hastings (2002), in support of the Caltrans BA of the Benicia-Martinez New Bridge Project, stated she would expect to see damage of auditory hair cells in salmon occurring with exposure to continuous sound at about 200 dB_{rms}. The peak pressure associated with a continuous sound of 200 dB_{rms} is equivalent to 203 dB_{peak}, thus Hastings (2002) concludes hearing damage to the sensory hearing cells of salmon onsets at a sound level of 203 dB_{peak}.

Hastings (1995) found destruction of auditory sensory cells when she and her colleagues exposed goldfish (*Carassius auratus*) to continuous tones of 189, 192, and 204 dB_{peak} at 250 Hz and 197 dB_{peak} at 500 Hz for approximately two hours. Four fish were exposed to each set of conditions and destruction of ciliary bundles was found to correlate with sound pressure level at a 95 percent confidence level. Hastings *et al.* (1996) also found destruction of sensory cells in the inner ear of oscars (*Astronautus ocellatus*) four days after being exposed to continuous sound for one hour to 180 dB_{peak} at 300 Hz. The authors found no damage in fish allowed to survive for only one day after exposure, suggesting that damage may develop slowly in the sensory cells of

[3] In the remainder of this document, rms pressure levels are referenced to one micropascal.

the fish's inner ears. NMFS is not aware of any similar studies conducted with green sturgeon or salmonids, however, the impacts are assumed to be similar given the relative similarity of the anatomical structure of the inner ear within fish species.

Sonalysts (1997) reported that they performed reaction testing with caged Atlantic salmon at a wide range of sound pressure levels and frequencies. They stated that although some avoidance was noted at certain specific levels and frequencies, no avoidance response was seen when the sound pressure levels (likely RMS) were over 180 decibels (dB). The report also included a brief discussion of previously unreported studies that show that beyond a brief startle response associated with the first few acoustic exposures, fish do not move away from areas of very loud noises and are expected to remain in the area unless they are carried away by currents.

To determine the level of underwater sound that would elicit a behavioral response, Turnpenny *et al.* (1994) exposed a variety of fish species to varying levels of sound and frequency. No significant avoidance was found for trout at exposure levels (metric not specified) of up to 150 dB, although a reaction threshold of around 170 dB was observed. The authors used pure tone bursts, which cause an effect at a lower sound pressure level due to the higher duty cycle of the signal.

In the early 1990s, pile driving operations in Puget Sound were reported to disrupt juvenile salmon behavior (Feist 1991, Feist *et a*l. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results were not conclusive, but suggest that pile-driving operations may result in a disruption in normal migratory behavior.

During the construction of the Benicia-Martinez Bridge Project in April 2002, observations were made during pile driving that suggest small fish subject to the exposure of elevated underwater sound pressure levels can be vulnerable to predation. The stomach of a piscivorous striped bass killed by high underwater sound pressure levels was examined and found to contain several freshly consumed juvenile herring (R. Blizard, Caltrans, pers. comm. May 2002 to D. Woodbury, NMFS). Although necropsies were not performed on the juvenile herring (*Clupea harengus*), the consensus of the biologists present at the site was that the striped bass were feeding heavily on killed, injured, or stunned herring prior to swimming into the zone of lethal sound pressure levels themselves.

It appears that physical damage to the auditory system of salmonids is likely to occur at levels at or above 200 dB_{rms}, which is near the SEL threshold at which physical injury to the organs adjacent to a fish's swimbladder is estimated to occur. A white paper written by Popper *et al.* (2006) proposes a dual metric approach, incorporating both SEL and peak pressure, in assessing potential physical injuries to fish from exposure to elevated levels of underwater sound produced during pile driving. The authors proposed interim single strike thresholds of 187 dB SEL and 208 dB peak. In a critique of the white paper, a NMFS scientist from the Northwest Fisheries Science Center in Seattle, Washington (Memorandum to Mr. Russ Strach and Mr. Mike Crouse, NMFS from Tracy Collier, NMFS, September 19, 2006) stated that exposure to multiple strikes must be considered in assessing impacts. They further stated that the method described in Hastings and Popper (2005) is appropriate. Specifically, to account for exposure to multiple impulses (strikes), the single strike SEL at a given distance from the pile is added to 10*log (number of strikes) to give a cumulative SEL. Thus, using the parameters set forth in the papers referenced above, an accumulated 187 dB_{SEL} is used to estimate the onset of physical injury to small fish. Given that larger fish can tolerate a larger dose before eliciting a similar response (Yelverton *et. al*.1975), 3 decibels are added to this threshold to obtain a threshold of 190 dB_{SEL} for adult salmonids and sturgeon. In response to this new information, an interagency working group, which included staff from NMFS, established interim criteria for evaluating underwater noise impacts from pile driving on fish. These criteria are defined in the document entitled "Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities" dated June 12, 2008 (Fisheries Hydroacoustic Working Group 2008). This agreement identifies a peak sound pressure level of 206 decibels (dB) and an accumulated sound exposure level (SEL)[4] of 187 dB as thresholds for injury to fish. For fish less than 2 g, the accumulated SEL threshold is reduced to 183 dB. Although there has been no formal agreement on a "behavioral" threshold, NMFS uses 150 dB_{RMS} as the threshold for adverse behavioral effects (NMFS 2009).

Pile driving under the proposed Project also would include work done with a vibratory pile driver. Vibratory pile driving is accomplished by attaching a variable eccentric vibrator to the head of the pile to drive the pile into the substrate. The interim criteria for sound injury thresholds for fish were established specifically for impact pile driving and were not intended to be applied to vibratory driving. However, for this assessment the interim criteria will be evaluated along with new criteria that have been recently published for vibratory driving (Hastings 2010). The recently proposed criteria for vibratory pile driving were based on findings that higher threshold levels specifically related to the effects caused by vibratory pile driving hammers are warranted (Hastings 2010). These preliminary criteria are:

Non-auditory tissue damage

Mass ≤ 0.6 g = 191 $dB\text{-}SEL_{accumulated}$
For fish between 0.6 and 102 g mass, cumulative SEL = 195.28 + 19.28*log10(mass)
Mass ≥ 102 g = 234 $db\text{-}SEL_{accumulated}$

Auditory tissue damage

Hearing generalists (e.g., salmonids): > 234 $dB\text{-}SEL_{accumulated}$
Hearing specialists (e.g., carp): 222 $dB\text{-}SEL_{accumulated}$

Temporary threshold shift (hearing loss)

Hearing generalists: 234 $dB\text{-}SEL_{accumulated}$
Hearing specialists: 185 $dB\text{-}SEL_{accumulated}$

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[4] Sound exposure level (SEL) is defined as the constant sound level acting for one second, which has the same amount of acoustic energy as the original sound. Expressed another way, the sound exposure level is a measure of the sound energy in a single pile driver strike. Accumulated SEL (SEL accumulated) is the cumulative SEL resulting from successive pile strikes. $SEL_{accumulated}$ is based on the number of pile strikes and the SEL per strike; the assumption is made that all pile strikes are of the same SEL.

Preliminary pile driving noise modeling will be conducted with the NMFS Underwater Noise Calculation Spreadsheet model (NMFS 2009) and available data. NMFS made several assumptions based on previous consultations to fill in information gaps when data is needed to run the model. When specific detailed engineering designs are developed for the Project during the PED phase, a more detailed modeling exercise will be conducted. The Compendium of Pile Driving Sound Data (California Department of Transportation 2007) provides sound level data on a variety of pile sizes and driver types and this information will be incorporated into the analyses of sound exposure during this consultation and the ensuing PED phase to ensure protection of exposed fish in the action area. In keeping with the generalized overview of Project effects necessary for this consultation, absent specific detailed actions that will be developed later in the PED phase, NMFS anticipates that all impact pile driving actions undertaken for the installation of sheet piles and concrete pilings will negatively affect fish present within the San Joaquin River channel or the Fourteenmile Slough channel during pile driving actions.

NMFS has constructed a generalized assessment of the pile driving impacts based on the information provided in the LSJRFS BA (Corps 2015). Although this information is not detailed enough to complete a full analysis, it will provide a simplified level of effects that will be useful in determining incidental take. The BA states that the Smith Canal gate structure will have a wall 800 feet long wall between the end of Dad's Point on the southeast side of the structure and the levee to the northwest. The wall is comprised of two parallel sheet pile walls, thus a total of 1600 feet of sheet piles will be needed to complete the structure. In addition, the two sides of the gate enclosure, which measures 70-feet by 70-feet, and are perpendicular to the wall alignment, will add an additional 140 feet of sheet piles (2 x 70 feet). The total length of sheet pile walls is approximately 1,740 feet. Each sheet pile is typically 2 feet wide (from the compendium of pile driving sound data) which means that approximately 870 piles are needed for the Smith Canal structure. The BA states that the Project will be divided into two years' worth of work, thus roughly 435 piles will be installed each year for the Smith Canal installation. The BA states that installation of the sheet pile wall will take 2 months each work season (42 work days not including weekends; 5 days per week x 8 weeks = 40 days (16 days of weekends) and 2 more work days to round out the two months (60 days total). Based on information provided in the compendium, a sheet pile wall installed at the Port of Oakland took 5 to 18 minutes per sheet pile section to drive to depth using the vibratory hammer. NMFS used an average value of 12 minutes to represent the typical pile. NMFS also assumed that roughly 10 piles will be driven each day based on previous consultations.

In the absence of site-specific data, NMFS recommends using an underwater attenuation rate of 4.5 dB per doubling of distance (NMFS 2009). It also supports the notion that sound levels of less than 150 dB do not contribute to the accumulated SEL for the purposes of assessing injury (NMFS 2009). NMFS calculated the total time for pile driving each day using the assumptions that it takes 12 minutes of pile driving at each sheet pile section and 10 piles per day, (12 minutes/pile * 60 seconds/minute*10 piles per day= 7,200 seconds total pile driving time per day, assuming 1 strike per second). NMFS then calculated the sound exposure for driving the sheet piles with a vibratory hammer using the spreadsheet calculator with the assumed attenuation rates and the following values for the 2 foot wide sheet piles based on the compendium.

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using a Vibratory Driver/Extractor

Material	Peak	RMS	SEL(for 1 second of vibratory driving)
24- inch AZ Steel sheet	177 dB	163 dB	162 dB

For the period of time that the sheet piles are driven during the day (7,200 seconds) the calculated distances to the different sound level parameters are shown below.
The $SEL_{accumulated}$ is 201.6 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = less than 1 meter (less than 3.3 feet)
Distance to 150 dB-RMS = 74 meters/ 245 feet
Distance to 187 dB-$SEL_{accumulated}$ = 63 meters/ 207 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 63 meters/ 207 feet (for fish < 2 g)

Using the criteria for vibratory hammers as proposed by Hastings (2010), NMFS finds the following risks. For the smallest fish (≤ 0.6 g), the distance to the 191 dB-$SEL_{accumulated}$ threshold for non-auditory tissue damage would be less than the distance calculated for the 187 dB-$SEL_{accumulated}$ threshold (i.e., 207 feet or 63 meters). However, juvenile salmonids and juvenile green sturgeon in the study area would be expected to be larger than 0.6 grams. Assuming a fish weight of 10 grams, the distance to the appropriate threshold for non-auditory tissue damage (i.e., 195.28 + 19.28*log10 (10 grams) = 215 dB-$SEL_{accumulated}$) would be much less than 1 meter. Most juvenile salmonids and green sturgeon in the Project area would be expected to be larger than 10 grams, thus they would have to be at the point source of the pile driving activities to sustain injury to non-auditory tissues. In addition, since the sound generated by the vibratory pile driving is less than 206 dB at 1 meter, the threshold for auditory tissue damage and hearing threshold shifts (greater than 234 dB required) would never be exceeded. Lastly, it is not expected that the exposed fish would remain in the same location over the entire day to experience the full duration of the pile driving due to river currents, tides, and behavioral movements.

Next, NMFS calculated the exposure distances for driving the sheet piles with the impact hammer to the final tip depth and load bearing criteria. NMFS calculated the total time for pile driving each day using the assumptions that it takes 5 minutes of pile driving (based on data from the compendium) at each sheet pile section and 10 piles per day, (5 minutes/pile * 60 seconds/minute*10 piles per day= 3,000 seconds total pile driving time per day, assuming 1 strike per second). NMFS calculated the sound exposure for driving the sheet piles with an impact hammer and the NMFS calculator using the following values for the 2 foot wide sheet piles based on the compendium;

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using an impact hammer.

Material	Peak	RMS	SEL (for 1 second of pile driving)
24- inch AZ Steel sheet	205 dB	190 dB	180 dB

For the period of time that the sheet piles are driven during the day (3,000 seconds) with the impact hammer, the calculated distances to the different parameters are as follows:
The $SEL_{accumulated}$ is 215 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = 9 meter (less than 29.5 feet)
Distance to 150 dB-RMS = 4642 meters/ 15,230 feet
Distance to 187 dB-$SEL_{accumulated}$ = 710 meters/ 2,329 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 1000 meters/ 3,281 feet (for fish < 2 g)

Based on these calculations, there is potential for behavioral modifications to fish that remain within a 4,642 meter radius of the sheet pile being driven during installation of the sheet pile wall (10 per day). There is the potential to exceed the threshold for physical injury if fish larger than 2 grams remain within a 710 meter radius of the pile driving actions (187 dB $SEL_{accumulated}$) or 1,000 meters if fish are smaller than 2 grams (183dB $SEL_{accumulated}$). This would create a zone that would cover the entire channel width of the San Joaquin River and for fish larger than 2 grams extend approximately 2,300 feet upstream and downstream from the location of the gate and flood wall installation during the construction activities. Any fish swimming through this reach during the impact hammer use would likely suffer some degree of injury and potentially mortality.

The construction of the flood gate's platform requires the installation of 24-inch diameter concrete pilings to a final tip depth and load bearing resistance with the impact pile driving hammer. Using the same methodology as described for the sheet piles, NMFS will use the spreadsheet calculator to determine the distances to the different injury thresholds. NMFS assumes that each pile will take approximately 20 minutes to drive and that 5 piles will be done each day. NMFS calculated the total time for pile driving each day using the assumptions that it takes 20 minutes of pile driving at each pile location and 5 piles per day, and 1 second between hammer strikes (20 minutes/pile * 60 seconds/minute*5 piles per day)= 6,000 seconds total pile driving time per day, assuming 1 strike per second). NMFS calculated the sound exposure for driving the sheet piles with an impact hammer and the NMFS calculator using the following values for the 24-inch concrete piles based on the compendium.

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using an impact hammer.

Material	Peak	RMS	SEL (for 1 second of pile driving)
24- inch concrete pile	185 dB	170 dB	160 dB

For the period of time that the concrete piles are driven during the day (6,000 seconds) with the impact hammer, the calculated distances to the different parameters are as follows:
The $SEL_{accumulated}$ is 198 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = less than 1 meter (3.3 feet)
Distance to 150 dB-RMS = 215 meters/ 705 feet
Distance to 187 dB-$SEL_{accumulated}$ = 46 meters/ 151 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 46 meters/ 151 feet (for fish < 2 g)

Based on these calculations, there is potential for behavioral modifications to fish that remain within a 215 meter radius of the piles being driven during installation of the gate foundation (assuming 5 piles per day). There is the potential to exceed the threshold for physical injury if fish remain within a 46 meter radius of the pile driving actions (187 dB $SEL_{accumulated}$ for fish larger than 2 grams or 46 meters if fish are smaller than 2 grams (183dB $SEL_{accumulated}$). This would create a zone that would cover 20 to 30 percent of the channel width of the San Joaquin River and extend approximately 150 feet upstream and downstream from the location of the gate and flood wall installation during the construction activities. Any fish swimming through this reach during the impact hammer use would likely suffer some degree of injury and potentially mortality. These are conservative estimates as the Corps intends to drive the piles behind the cofferdam in the dry. Noise will mainly be transferred through the sediment horizon and not through the water, due to the air surrounding the pile being driven. All of these factors will reduce the zone in which fish may be injured or killed.

Using the same assumptions as used for the Smith Canal structure, the sound effects related to the installation of the gate structure in Fourteenmile Slough will result in essentially the complete blockage of the channel at the location of the structure. The channel is only 300 feet wide, and even with the lower intensity of the vibratory hammer for sound generation, the radius of sound that exceeds the thresholds for behavioral modifications is 245 feet. This would cover approximately all of the channel when pile driving is next to the shore and the whole channel when construction is occurring in mid-channel. The use of the impact hammer to finish driving the sheet piles would create an extensive area in which injury or mortality could occur, approximately a zone with a radius of 2,300 feet that extends up and down the channel through which no fish could avoid injury. When the concrete piles are being installed, the coverage will extend across the complete channel as the installation occurs in the middle of the channel and the radius of effects is approximately 151 feet.

2. Turbidity Related Effects

The Corps has stated that the Project will have a 10 year life span starting in 2018 and ending in 2028. Different project sites within the action area will be undergoing construction actions during this period of time. During the clearing and grubbing phases of the construction actions at each of the proposed sites, all vegetation will be removed from the top 75 percent of the levee's waterside face and 100 percent of the landside face. The actions will leave the soil exposed and disturbed for the future construction activities to take place. However, this condition accelerates the potential for erosion from any precipitation events that may occur during construction or after the construction work window has ended without proper erosion management practices. The Corps has stated in their BA that they will implement erosion control measures (standard construction BMPs), including a Storm Water Pollution Prevention Program and a Water Pollution Control Program that are designed to minimize soil or sediment from entering the river, sloughs, or adjacent waterbodies during construction activities. However, post-construction and off-season controls were not explicitly described in the BA, and NMFS must assume that monitoring and maintenance of the BMPs during these periods may not be as rigorous as during the active construction seasons of the Project. Furthermore, the Corps has stated that all exposed levee slopes will be hydroseeded in an attempt to revegetate the exposed slopes with native grasses and forbs. This action would aid in preventing erosion from occurring and soils entering the adjacent waterways, but no monitoring plans to determine the success of this action are described in the BA. Therefore NMFS must assume that some of these actions will not be successful and erosion will occur on a portion of the slopes exposed by construction activities and which have had failures of the hydroseeding practices to establish a cover of vegetation.

During the installation of the sheet pile walls used in the construction of the two flood gate structures, NMFS anticipates that sediments from the bottom of the waterway channels will be disturbed by the construction activities and resuspended into the overlying water column. This will create localized turbidity plumes. Construction activities for these two structures will take several years. The Smith Canal structure is anticipated to take two years for completion, with the majority of the work occurring over the two summer work windows. The flood gate structure on Fourteenmile Slough is similar in construction design with a narrower channel width requiring a shorter sheet pile wall. However, it will also take approximately two summer work windows to complete due to the necessity of maintaining navigable waters during construction. During these periods, NMFS anticipates that construction related turbidity events will occur as a direct effect of the Project's actions.

During the long term period of gate operations, the narrow gate opening (~50 feet) will create a higher velocity flow through the structure than currently exist through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

Effects of turbidity on fish and aquatic habitat

Suspended sediments can adversely affect salmonids in the area by clogging sensitive gill structures (Nightingale and Simenstad 2001) but are generally confined to turbidity levels in excess of 4,000 mg/L. Based on the best available information, NMFS does not anticipate that turbidity levels associated with the erosion from levee waterside faces in the Project action area or the sheet pile installation itself will increase to these deleterious levels. However, responses of salmonids to elevated levels of suspended sediments often fall into three major categories: physiological effects, behavioral effects, and habitat effects (Bash *et al.* 2001). The severity of the effect is a function of concentration and duration (Newcombe and MacDonald 1991, Newcombe and Jensen 1996) so that low concentrations and long exposure periods are frequently as deleterious as short exposures to high concentrations of suspended sediments. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 nephelometric turbidity units [NTUs]) that are expected to result from this Project. Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barret *et al.* 1992). Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton, and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987, Newcombe and MacDonald 1991). These impacts to the aquatic environment decrease the availability of food resources for salmonids and sturgeon through trophic energy transfers from the lowest trophic levels (*i.e.,* phytoplankton and periphyton) through intermediate levels (*e.g.,* invertebrates) to higher trophic levels (*i.e.*, salmonids and sturgeon).

Resuspension of contaminated sediments may have adverse effects upon salmonids or green sturgeon that encounter the sediment plume, even at low turbidity levels. Lipophilic compounds in the fine organic sediment, such as toxic PAHs, can be preferentially absorbed through the lipid membranes of the gill tissue, providing an avenue of exposure to salmonids or green sturgeon experiencing the sediment plume (Newcombe and Jensen 1996). Such exposures to PAHs have been linked with declines in the immune systems of exposed fish as well as damage to genetic material through formation of breaks or adducts on the DNA strands. Similarly, charged particles such as metals (*e.g.*, copper), may interfere with ion exchange channels on sensitive membrane structures like gills or olfactory rosettes. This reduces the sensitivity of fish to detect smells or chemical cues in their environment and may interfere with ion exchange metabolism across cellular membranes necessary for osmoregulation. Increases in ammonia from the sediment may create acutely toxic conditions for salmonids or green sturgeon present in the channel's margins.

Based on the timing of the levee construction and pile driving actions (mid-July through October 31 in the San Joaquin River area), NMFS expects the direct impacts created by these activities to be experienced by adult CCV steelhead migrating upstream to the watersheds of the Calaveras and San Joaquin Rivers, foraging adult green sturgeon, and rearing juvenile green sturgeon.

Although some steelhead smolts may be migrating downstream at this time too, their numbers are expected to be low compared to the peak of migration in spring and would tend to be associated with rain events or pulse flow operations on the tributaries. There is likely to be little exposure to any CV spring-run adults or outmigrating juveniles resulting from the reintroduction efforts based on the expected timing of their life histories. In contrast, levee construction activities on the Calaveras River (mid-April through October 31 as indicated for tributaries and sloughs in the BA) may additionally expose a large proportion of the emigrating CCV steelhead smolts from that tributary to elevated turbidity if there is hydrologic connectivity between the Delta and the upper watershed. There is also some potential in the tide water sections of the Calaveras River for adult and juvenile CV spring run from the reintroduction effort to be exposed to elevated turbidities based on their expected migration periods.

Increased flows in the main channel of the San Joaquin River, as a result of pulse flows or precipitation events in September and October, are expected to ameliorate the negative effects of increased turbidity by shortening the duration of migration through the action area and diluting the resuspended sediments in the water column. Likewise, hydraulic connectivity in the Calaveras River is typically associated with recent large precipitation events and the rainy season in general. Increased turbidity due to rain runoff is expected to be similar to or greater than that generated within the construction area by pile driving activities and levee construction.

Therefore, actions that take place early in the work window on the San Joaquin River (July and August) are expected to have insignificant effects on listed salmonids since the likelihood of their presence in the action area is considered low and the turbidity levels are not expected to reach a level where take occurs. Should in-water work be postponed or started later in the work window (*i.e.*, September or October), then the probability of in-water work overlapping with listed salmonid presence increases and the potential for exposure to elevated turbidity increases. This increases the risk for non-lethal levels of take to exposed fish, although the level of risk is considered to be still quite low.

For the Calaveras River, turbidity during a work window that overlaps with a loss of hydraulic connectivity in the spring (mid-April to June) or the onset of the dry season when the river typically loses it connection between the Delta and the upper watershed, will have insignificant effects on listed salmonids. If listed salmonids are not migrating through the work area due to a loss of a functional migratory corridor related to the lack of hydraulic connectivity, then fish cannot be exposed to the Project's actions in this location and the potential increase in turbidity related to construction activities. Take is not likely to occur since listed salmonids are not likely to be present in the active work area.

The exposure risk to green sturgeon is less clear. It can be anticipated that juvenile green sturgeon could be found year-round in the central Delta, particularly in the deeper sections of the DWSC based on sturgeon behavior and their preference for deep holes in river channels. Presence on the shallower margins of the river is likely to occur at night, when fish are foraging in those areas. Therefore, the elevated turbidity levels created by the sheet pile installation during the daylight construction period may not persist into the night when sturgeon could be anticipated to move into the work area, thus reducing their exposure potential. If fish are not present when the turbidity conditions exist, they are unlikely to incur any demonstrable effects from the turbidity event, thus no take occurs. Based on this behavioral characteristic for nocturnal foraging, the risks are considered negligible to juvenile green sturgeon and the potential for take is extremely unlikely.

2.4.1.2 Effects Related to Long Term Operations of the Flood Control Gates

The Corps described the operations of the flood control gates on Smith Canal and Fourteenmile Sloughs over the long term (Corps 2015). The gates will typically be operated only during extreme high tides and flood events when the water elevation exceeds + 8.0 feet (NAVD 88) in the channels containing the gates, or when operated for maintenance purposes. Generally, extreme high tides and floods associated with the rainy season occur between November 1 and April 30. When operated for forecasted high tides above +8.0 feet, the gates will be closed on the lowest tide prior to the predicted high tide, typically within a 24 hour period. The gates will not be opened until the high tide elevation drops below +8.0 feet, thus allowing any accumulated water behind the gate to flow out. The Corps predicts that the duration of the gate closures for extreme high tides should not last more than 6 to 12 hours per a high tide event. They further state that the closures related to extreme high tides will occur approximately 10 times a month during the months of January and February, and rarely will two extreme tides occur within a 24 hour period. On these rare occasions, the gates may remain closed for more than 24 hours.

These episodes of extreme tides create larger than normal movement of waters in the delta and may stimulate adult fish holding in the Delta to move upstream to spawn. When the gates are operated, any fish moving with the increased tidal activity may enter the waterways behind the gates on prior tides and become trapped by the closed gates. However, fish trapped behind the closed gate would typically be detained for less than 24 hours, and usually only for 6 to 12 hours until the next ebb tide.

Fish trapped behind the gate will have typically short term exposures to the waters behind the gates, and any deleterious water quality issues or predator populations that may exist there. Any fish caught behind the gates cannot leave the area of degraded water quality until the gates are reopened and thus are exposed to any negative conditions existing for the duration of the closure. The short duration of exposure is probably not sufficient to cause direct mortality from any contaminants that might be present, but sublethal effects may start to manifest themselves even with exposures of only a few hours. Both Smith Canal, and Fourteenmile Slough, as well as several waterways draining to the eastern Delta in the action area, are listed under the EPA's 303(d) listing of impaired water bodies in California (State Water Resources Control Board 2010) containing elevated levels of organic materials, pesticides, heavy metals, and pathogens, as well as many other constituents that impair water quality. Furthermore, it is unclear how the physical barriers will affect the level of contaminants in the impacted waterways, but it is likely to degrade water quality over the long run by preventing dilution and muting tidal exchange with the larger Delta. Finally, when fish are trapped behind the gates, they become susceptible to predators that may reside in the waterways behind the gate. Entrapped fish will be exposed to these predators for the duration of the gate closure with a reduced avenue of escape through the narrow gate opening. Fish such as CCV steelhead smolts and juvenile CV spring run Chinook salmon are highly vulnerable to predation by predators such as striped bass (*Morone saxatilis*) or largemouth bass (*Micropterus salmoides*) that may also occupy the waters behind the gates. Adult fish are less likely to be predated upon, unless marine mammals such as California sea lions (*Zalophys californianus*) also are present in the waterways when they are closed off. Sea lions are known to occur within the Stockton DWSC leading to the Port of Stockton and are likely to be present near the Smith Canal gates.

The Corps has indicated that if necessary the gates will be closed for an extended period during flood conditions particularly when they are coupled with high tides. If flood conditions, either by themselves or in combination with high tide events, raise the water elevation to greater than +8.0 feet NAVD 88, the gates will be closed until the water elevation recedes below +8.0 feet. Records show that the high water conditions may last several days. Over the last 20 years, these high water conditions happen on average three times a year, with the high waters lasting from a few days to several weeks. As indicated above, there is the potential for listed fish to be trapped behind the flood control gates when they are closed. Under flood conditions, the longer duration of gate closures will expose fish to longer periods of degraded water quality or predation within the enclosed water bodies. Furthermore flood conditions usually coincide with increased precipitation events that create surface runoff from upland areas. This results in increased storm water flows into waterbodies such as Smith Canal and the sloughs feeding into Fourteenmile Slough. Storm water runoff has the potential to be heavily contaminated with organic materials (which decrease dissolved oxygen content in the water), petroleum products from roadways, heavy metals from roadways, pathogens, and pesticides. Storm water is cited as a source for these contaminants in Smith Canal and the eastern Delta waterways, including Fourteenmile Slough, Mosher Slough, and Fivemile Slough (State Water Resources Control Board 2010). Elevated contaminant loads coupled with longer exposure periods will increase the likelihood of sublethal and lethal effects on exposed fish. Furthermore, increased durations of gate closure will expose any listed fish trapped behind the gates to longer periods of predation risk in those waters.

Periods of high runoff that could trigger longer gate closures usually occur in the winter and spring seasons. This period overlaps with the migrations of adult and juvenile CCV steelhead in the San Joaquin River and Calaveras River basins. Likewise, adult and juvenile CV spring-run Chinook from the experimental population and their future progeny would be migrating through the San Joaquin River adjacent to the Smith Canal flood control gates during the late winter and spring periods. There is also an increased potential for adult green sturgeon to begin movements upstream into the San Joaquin River in response to increased flows in the mainstem of the river and its tributaries. Movements of juvenile green sturgeon in the Delta may also be enhanced by increases in river flows and increased turbidity.

It is uncertain what the risk to the populations of listed fish will be due to entrapment behind the gates. If the gates remain closed for extended periods of time, then no new fish will be exposed to entrapment due to gate operations. However, any individual fish that has been trapped behind the closed gates will be vulnerable to increased mortality with prolonged closures. In contrast, more frequent gate operations expose more individual fish to the effects of the flood control structure, but the duration of their captivity is shorter, and lethal effects are less likely to occur due to exposure to contaminants and predation. Although there is significant risk to any individual fish trapped behind the gates, the risk to the population depends on the proportion of the population moving past the gates at the time the gates are closed and what fraction of that number is actually behind the gates when they are operated. This level of detail is unknown at the moment.

Risks to fish are not limited to being entrapped behind the gates when they are closed. The construction of the flood control gates and the accompanying flood wall create a barrier to the free exchange of water into the Smith Canal and Fourteenmile Slough waterways during the daily tidal cycle. The relatively narrow opening of the gates (50 feet) compared to the widths of the unobstructed channels will create a region of high velocity flows through the gate openings with each tidal change in water surface elevation. This zone will be bi-directional as a result of the changes in tidal elevation; flow will move from the area of higher water elevation to the area of lower water elevation depending on the stage of the tide. On the flood tide, water elevations will be increasing on the outside of the gate structures relative to the inside of the gate structures and water will flow up-channel through the narrow gate opening into the area behind the gates at increasing velocity due to head differentials between the two sides of the gate structure. Flow through the gates will diminish as the two water elevations reach equilibrium at the full high tide portion of the tidal cycle. When the tide changes to ebb, the water inside the flood structure will be higher than the water elevation outside and remain so for a longer period of time due to the gate constriction. The flow will now go in the reverse direction through the gate at high velocities.

The creation of a high velocity stream through the gate opening creates a field of velocity shears and their resulting eddies and turbulence along the boundary between high velocities and low velocities on the down current side of the gate. The region of velocity shears and turbulence creates favorable habitat for predators to hold and feed on prey as the prey moves through the high velocity stream. This is particularly true when the flood structure creates vertical structure for predators to orient to immediately adjacent to the higher velocity flow, and hold station outside the higher velocity flows without physically exerting themselves to remain in the favorable feeding locations. The structure also creates shade and obscures the presence of the predators holding against the vertical sheet pile wall, creating an increased risk of predation for smaller sized fish such as juvenile CV spring-run Chinook salmon and CCV steelhead smolts that are entrained in the fast moving stream of water going through the gate opening. This condition will occur typically four times a day with each change of the tide while the gates are open.

In addition to the creation of the high velocity flows through the gate openings and increased predation risks, the flood gate structures also are likely to degrade water quality conditions inside the waterways they “protect”. The presence of the gates will reduce the free exchange of water within the waterways they block with the larger Delta system. This will reduce the volume of water exchanged on each tidal cycle with the larger Delta water volume and increase the residence time of the water behind the gate structures and flood wall. This situation is likely to allow contaminants behind the flood structure to increase in concentration since they are not being flushed out of the system as fast as the pre-gate conditions allowed. Finally, without appropriate modeling, NMFS cannot predict what the magnitude of the water quality changes will be, however the changes are expected to occur under all water elevations, and be exacerbated when the gates are closed.

In summary, the long term operations of the flood control gates on Fourteenmile Slough and Smith Canal will create barriers to the free movement of individual fish moving within close proximity to the gates and which are subsequently entrained through the flood control gates. Listed fish that enter through the narrow gate opening will be subject to increased predation risk and exposure to degraded water quality conditions; both conditions are regarded as take. The gate structures will also create physical conditions that decrease the value of the habitat adjacent to these structures. Diminished circulation will decrease flushing flows through these waterbodies, potentially allowing any contaminants discharged into the waterbody behind the structures to increase in concentration and not be transported away from the confined waterbodies. The narrow gate opening will create hydraulic conditions that will favor predatory fish, which will be attracted to the open water structure created by the flood barrier. Both of these physical conditions will increase the level of take of any listed fish exposed to them. These conditions will be present at all water elevations to some extent as described above.

2.4.1.3 Long Term Effects of Levees, Loss of Riparian Habitat, and Vegetation Management under the ETL

The Project perpetuates the presence of miles of engineered levees in the action area to ensure the protection of surrounding urban areas and agricultural lands from flooding. The Corps estimates in their BA that the total amount of horizontal flood features, including the flood control structures is approximately 24.5 miles. The Corps has stated that the preservation of the levee system is non-discretionary in their BA. The Corps has also estimated that approximately 20,000 lineal feet out of 25,000 lineal feet of SRA present in the Project action area will be lost on the lower waterside levee banks, as well as approximately 9 acres of riparian woody vegetation (see Table 7) due to Project's discretionary actions of vegetation removal.

The construction of levees to protect against flooding has significantly altered the environment of the eastern Delta, the east side tributaries that feed into the Delta, and the Calaveras and San Joaquin rivers. Levees replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs in the Delta that provided a spectrum of habitat complexities. Shallow water habitats had a broad range of depths and water velocities present due to the presence of shallow water and riparian vegetation, fallen trees and woody materials (*i.e.*, IWM) that existed on their banks, and the ability of the river to migrate across the floodplain to create additional complexity in the geometry of the river's cross section. Native fish species, including listed salmonids and green sturgeon, evolved under these environmental conditions. In addition, naturally flowing rivers were able to construct riverside benches and naturally formed levees during flood events. These benches could be up to 20 feet high and extended for considerable distances inland creating suitable conditions for the establishment and successional development of structurally diverse riparian vegetation communities (The Bay Institute 1998). Large, continuous corridors of riparian forests and vegetation were present along major and minor rivers and streams in the Central Valley and the Delta periphery. Non-tidal freshwater emergent marshes were present throughout the action area, giving way to tidal freshwater emergent marshes in the primary zone of the Delta (Whipple et al. 2012).

The construction of levees and the "reclamation" of the flood plains and Delta islands eliminated these riparian areas. Only remnant riparian forests and fringing tidal and non-tidal freshwater marshes exist in the action area today. Many of the levees are extensively riprapped with stone armoring on the waterside of the levee and are devoid of any significant vegetation, with the exception of non-native weeds and plants. Only in a few areas where a waterside bench exists outside of the levee toe and vegetation is allowed to grow, does naturally established riparian vegetation grow. These stands of riparian vegetation are discontinuous and frequently very narrow in width, providing a fraction of the ecological benefits of their historical predecessors. In addition to the loss of riparian vegetation, riprapping of levees creates other environmental alterations. The effects of riprapping (USFWS 2000) on riverine processes has been shown to:

- Halt new accretion of point bars and other depositional areas where new riparian vegetation or marsh plants can colonize.
- Arrest meander migration which over time reduces habitat renewal, diversity, and complexity.
- Incise the thalweg of the river adjacent to the armored areas while narrowing the low flow channel width.
- Create relatively smooth, hydraulically efficient surfaces along the riprapped section of levee, which is contrary to the habitat requirements of native fishes, including salmonids and green sturgeon, for hydrodynamic complexity.
- Fill in sloughs, tributary channels, and oxbow lake areas, causing loss of nearby wetland habitat and diversity.
- Limit lateral mobility of the channel, thus decreasing general habitat complexity of the nearshore aquatic area, and reducing complex lateral habitats, including small back waters and eddies which reduces important refugia for numerous species of plants, invertebrates, fish, birds, and mammals.
- Decrease nearshore roughness, causing stream power (*i.e.*, velocities) to increase more rapidly with increasing discharge, thus often eliminating refugia areas for fish and aquatic organisms during high flows and causing accelerated erosion at the downstream interface between the riprapped section and adjacent earthen sections.
- Halt erosion and reduce habitat complexity, thus reducing the ability of near shore areas to retain sediments and organic materials, including IWM. Critical stream refugia areas are also lost due to the isolation of the river from its watershed, primarily by uncoupling the biotic and hydrologic interactions between the stream and the riparian zone.
- Impede plant growth through the thick rock layer at the waterline, which results in vegetation establishing itself farther back from the shoreline, thus reducing the contribution of allochthonous food resources for aquatic invertebrates.
- Halt erosion, which stops woody vegetation from falling into the river, thus causing a long term reduction in the recruitment of new IWM to the system, which results in a wide range of negative effects.

- Halt the retention of IWM that becomes lodged on the riprapped bank during high flows thus preventing the long term retention of such IWM and the habitat they provide.

The intent of riprap is to stabilize stream channels and limit natural fluvial processes. The reduction of the erosion and consequent deposition cycle, naturally inherent to all alluvial channels, eliminates a channel's ability to maintain bedforms for salmonid habitat and impairs the ability for a stream to be maintained in a dynamic steady state. This alteration of the aquatic ecosystem has diverse deleterious effects on aquatic communities, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling *et al*. 2001). Riprap does not provide the intricate habitat requirements for multiple age classes or species similar to natural banks, or banks that include IWM (Peters *et al*. 1998).

Loss of IWM negatively impacts salmonids through multiple phases of their life history. Schaffter *et al*. (1983) showed that juvenile Chinook salmon densities along riprapped banks are one third that of natural banks with the presence of fallen trees and their root balls in the water. They concluded that traditional riprap methods of protection will likely cause decreases in the salmon numbers in the Sacramento River basin. USFWS (2000) reported that in studies conducted in the Sacramento River near the Butte Basin, the highest number of juvenile Chinook salmon were associated with the nearshore areas with woody material, sloping banks, and moderate velocities. Juvenile Chinook salmon catches (measured as catch per unit effort or "CPU") were consistently lowest at riprapped sites and highest at natural bank sites (areas with overhead cover and instream woody cover) and intermediate in areas where experimental mitigation studies with artificially placed IWM. USFWS (2000) reported that additional studies conducted between Chico Landing and Red Bluff on the Sacramento River confirmed the low value of riprapped banks, the high value of natural banks with varying degrees of instream and overhead woody cover, and the intermediate value of mitigated sites.

In large mainstem streams and rivers such as the Sacramento and San Joaquin rivers, the primary benefit of IWM is to the channel margins. The woody materials act to deflect and break up stream flow, creating small eddies, pools, undercut banks, variability in channel depth, and back water areas conducive to rearing and growth (Murphy and Meehan 1991, Bisson *et al*. 1987). Sediment that is trapped by the woody material and stored along the channel margins contributes to the hydraulic and biologic complexity of the stream reach, particularly where organically rich materials are present (Bisson *et al.* 1987). These storage areas create new habitat complexity by trapping inorganic material that creates bars and holes and organic materials that contribute energy and carbon to the local food web of the stream reach (Murphy and Meehan 1991, Bisson *et al.* 1987). These breaks in the river flow also create beneficial holding areas with plentiful food resources and the conditions where salmonids can hold with minimal energy expenditure and feed while rearing. These areas are also beneficial to a wide range of other species native to the system. Such refuges are critically important to the lower river reaches where levee construction and riprapping have disconnected the rivers from the adjoining floodplain where these refuges and rearing habitats formerly existed.

Riprapping affects the stability of IWM along the river channel margin. Stable wood retention is important for creating and maintaining good fish habitat (Bisson *et al.* 1987). Whole trees and their root balls are more important for long term stability than smaller fragments, as they tend to stay in place for long periods of time. These large pieces of wood may remain in place for decades and in the process trap additional IWM, thus adding to the structure. The longevity of large woody debris however may mask changes in the input of woody materials to the river. Since these large pieces of wood would normally be slow to decay, a decline in the woody material input may be masked. Riprapping of the upper river and Delta waterway banks prevents the normal input of upstream woody materials through erosion. The smooth hydraulic roughness along the riprapped banks prevents pieces of woody materials from becoming anchored and remaining in place. The woody materials are transported downstream, but the riprapping of the lower river and Delta waterway banks further limit these pieces from becoming lodged on the banks and the woody material is lost to the system. There is a continuing reduction of IWM input from upstream and local waterways, so that the presence of large pieces of IWM in the Delta is becoming exceedingly rare. Existing pieces that are removed or break apart from decay are not being replenished from upstream.

Like the studies upriver in the mainstem Sacramento River, salmonids in the Delta are associated with natural banks and IWM cover where there is sandy or muddy substrates and shallow water shorelines (McLain and Castillo 2009). Areas with riprap and a lack of cover tended to be dominated by non-native predators and these riprapped shorelines had lower densities of salmonids present. Other studies have shown this trend for non-natives, in particular piscivorous fish that prey on salmonids, (Nobriga *et al.* 2005, Brown and May 2006, Brown and Michniuk 2007, and Grimaldo *et al.* 2012). It is unclear whether the low density of salmonids in riprapped areas is caused by salmon avoiding these areas volitionally or whether they are very vulnerable to predation from non-native predators with a resulting high predation loss (Schmetterling *et al.* 2001, McLain and Castillo 2009).

The continuation of the Corps' ETL policy of no vegetation within 15 feet of the levee toe on both the waterside and landside of the levee greatly exacerbates the negative attributes of the current armored levee habitat in the Delta and Project action area. Removal of the vegetation on the waterside and landside of the levees prevents the input of allocthonous organic materials to adjacent waterways and severely reduces the function of riparian and nearshore habitat along the affected levee reaches. By preventing the input of organic materials that serves as a source of energy and organic carbon, aquatic and terrestrial food webs are negatively impacted. Furthermore, compliance with the ETL policies prevents the establishment of riparian vegetation communities. The ETL policy does not allow woody vegetation to become established that could eventually be recruited into the adjacent aquatic habitat through erosion or death of the woody plants. Allowance of only grasses, sedges, and small bushes to grow on the waterside banks of the levees will not create the full functionality of a riparian zone, or create the equivalent complexity of habitat that a full riparian vegetation community would possess. By reducing or eliminating the potential for establishing riparian communities along the Project's levee reaches, the goals of the NMFS Salmonid Recovery Plan (NMFS 2014) are hampered. Recovery goals that have to do with establishing beneficial habitat in the Delta (Del 1.4; Del 1.7, 1.8, 1.27, and 2.15) are impeded by preventing the establishment of appropriate riparian zones beneficial to listed salmonids and other native species.

Furthermore, the ongoing requirement under the ETL to remove vegetation will typically require the application of herbicides to control vegetation on the levee faces. Herbicides and their additives, such as surfactants, can have negative or deleterious effects upon sensitive receptors, such as fish, invertebrates, or plants, in the aquatic environment. Spraying of herbicides on "unwanted" vegetation can create situations where the herbicides drift into adjacent waters and contaminant those water bodies, or is contained in runoff from surface flow during rain events.

The Corps has proposed constructing a setback levee along portions of the Delta Front levee construction area (Fourteenmile Slough). The existing levee would be partially degraded and a new levee constructed landward of the remnant existing levee. The land between the existing levee and new levee would become a mitigation planting area to offset Project environmental impacts. The Corps anticipates that approximately 14 acres will be created between the water's edge and the vegetation free zone of the new levee. The length of the setback levee is anticipated to be approximately 7,000 feet and the width would vary from 60 to 90 feet. The plans for this action are relatively coarse at this time and still in the conceptual stage. More resolution to the plantings and elevations of the setback levee planting will be developed during the PED phase of the Project. The Corps anticipates that the development of Mitigation and Monitoring Plans (MMPs) will occur during the PED phase in coordination with natural resource agencies and the Corps. While this setback levee will provide very valuable habitat to many native species, its benefits to listed salmonids and green sturgeon are uncertain. Its location is separated from any known active migratory corridor for these fish species, and rearing for juveniles of either the listed salmonids or green sturgeon is unlikely to occur in this area under present environmental conditions. The benefits derived from creating a setback levee in this location to listed salmonids and green sturgeon is likely to be negligible.

Given the extensive loss of upstream spawning grounds and the extreme modification of Delta habitats, careful consideration of the impacts of future levee projects is needed. Future projects should focus on channel margin enhancement to protect and restore key migratory and rearing areas. Degradation of channel margins by retaining riprap and removing riparian and nearshore vegetation should be mitigated onsite first, or at least elsewhere on the migratory corridor. Benefits from offsite mitigation should be carefully evaluated as the species impacted from the Project development may not benefit at all from mitigation conducted elsewhere, particularly if the mitigated area is removed from the migratory corridors of the impacted fish populations (*i.e.*, the ESUs and DPSs of listed fish).

The perpetuation of the current levee system will result in the diminished functioning of the aquatic and riparian ecosystems, which reduces the contributions of these habitats to the survival of rearing and migrating listed species, particularly salmonids. The reduction in the quality and quantity of beneficial habitat through previous actions, and the continued maintenance of these poorly functioning habitats through discretionary actions of vegetation management results in the take of listed fish due to diminished habitat value. This take is in the form of "harm" which is defined as including significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. This would include the permanent disruption of the interlocking food webs associated with shallow water habitats, the riparian zones, and the floodplains adjacent to the river, as well as the detrimental effects of armoring the waterside levee faces with riprap as described above which includes predation and displacement from the nearshore areas. The Corps has stated that there are approximately 24.5 miles of lineal horizontal flood features in the Project, which NMFS considers as negatively affecting the functioning of the adjacent aquatic habitat. Of this, the Corps estimated that approximately 5 miles (~25,000 feet) of impacted SRA vegetation are located on migratory corridors or waters otherwise considered to be routinely accessible to listed salmonids or sDPS green sturgeon. Of this amount, approximately 20,000 feet will be lost due to Project actions. Since it is impossible with the currently available monitoring data to determine how many individual fish will be taken through the loss or modification of the habitat, NMFS will use the values for lineal feet of SRA impacted and lost on waters bearing NMFS' listed species as ecological surrogates for the detrimental effects upon listed fish.

2.4.1.4 Effects to Critical Habitat

CCV Steelhead Designated Critical Habitat

The effects to designated critical habitat for CCV steelhead related to the direct effects of construction actions will be short lived during each construction season, but will impact critical habitat each year, for 10 years; from 2018 until 2028. Within the action area of the Project, the PBFs for designated critical habitat for CCV steelhead are freshwater rearing habitat, freshwater migration corridors, and estuarine areas. As described earlier in this document, the construction actions are anticipated to create elevated levels of noise due to construction equipment moving on the levees and the actual construction activities themselves, and is particularly relevant to those portions of the action area along the Calaveras River and the portions of the mainstem San Joaquin River adjacent to the mouth of the Calaveras River. These sections are active migratory corridors for CCV steelhead originating in the Calaveras River watershed. The period of active migration for emigrating CCV steelhead smolts in the Calaveras River during spring overlaps with the proposed work window of mid-April through October 31 on the Calaveras River. Noise related to construction equipment and vehicles and the proposed construction activities on the levees will degrade the functioning of the freshwater rearing PBFs during the emigration period. NMFS expects that fish will be startled by the construction activity and temporarily leave the nearshore area while the construction is taking place. NMFS assumes that fish will move to an area of the river that is quieter and resume feeding and holding during their rearing phases. Migration may also be affected by this construction noise. Migration during the daytime may be depressed by the construction activities along the levees, and fish will hold until evening and night before moving through the active construction areas when construction activities cease for the night. Although there is some potential to affect adult upstream migrations in the fall, this would only occur if there was hydraulic connectivity between the upper portions of the Calaveras River watershed and the Delta. Typically this does not happen until after October 31, and the onset of the winter rainy season. Overall, the impacts to critical habitat related to construction equipment traffic and construction activities are expected to be temporary and result in no permanent damage to the PBFs of the designated critical habitat. When construction in a given reach of the levee is completed, the noise from the construction actions ends and no further construction related noise will enter the aquatic system.

Construction of the flood control gates is scheduled to take 2 years, thus the impacts to the freshwater rearing and freshwater migratory corridor PBFs from pile driving will be temporary and will not create any permanent damage to the designated critical habitat in the area. In contrast to the short term immediate effects of construction, the long term effects of building and operating the flood control gates and maintaining the levee slopes will impact freshwater rearing and migratory corridor PBFs for the foreseeable future. As described previously, the flood gate structures have the potential to entrap migrating adult, smolt, and juvenile CCV steelhead during their migratory movements. Fish that are present on the upstream side of the gates when they are closed will experience a delay in their migration (a migratory obstruction) and exposure to potential water quality degradation while the gates are closed. Furthermore, while entrapped or in proximity to the gates when open, smolts and juveniles may experience greater risks from predation, which reduces the quality of the habitat for rearing, as well as for migration.

As previously described in this document, the perpetuation of the levees, their armored riprapped waterside faces, and the removal of vegetation under the ETL for the Project, will diminish the functioning of the action area's waterways for rearing and migration of CCV steelhead. Levees simplify riverine and estuary habitat complexity and reduce the integrity of the riparian and wetland corridors associated with stream borders and sloughs. Levees also isolate the floodplains from the river, destroying the valuable interface between the riparian and the adjacent aquatic communities that depend on an exchange of inorganic and organic materials to fully function. Riprapping the waterside faces of the levees to provide protection against erosion reduces the ability of riparian vegetation to establish itself, changes the hydrodynamics of the river adjacent to the bank in an ecologically unfavorable manner, and reduces and prevents the establishment of IWM along the river's edge. The continued use of the "no vegetation" policy of the ETL as a standard practice of levee maintenance ensures that riparian vegetation will not become established along the levee's waterside face and the area within 15 feet of the toe of the levee. Taken together, the armored levees and the long term implementation of the ETL "no vegetation policy" prevent the designated critical habitat in the action area from reaching its full conservation value.

sDPS of North American Green Sturgeon Designated Critical Habitat

The potential impacts to sDPS green sturgeon critical habitat are similar to that just described for the CCV steelhead critical habitat. In freshwater riverine and estuarine systems, NMFS expects that the PBFs affected by the Project will include food resources, water quality, water depth, and migratory corridors. The construction actions will create temporary noise impacts on the waterways of the action area as described for the CCV steelhead above. Presence of juvenile sDPS sturgeon however are likely to overlap with all of the construction work windows since juveniles are expected to be present year round in the action area, but particularly in the Stockton DWSC and the mainstem San Joaquin River. Adults are most likely to be present in the winter and spring, but may also be present year round in low numbers. Potential effects range from delay of migration through the affected reaches due to behavioral avoidance of the construction sounds to injury or death from the intense levels of sound generated by the impact hammers used to drive the sheet piles for the flood control walls and gates (potentially a complete blockage of migration through the affected area). As described for the CCV steelhead, construction follows a work window that spans 4 to 7 months each year (depending on location) but will continue for 10 years (2018 to 2028) over the course of the Project. Thus, exposure to construction noise will continue intermittently for the next 10 years depending on the work window and the construction locations. There will be no permanent impacts to designated critical habitat due to the construction generated noises, and no noise related effects when construction is not occurring or when construction has been completed in 2028.

The long term effects of the Project on designated critical habitat for sDPS green sturgeon include the potential degradation of water quality in the areas behind the flood control gates. Poor water quality and elevated contaminant concentrations due to low water exchange rates can impact sDPS green sturgeon, particularly juveniles that rear in these waters year round and consume prey exposed to the contaminants. The prey base (green sturgeon food resources) are likely to bioaccumulate some of the contaminants listed in the 303d list for impaired waters that are present in the Smith Canal. Alternatively, prey populations may be diminished due to mortality related to the contaminants present or perhaps a combination of diminished prey populations with the remaining prey populations bearing contaminant loads that are then transferred to the green sturgeon that consume them. Green sturgeon that consume contaminated prey may incur sublethal or lethal effects depending on the load and type of contaminates consumed.

The long term presence of the levees, armored levee faces with riprap, and the “no vegetation” policy of the Corps ETL will impair the functioning of the riparian and aquatic habitats as already discussed in this Opinion. NMFS expects that food resources will be negatively affected due to a lack of riparian and shallow water habitat that would benefit food webs in the action area. Likewise the benefit of diverse channel morphology and variable flows and water depths that a naturally meandering river channel would provide are prohibited from occurring due to the levee construction and armoring. This affects the quality of the migratory corridor, food resources, and variable water depths identified as PBFs for freshwater riverine systems and estuarine habitats.

2.5 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

2.5.1 Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the riverine and Delta sloughs within the action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Many of these intakes are minimally regulated by either State or Federal agencies, having been in place for decades.

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the action area. Numerous dairy operations occur to the north of Stockton, with sloughs and irrigation canals running through these facilities to the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

2.5.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest- to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.5.3 Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. There are multiple boating facilities (private and public docks and marinas) within the immediate vicinity of the action area that would draw boaters to the area. In addition, the DWSC is a main access point for boaters traveling between the Stockton area and the western Delta and is heavily utilized by recreational boaters. Any increase in recreational boating due to population growth would likely result in increased boat traffic in the action area. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the Delta. Furthermore, increased recreational boating, particularly those that can be trailered from one water body to another, greatly increases the risk of spreading non-native invasive species into the Delta.

Increased commercial activity in the Port of Stockton has the potential to increase commercial shipping in the Port of Stockton. Increased commercial shipping increases the potential for spills of petroleum products and other lubricants into the DWSC from the large vessels, as well as the introduction of non-native invasive species into the area waterways through the discharge of ballast waters. Ship movements increase the resuspension of sediments from the channel bottom which may introduce contaminants into the water column and increase turbidity in the DWSC. Finally, increased shipping traffic may increase the risks of propeller entrainment and propeller strikes to listed fish in the DWSC. Propeller strikes are particularly dangerous to adult sturgeon (Brown and Murphy 2010, Balazik *et al*. 2012).

2.5.4 Global Climate Change

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change [IPCC] 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9 °F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting salmonid PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to outcompete native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2ºC and 7ºC by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Dettinger 2005), with a drier hydrology predominated by precipitation rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.*, Sacramento River winter-run Chinook salmon and California Central Valley steelhead) that must hold below the dam over the summer and fall periods.

2.5.5 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions as well as illegal placement of riprap occur within the watersheds of the Sacramento, Calaveras, and San Joaquin rivers, as well as the waterways of the

Delta. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, land owner, or by the state. Landowners may utilize roads at the top of the levees to access parts of their agricultural lands and repair the levees to protect property with unauthorized materials (*i.e.*, concrete rubble, asphalt, etc.). The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the Project.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, NMFS add the effects of the action (section 2.4) to the environmental baseline (section 2.3) and the cumulative effects (section 2.5), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's Opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. NMFS described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, NMFS also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.
The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, NMFS also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of

extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this Opinion. NMFS then consider how the status of populations in the action area, as described in the *Environmental Baseline*, is affected by the proposed action. Effects to individuals are summarized, and the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal physical and biological features within the defined area that are essential to the conservation of the species. Physical or biological features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.6.1 Summary of the Status of the CV Spring-Run Chinook Salmon ESU

The CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011a). This review found that the biological status of the ESU has worsened since the last status review. In the 2011 status review, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups outside of the northern Sierra diversity group. In addition, Mill, Deer, and Butte creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), NMFS cannot say based on the trend over the past four years that the risk of extinction for the ESU has improved. In light of this, NMFS is attempting to re-establish CV spring-run back into the San Joaquin River basin where it historically occurred, creating an additional "diversity group" in formally occupied habitat. It is the members of this experimental population and their progeny that will be present in the Project's action area.

2.6.2 Summary of the Status of the CCV Steelhead DPS

All indications are that natural CCV steelhead have continued to decrease in the abundance and in the proportion of natural fish to hatchery origin fish over the past 25 years (Good et al. 2005; NMFS 2011b); the long-term natural population trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. There is a continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts, indicating that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent stream habitat restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin River basin continue to show an overall very low abundance, and fluctuating return rates. This particular diversity group (southern Sierra Nevada) is at a high risk of extirpation due to its low numbers and the precarious conditions of its spawning and rearing habitats below the rim dams in the basin's tributaries. The southern Sierra Nevada diversity group is the population of CCV steelhead most likely to be present in the action area. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that the available data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, where ladder counts are made at the hatchery. These wild populations are likely to be at a high risk of extinction due to the extensive spawning of hatchery-origin fish in the natural areas occupied by the wild populations.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011b). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish populations. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The CCV steelhead DPS is at high risk of extinction (NMFS 2011b), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

2.6.3 Summary of the Status of the sDPS of North American Green Sturgeon

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a, 2015).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists that spawns in the Sacramento River basin, but that some sporadic spawning may occur in tributaries to the mainstem when conditions permit (Seesholtz *et al.* 2015). Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a, 2015).

Adult green sturgeon potentially migrate through the action area to reach upstream riverine habitat based on catches of green sturgeon in the San Joaquin River mainstem, upstream of the Delta (CDFW sturgeon report card data). Juvenile green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (Allen and Cech 2007). Juvenile and subadult green sturgeon may rear in freshwater and brackish water for up to three years in the Delta, including the Project's action area. During laboratory experiments, juvenile green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile green sturgeon were captured during the summer in shallow shoals (1-3 m deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats in other Delta region waterways.

There is a strong need for additional information regarding sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.6.4 Summary of the Status of the Environmental Baseline and Cumulative Effects in the Action Area

The action area is used by the southern Sierra Nevada Diversity Group of CCV steelhead, the San Joaquin River basin experimental population of CV spring-run Chinook salmon, and the sDPS of green sturgeon and are the groups of listed fish that are the subject of this Opinion. Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing.

Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from meandering riverine waterways and sloughs lined with a dense riparian vegetation and emergent marshes, to a highly leveed system under varying degrees of constraint, prohibiting natural riverine erosional processes and seasonal flooding of adjacent riparian benches and floodplains. Levees have been constructed near the edges of the San Joaquin and Calaveras rivers and regional Delta sloughs. These levees completely separate and isolate most floodplains from these waterways (USFWS 2000, Schmetterling *et al.* 2001)). Severe long-term riparian vegetation losses have occurred in the Delta, including those parts of the lower San Joaquin River and the eastern Delta and tributaries in the action area, and there are large barren reaches without the presence of these essential riparian features due to the high amount of armoring riprap present (USFWS 2000). The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, and the removal of riparian vegetation and IWM have likely negatively affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The *Cumulative Effects* section of this Opinion describe how continuing or future effects such as non- Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that reduce the carrying capacity of the rearing and migratory corridors.

2.6.5 Summary of Project Effects on CV spring-run Chinook salmon, CCV steelhead, and sDPS Green Sturgeon Individuals

1) Direct Short-term Construction Related Effects

a) CV Spring-run Chinook salmon

NMFS considers the predominant origin of CV spring-run Chinook salmon in the Project's action area to be derived from the experimental populations released into the San Joaquin River as part of the SJRRP effort. Individuals from these releases and any future progeny are afforded threatened status under the ESA once they leave the area of introduction. NMFS expects that the experimental population (and their naturally spawned progeny) will exhibit life history traits similar to their stocks of origin, particularly regarding run timing of adults and emigration timing of smolts. NMFS expects that adults returning in late winter and continuing through June will not be exposed to any construction actions in the mainstem of the San Joaquin River due to the proposed work window of mid-July through October 31. Likewise, young of year juveniles and smolts should not overlap with the construction work window during their outmigration in the San Joaquin River.

Construction work windows in the Calaveras River and the action area sloughs are from mid-April through October 31, thus there is the potential for several months of overlap for adults and young of the year juveniles and smolts from mid-April through June. Water temperatures in the mainstem San Joaquin River and ambient flows after June would typically be marginal for the survival of emigrating juveniles or for attracting adults upriver. The likelihood that fish would be present in any of the sloughs other than French Camp Slough is low. The other sloughs in the action area are isolated from the main migratory corridors for the CV spring-run population of interest by miles of channels and the presence of either adults or juveniles is considered unlikely. Fish presence in the tidal reaches of the Calaveras River or in French Camp Slough in close proximity to the San Joaquin River is more likely. These fish have the possibility of being exposed to both construction related noise due to levee rehabilitation and turbidity directly related to the construction actions, but not pile driving actions associated with the construction of the flood control gates and sheet pile walls. This later action will take place during the summer work period when CV spring-run Chinook salmon are not expected to be present in the action area waterways. None of the exposures are considered to be life threatening and will likely only amount to harassment or behavioral modification of their migration (and any rearing behavior that may occur for juveniles). NMFS expects that fish may be startled by construction noise and activities on the upland portions of the levees and flee the area. Turbidities are unlikely to increase to a level where any long lasting physical damage occurs, rather only behavioral changes are anticipated (*i.e.*, reduced foraging success, leaving the area of the turbidity plume). The impact to individual fish is considered to be of low intensity and no injury or mortality is expected to occur, thus the impacts to the population in the San Joaquin River basin and to the CV spring-run Chinook salmon ESU are considered to be minimal for the direct construction effects.

b) CCV Steelhead

NMFS considers the predominate origin of CCV steelhead in the action area to be either from the San Joaquin River basin tributaries or from the Calaveras River basin and thus are members of the Southern Sierra Nevada Diversity Group. A portion of the steelhead present in the San Joaquin River basin are hatchery strays from other river basins, since adult adipose fin clipped fish are identified each year in tributary monitoring (*i.e*., fish weirs), but no steelhead hatcheries are present in the San Joaquin River basin. Adult steelhead typically enter the basins waterways starting in early fall (September and October) but do not peak until early winter (November through January) and may continue through early spring. Smolts typically enter the Delta from March through June, with peaks in April and May and continuing into June, dependent on ambient water temperatures and flows in the basin.

Construction activities in the mainstem of the San Joaquin River from mid-July through October 31 may expose the early portion of adult returns in September and October. It is unlikely that emigrating steelhead smolts will encounter construction activities since the construction window ends (October 31) before steelhead smolt emigration starts in the basin and doesn’t start back up (mid-July) until the smolts are done emigrating.

Construction work windows in the Calaveras River and the action area sloughs are from mid-April through October 31, thus there is the potential for several months of overlap for adult steelhead and smolts from mid-April through June with construction activities. Adults entering the Calaveras River must wait until the upper watershed below New Hogan Dam connects hydraulically with the tidal reaches of the lower Calaveras River in the action area before migrating upriver. This usually doesn't occur until after winter rains create higher flows in the upper river. Adult steelhead may be holding in the tidal reaches of the Calaveras River as early as September and October waiting for the flows to increase and create the connection. These fish may be exposed to the end of the work window while holding. Steelhead smolts trying to emigrate downstream to the Delta may be present at the mid-April start of the construction season in the lower Calaveras River and therefore be exposed to construction actions. This earlier start date also applies to the other sloughs in the action area. The likelihood that fish would be present in any of the sloughs other than French Camp Slough is low. The other sloughs in the action area are isolated from the main migratory corridors for the CCV steelhead population of interest by miles of channels and therefore the presence of either adults or juveniles is considered unlikely.

Those fish present in the action area when construction activities are taking place on the levees have the possibility of being exposed to both construction related noise due to levee rehabilitation and turbidity directly related to the construction actions. Those adult steelhead present in September and October also have the possibility of exposure to pile driving actions associated with the construction of the flood control gates and sheet pile walls, which will be addressed separately below. Exposure to construction related noise from levee rehabilitation and construction equipment traffic is not likely to reach levels where injury or mortality will occur. The more likely result of this exposure is harassment or behavioral avoidance of the noise. This will result in a minor impact to rearing and migratory behaviors as it is expected that fish will leave the area where the construction activities are taking place and return once the noise has abated. Furthermore, since the expected noise levels are of low intensity and only occur during the day when construction activities are happening, fish can move at night or move through the construction area without injury even if noise is occurring. There is also the potential for exposure to turbidity plumes from the exposed soil levee surfaces during construction, particularly during spring precipitation events. Rain in the September and October time frame is less likely to occur. The Corps has indicated in their BA that they will implement conservation measures to prevent erosion and turbidity from occurring by using construction BMPs to minimize or avoid erosion and sediment transport in the work zones. Implementation of these BMPs will reduce the impact of turbidity on exposed fish to negligible levels.

The impacts of the pile driving actions associated with the installation of the flood control gates and sheet pile walls are more severe than the levee rehabilitation construction activities. NMFS expects that the main exposure to the pile driving actions will occur at the Smith Canal gate location due to its close proximity to the DWSC and the Calaveras River confluence. Pile driving actions associated with the Fourteenmile Slough location are not expected to affect CCV steelhead since this site is isolated by miles of delta waterways that separate it from the main channel of the San Joaquin River. The main channel of the San Joaquin River acts as the prime migratory corridor for CCV steelhead in the watersheds of the San Joaquin and Calaveras rivers. NMFS anticipates that pile driving exposure will occur if the construction window for the flood control gates slips from mid-July through mid-September to a later date in the work window that occupies more of the September through October time frame. The Corps' BA states that pile driving actions will occur over a 2 month period each work season for the two years that it is anticipated to take to construct the gates and sheet pile walls. If the pile driving occurs during the anticipated summer work window, then the exposure of CCV steelhead to the pile driving is limited to early arriving adults in the DWSC adjacent to the Smith Canal location in early September.

The radius of adverse effects resulting from the use of impact hammers to drive the approximately 435 sheet piles each year will cover the entire channel width from the location of the Smith Canal flood control gates to the opposite shoreline of the DWSC on Rough and Ready Island. Injury or death from single strike noise levels exceeding a peak of 206 dB will extend 9 meters from the sheet pile being driven by the impact hammer. Injury or death from exposure to the 187 dB $SEL_{accumulated}$ over the course of a day will extend out to 710 meters (~ 2,300 feet). The channel width is only 500 to 800 feet wide at the Smith Canal construction location, therefore all fish passing through this reach will be exposed to sound levels that will likely result in injury or death during this phase of the flood gate installation.

For installation of the 24-inch diameter concrete pilings with an impact pile driving hammer, the range of injury or death for a single strike peak noise level of 206 dB is less than 1 meter. The range to the 187 dB $SEL_{accumulated}$ threshold for injury or death is approximately 46 meters (~150 feet) and encompasses approximately 20 to 30 percent of the channel width. Levels of noise that would elicit behavioral response (> 150 dB) would span the entire channel width.

For installation of the sheet piles with a vibratory hammer, the range at which the received sound levels will exceed the level of risk for an adult steelhead for auditory or non-auditory tissue damage (234 dB) is at the point source (zero distance). Thus, there is no risk to adult salmonids when using the vibratory hammer, based on the criteria from Hastings (2010) for tissue damage. The distance at which behavioral effects (>150 dB) occur is 74 meters (250 feet), which covers approximately 30 to 50 percent of the DWSC width at the Smith Canal location.

NMFS anticipates that the Corps will conduct most of its pile driving actions during the summer, and only the last two to three weeks of the gate installation will occur in September and thus overlap with a small fraction of the adult steelhead migration. It is also expected that pile driving will only take place during the daylight hours, therefore allowing free passage of fish during the nocturnal periods when pile driving is not occurring and no adverse sound effects related to the construction activities are present. After 2019, no more pile driving will occur at the Smith Canal location.

NMFS anticipates that only a small number of adult steelhead from the Southern Sierra Nevada Diversity Group will be present during the pile driving actions and therefore be exposed to the adverse effects of the action. Individual fish that are present during the pile driving actions, particularly when the impact hammer is used to drive the sheet pile sections to their final tip depth, may suffer injury or death from their exposure. Since the majority of adult steelhead migrants are not expected to be present until several weeks later in November and December, when the construction window has closed for the season, NMFS believes that most of the population will be unaffected by the pile driving actions. Therefore, the impacts to the Southern Sierra Nevada Diversity Group of CCV steelhead will be minimal in regards to the pile driving actions. This will translate to a low effect to the overall CCV steelhead DPS in relationship to the pile driving actions, as the majority of the DPS exists outside of the action area and will not be exposed, and since the Southern Sierra Nevada Diversity Group will be minimally impacted, thus preserving the spatial diversity necessary for the DPS viability according to Lindley *et al.* (2007), the overall status of the CCV steelhead DPS will not be changed.

c.) sDPS of North American Green Sturgeon

NMFS considers that all green sturgeon that are found within the action area are from the sDPS of green sturgeon. It is highly unlikely that any individuals from the nDPS will be found this far upstream into the Delta. Juvenile sDPS green sturgeon are assumed to be present in the action area year round, as the juveniles may spend 1 to 3 years in the Delta rearing before emigrating to the marine environment as sub-adults. Adult sDPS green sturgeon typically enter the estuary from the ocean starting in January and February and move upstream towards their spawning grounds in the Sacramento River basin through the spring. Some adults may return downstream in late spring or early summer either as successful or unsuccessful spawners. Other adults may hold upriver and move downstream starting at the end of summer and continuing into the fall and early winter. Therefore, adult green sturgeon may be found year round in the Delta, as indicated by the sturgeon fishing report cards collected by the CDFW, with the fewest typically present in the summer. In addition, the annual sturgeon report cards indicate, that at least on occasion, individual green sturgeons are caught in the San Joaquin River upstream of Stockton, implying that they have the potential to move through the action area via the DWSC and the San Joaquin River. NMFS also believes that both adult and juvenile green sturgeon will utilize deeper channels and holes to hold and move, at least during the day, and then make forays into shallower water to forage. NMFS does not believe that green sturgeon will utilize the waterways and sloughs in the north Delta portion of the action area, including Fourteenmile Slough, Fivemile Slough, Mosher Slough, and Ten Mile Slough to the same extent as the DWSC and the mainstem San Joaquin River. As indicated for spring-run Chinook and CCV steelhead, these waters are isolated from the main channels of the San Joaquin River and are relatively shallow with little inflow. Green sturgeon may utilize the tidal portion of the Calaveras River as it is in close proximity to the San Joaquin River and has both tidal and riverine flows associated with it. In a similar fashion, green sturgeon are likely to be found at the junction of French Camp Slough and the San Joaquin River since it is in close proximity to a migratory corridor for sturgeon.

Green sturgeon will be exposed to construction activities and construction vehicle noise throughout the work windows from mid-April through October 31 in the Calaveras River and action area sloughs, and from mid-July through October 31 in the mainstem San Joaquin River. The Project will have 3 years of construction activities in the Central Stockton area from 2018 to 2020, and 8 years of construction activity in the North Stockton portion of the action area from 2021 to 2028.
Those fish present in the action area when construction activities are taking place on the levees have the possibility of being exposed to both construction related noise due to levee rehabilitation, and to turbidity directly related to the construction actions. Exposure to construction related noise from levee rehabilitation and construction equipment traffic is not likely to reach levels where injury or mortality will occur. The more likely result of this exposure is harassment or behavioral avoidance of the noise. This will result in a minor impact

to rearing behavior in juveniles and migratory behaviors in adults as it is expected that fish will leave the area where the construction activities are taking place and return once the noise has abated. Furthermore, since the expected noise levels are of low intensity and only occur during the day when construction activities are happening, fish can move at night or move through the construction area without injury even if noise is occurring. The nocturnal behavior of juvenile sturgeon may further reduce exposure as fish may not utilize the shallow areas near the levees until night time, and thus reduce their proximity and exposure to the noise generated during the day. There is also the potential for exposure to turbidity plumes from the exposed soil levee surfaces during construction, particularly during spring precipitation events. Rain in the September and October time frame is less likely to occur. The Corps has indicated in their BA that they will implement conservation measures to prevent erosion and turbidity from occurring by using construction BMPs to minimize or avoid erosion and sediment transport in the work zones. Implementation of these BMP will reduce the impact of turbidity on exposed fish. Moreover, sturgeon routinely occupy turbid waters so that elevations of turbidity along the shorelines from runoff may not have any noticeable effects upon exposed sturgeon.

The impacts of the pile driving actions associated with the installation of the flood control gates and sheet pile walls are more severe than the levee rehabilitation construction activities. NMFS expects that the main exposure to the pile driving actions will occur at the Smith Canal gate location due to its close proximity to the DWSC. Pile driving actions associated with the Fourteenmile Slough location are not expected to affect sDPS green sturgeon since this site is isolated from the main channel of the San Joaquin River. The main channel of the San Joaquin River acts as the prime rearing and migratory corridor for sDPS green sturgeon in this portion of the Delta.

Pile driving activities will last approximately 2 months each year for the two years that are projected for the completion of the Smith Canal flood control gate. Exposure is expected to occur over the summer from mid-July to mid-September. Based on this timing, NMFS believes that mainly juvenile green sturgeon will be exposed to the pile driving activities. Adult green sturgeon are least likely to be present during the summer. The data found in the CDFW sturgeon report cards imply that summer is the least likely time to catch green sturgeon in the San Joaquin River and Delta, as compared to the fall, winter, and spring periods.

The exposure risks of the pile driving upon green sturgeon will have the same distances and thresholds to injury as previously described for the CCV steelhead above. The only potential difference to exposure risk is the bathymetry of the DWSC in relation to the location of the Smith Canal gate structure. The gate structure is on a shallow bench that drops off sharply into the DWSC dredged channel. Fish located on the bottom of the channel may have some protection from the noise generated by the pile driving actions. Sound waves traveling away from the gate structure location will have to “bend” or spread to ensonify the channel bottom of the DWSC. This spreading will diminish the strength of the sound wave as it travels. However, sturgeon laying on the bottom may also receive sound waves traveling through the substrate, although these will be of a lower intensity than those in the water column above it. Any sturgeon located on the shallow bench, as well as up high in the water column, will receive the full intensity of the generated sound waves emanating from the sheet pile being driven into the substrate.

NMFS anticipates that only a very small number of adult green sturgeon will be present during the pile driving actions and therefore be exposed to the adverse effects of the action. Most individuals that will be exposed to the pile driving actions are expected to be juveniles rearing in the DWSC in the vicinity of the Smith Canal gate structure. Individual fish that are present during the pile driving actions, particularly when the impact hammer is used to drive the sheet pile sections to their final tip depth, may suffer injury or death from their exposure.

Since the majority of adult green sturgeon are not expected to be present until later in the fall and winter when the construction window has closed for the season, NMFS believes that most of the adult population utilizing the San Joaquin River and DWSC will be unaffected by the pile driving actions. Furthermore, the majority of adult green sturgeon, as represented by catch numbers in the report cards, are located in the Sacramento River waterways and western Delta and not in the San Joaquin River. The avoidance of the adult population to the effects of the pile driving actions protects the future spawning potential of those adults. The loss of juveniles is likely to occur as a result of the pile driving. The relative number of juveniles that are anticipated to be present in the DWSC adjacent to the Smith Canal location is small compared to the number of juveniles present in the Delta as a whole, based on the relative area of habitat available to juveniles throughout the Delta. Therefore, the impacts to the adult and juvenile sDPS green sturgeon population will be minimal in regards to the pile driving actions, as the majority of the DPS exists outside of the action area and will not be exposed.

2) Direct Long-term Construction Related Effects

a) Smith Canal Gate Structure

All species considered in this Opinion have the potential to encounter the Smith Canal gate structure during their normal migratory movement and rearing behaviors in the San Joaquin River. All species will be present at some point in time when the Corps anticipates the gate will be operated to protect against high water elevations (November 1 through April 30). This period overlaps with both adult and juvenile migrations of CCV steelhead and the re-introduced population of CV spring-run Chinook in the San Joaquin River basin. Juvenile green sturgeon are assumed to be present year round in the DWSC location adjacent to the Smith Canal location. Adult green sturgeon are assumed to be present primarily from fall through spring in the DWSC based on the sturgeon report card data.

All species will be affected by the poor water quality behind the flood control gates in Smith Canal if entrapped by the operations of the gate for flood protection. NMFS expects that water quality will degrade in the future due to a decrease in tidal flushing of the Smith Canal waterway and an increase in the residence time of water behind the sheet pile walls due to the obstruction of the channel. Salmonids and sturgeon tend to be sensitive fish species to reduced water quality compared to other fish species, particularly non-native species such as centrarchids, ictalurids, and cyprinids that now are common in the Delta.

As mentioned earlier in the effects analysis, it is uncertain what fraction of the listed fish populations will be present when the gates are operated, and of that fraction present, how many will be entrapped behind the gates. It is certain that those fish trapped behind the gates will be exposed to more highly degraded water quality conditions than those fish remaining outside the gates, and will likely have a higher risk of predation while remaining behind the gates. NMFS assumes that fish trapped behind the gates are likely to be lost to the system. However, when the gates are closed, no additional listed fish are exposed to the degraded water quality or to any additional predator risk behind the gates for the duration of the closure. In contrast, when the gates are operated frequently, as for the high tide events, more fish are potentially exposed to entrapment behind the gates, but for shorter periods of time. Without site specific information, it is impossible to say whether more fish are lost when the gates are closed for a longer duration with less frequency of operation, or if more fish are lost due to shorter closures with a higher frequency of operations.

An additional threat to listed fish, but in particular CCV steelhead smolts and juvenile CV spring-run Chinook salmon, is the high velocity flow of water through the open gate of the structure during the tidal cycle each day. As explained in the effects analysis, the differences in water elevation between each side of the flood control structure during tidal changes will create head differentials that induce high velocity flows of water through the relatively narrow 50 foot gate structure. Such high flows create velocity shears with resulting eddies and turbulence in the narrow channel, which predatory fish use to their advantage to prey on smaller fish such as steelhead smolts and Chinook salmon juveniles. By creating this hydrodynamic condition in association with vertical structure in an open water environment to which predators will congregate, the level of predation risk is increased beyond what was originally present in this location. It is unknown whether juvenile green sturgeon will be as vulnerable to predation as salmonids, but it is likely that some predation will occur.

It is also unknown how adult salmonids will react to this hydrodynamic feature of the gate structure. Adult fish may be attracted to the outflow of water from the gate structure on the falling tide and congregate in the area of the gate. This may increase their vulnerability to predation by sea lions that are observed in the DWSC on occasion. Sea lions may become habituated to the presence of adult fish in proximity to the gate structure and increase their predation rates on these congregating adult fish.

The risk presented to the populations of listed CCV steelhead, CV spring-run Chinook salmon and sDPS green sturgeon by the long term operations and presence of the Smith Canal flood control structure is uncertain. The proportion of the populations that will come in contact with the gate structure as fish migrate through the DWSC is unknown, since neither the spatial distribution of fish across the channel nor the use of the shallow bench along the northern river bank by the different fish species and life stages is known. However, it is certain that the gate structure enhances the risk to passing salmonids and green sturgeon above the current conditions and therefore should be considered as adversely affecting the populations of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon in the action area. The presence of the gate structure will continue into the foreseeable future, thus creating a perpetual source of poor water quality and predation impacts to the action area, and a permanent adverse effect to the listed species. The frequency of closure for short term operations (tidal) is estimated to occur approximately 10 times a month during January and February, but gate closures should last no more than 6 to 12 hours. Taking the maximum closure time of 12 hours and a closure frequency of 10 times per month in January and February, the gates will be closed approximately 17 percent of the time during these two months. For flood events, the Corps has estimated that the gates will be closed on average three times a year from a few days to a few weeks based on the past 20 years of hydrology records. If the gates are closed for 3 weeks every year for high water elevations due to tides and inflow, then the gates are closed approximately 12 percent of the time out of 25 weeks (November through April).

NMFS finds that the frequency of the closures and their duration will not substantially affect the experimental population of CV spring-run Chinook salmon moving past the Smith Canal flood control gates. Gates will be operated for approximately 17 percent of the time in January and February when a few adults may be moving upriver to spawning grounds. The majority of adults are expected to migrate upriver later in the year. Few CV spring-run Chinook salmon juveniles or smolts would be expected to be moving downstream at this time past the Smith Canal flood gate location, thus exposure to the tidal operations are limited. Some individuals may be present and subsequently entrapped by the operations of the gates and lost. NMFS also finds that the numbers of CV spring-run Chinook salmon adults or juveniles from the experimental population that will be entrapped by closures of the gate for "high water inflow events" to the Delta is likely to be small compared to the overall population and thus is not likely to affect the population substantially. The gates may be closed for approximately 12 percent of the operating season (3 weeks out of 25 weeks; November through April) but will only amount to three gate closures per year on average. Thus, there are only three events per year that will trap fish behind the gates. It is unlikely that these three closure events will overlap with a substantial proportion of the population being present at the gate when it is closed. While the gates are closed during high water events, juvenile and adult fish in the DWSC are unaffected by the presence of the gate structure. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CV spring-run Chinook salmon in the ESU. The low impact to the CV spring-run experimental population and its progeny over the foreseeable future will not substantially affect the larger CV spring-run Chinook salmon ESU population and will not negatively affect its viability.

NMFS finds that the operation of the Smith Canal flood gate is unlikely to substantially affect the population of CCV steelhead moving past the Smith Canal flood control gates. Gates will be operated for approximately 17 percent of the time in January and February when adults may be moving upriver to spawning grounds, leaving the gates open for 83 percent of the time. The majority of adults are expected to migrate upriver in December and January with the run tapering off quickly in February and March. The gate operations for tides overlaps with a significant proportion of the adult spawning run, however, there is low probability of steelhead being attracted into Smith Canal due to a lack of any tributary inflow, although some false attraction may be created by the high velocity currents described above as a result of tidal elevation differentials. The duration of any entrapment for adults in response to tidal operations will be typically brief, and exposure to contaminants should not result in mortality. CCV Steelhead smolts are not likely to be emigrating downriver at the time that gates are being operated for the high tides. Therefore, there is a low risk of smolts being entrapped by the gates closing. Gate closures for high water events due to high inflows will result in an average of three closures per year, meaning that there are only that many gate closures to entrap adults or juveniles. While the fish trapped behind the gates for flood closures are likely to be lost to the population, there are no new fish being entrapped by gate operations on additional days while the gates remain closed. As already discussed for CV spring-run Chinook salmon, the number of fish present when the gates are closed, and subsequently trapped behind the closed gate, is unlikely to represent a substantial proportion of the population present in the system, thus impacts to the entire population are minimal. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CCV steelhead in the DPS. The low impact of the Smith Canal gate to the CCV steelhead population in the San Joaquin River basin over the foreseeable future will not substantially affect the larger CCV steelhead population and will not negatively affect it viability.

NMFS finds that the operation of the Smith Canal flood gate is not likely to substantially affect the population of sDPS green sturgeon in the Central Valley. The gates will be operated when both juvenile and adult green sturgeon are present in the vicinity of the gate structure. Individual fish may be present in the DWSC and potentially on the flats in front of the gates and thus may become vulnerable to entrapment behind the gates when they are closed. Some of these individuals may be lost to the population. However, available information indicates that green sturgeon are present in low densities and numbers in this area of the Delta based on the low numbers of fish catches on the CDFW sturgeon report cards, compared to other areas of the Delta. The majority of reported green sturgeon catches in monitoring efforts and sport fishing catches indicate that green sturgeon utilize other areas of the Delta and Sacramento River watershed for their life history needs, rather than the DWSC in the Port of Stockton. Using the same reasoning as given for CV spring-run Chinook salmon and CCV steelhead, there is a low likelihood of trapping green sturgeon behind the gates due to the low frequency of gate closures overall, compared to the time they are open, and the low numbers of fish present. The loss of the few individual fish that are trapped behind the gate when it is closed will not substantially affect the overall population of green sturgeon in the Central Valley and should not impair the viability of the DPS.

b.) Direct Long-term Erosion from Construction Actions

The Project's construction activities will create exposed soil on the levee faces on both the waterside and landside of the levees. The Corps has proposed construction BMPs to reduce and minimize erosion during the construction activities, including hydoseeding the exposed soils with native grasses. The intent is to create a layer of vegetation to prevent rain events from eroding soils on the levee faces that can then be carried by the surface runoff into adjacent waters. The Corps has not described any long term management of these levee surfaces to ensure that the hydroseeded surfaces are actually successful in establishing a grass cover. The Corps has stated in their BA that the responsibility for long term management of the levees belongs to the local sponsors after construction is completed, and not to the Corps. Thus, it appears that the long term management of levee erosion control belongs to the local sponsors, and is not under the authority of the Corps. It normally takes several weeks to months to establish a cover of grass after seeding and typically some form of irrigation is required to promote growth. If no irrigation is provided, the growth of grass is not likely to occur until after the first rains in the fall or winter, at which time the bare levee soils are vulnerable to erosion until the grass attains the necessary coverage and density to prevent erosion from occurring. Bare soils with little or no vegetative cover are likely to have significant erosion. It is during this period that localized turbidity events are likely to occur in the waterways adjacent to the bare soil levee faces. The level of turbidity will depend on the percent coverage of grass on the levee face, the density of the actual grass plants in the vegetated areas, as well as the intensity of the rain event.

NMFS does not expect that the erosion on the levees will reach the levels that adjoining waters are compromised for listed salmonids due to turbidity. Such erosive actions are likely to be prevented from continuing by the local reclamation districts eventually performing maintenance actions in areas showing signs of erosion to protect their levees. Corrective actions such as placement of straw on exposed levee faces or installing straw wattles to check runoff are typically carried out. NMFS believes that the effects of localized turbidity events from post construction erosion will not substantially affect the CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon using the action area waterways. Fish rearing and migration may be temporally disrupted but long term effects should be minimal. Furthermore, turbidity events in the Project's action area related to post construction erosion will not affect populations of listed fish in other areas of the Central Valley and should not affect their viability.

3) Long Term Effects of Levees, Loss of Riparian Habitat, and Vegetation Management under the ETL

The Project, through its maintenance of the levee structures in their current alignment with riprap armoring will perpetuate the miles of engineered shoreline in the action area. As described in the effects analysis, levees replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs in the Delta that provided a spectrum of habitat complexities. Shallow water habitats had a broad range of depths and water velocities due to the presence of shallow water and riparian vegetation, fallen trees and woody materials (*i.e.*, IWM) that existed on their banks, and coupled with the ability of the river to migrate across the floodplain, created additional complexity in the geometry of the river's cross section. Levees isolated the rivers from these floodplains. This has removed the vital role of the seasonally inundated terrestrial floodplains in the Delta ecosystem, which provided valuable nutrients, organic carbon, energy, refugia, and rearing habitat for native fish species including the listed salmonids and green sturgeon that are the subject of this Opinion.

Within the Project area, the levees have existed for over a century due to early reclamation of the Delta for agriculture (The Bay Institute 1998). This isolation from floodplains and the removal of riparian zone vegetation and habitat has become part of the baseline for the action area. The degradation that levees created on the Delta ecosystem was exacerbated by the practice of armoring them with rock riprap to provide erosion protection. The negative aspects of riprap have already been described in section 2.4.1.3 of this Opinion. Riprap impedes the establishment of riparian vegetation, which is already severely constrained by the presence of the levees and their alignment along the area's waterways which isolated the waterways from their adjacent floodplains.

In the current Project proposal, the Corps has estimated that approximately 20,000 lineal feet of a potential 25,000 lineal feet of existing SRA in the Project area will be lost along the lower levee waterside faces. In addition, approximately 9 acres of woody riparian vegetation is expected to be lost along the lower waterside faces of levees in the Project area. Almost all of this loss occurs along the San Joaquin River, Calaveras River and French Camp Slough. These areas are part of the migratory corridors used by the species under consideration in this Opinion. To mitigate for these losses, the Corps has incorporated as part of the Project proposal, a 7,000 foot long setback levee along the Delta Front (Fourteenmile Slough). In addition, the Corps has committed to purchasing credits from the Cosumnes River Floodplain Mitigation Bank (2 credits acres of floodplain mosaic wetland to compensate for one acre of permanent open water impacts and 3 acres of temporary open water impacts) plus shaded riverine credits and floodplain mosaic wetlands for losses of SRA. As previously described, these mitigation measures do not occur along the migratory corridors or within habitat that are used by the CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon affected by the Project. The preferred location for mitigation would be along the migratory corridors used by these fish so that they would derive benefits from them.

The effects of these perpetuated changes to the Delta ecosystem is to continually reduce the survival and growth of listed salmonids and green sturgeon within the waterways of the action area. Fish are unable to obtain the necessary ecological benefits afforded by the natural shorelines and riparian habitat that formerly existed in the Delta due to the presence of the levees and the riprap armoring of the levee faces. The incorporation of the ETL levee vegetation policy further precludes the establishment of any riparian zone vegetation along the levee waterside face except in the circumstance where a variance to the policy can be obtained. Although the Corps has stated that they will seek a variance to revegetate riparian areas and will strive to minimize the removal of vegetation along the water's edge, the extent of this is uncertain. Furthermore, the Corps has not indicated that they will attempt to enhance and restore riparian habitat along the action area waterways to offset decades of habitat loss. This leads to a stagnant status quo of Delta habitat and ecological function of the aquatic habitats, and continues the degraded value of the aquatic and riparian habitat in the action area for the benefits of listed species. Thus, the implementation of the ETL policy and the preservation of the levee/riprapped revetment habitat of the waterside edges of the Project area, as proposed in the Project, prolongs the marginal habitat and diminished ecosystem function present in the action area and impedes the restoration of Delta habitat as called for in the Central Valley Recovery Plan (NMFS 2014).

When evaluated in the context of the whole Central Valley, the Project action area is a small proportion of all the miles of waterways and habitat available to the listed species under consideration in this Opinion. The Project does not substantially improve the available habitat, but rather maintains the status quo in the action area, although the status quo portrays a poorly functioning aquatic habitat disconnected from its terrestrial floodplains under the current environmental conditions.

NMFS observes that the migratory corridor and rearing habitat for CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon remains nominally the same as the pre-Project conditions: a highly degraded aquatic environment with minimal riparian habitat combined with extensive riprapped banks on the levee faces. The overall survival rate through the post-Project reaches in the San Joaquin River and Calaveras River may not be distinctly different than the pre-Project survival rates, although these survival rates are probably substantially lower than those seen in natural river migratory corridors.

The effects of the Project and its continued ecological conditions will not affect the rest of the Central Valley's habitat for CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon. Thus, the trajectories of the populations of these listed species will be negligibly affected by the proposed Project; neither benefited nor diminished.

2.6.6 Summary of Project Effects on CCV steelhead and sDPS Green Sturgeon Critical Habitat

Within the action area, the relevant PBFs of the designated critical habitats for listed CCV steelhead are migratory corridors and rearing habitat, and for sDPS green sturgeon the six PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on the effects of the Project described previously in this Opinion, the impacts to the designated critical habitat diminish the value of the designated critical habitat for both CCV steelhead and sDPS green sturgeon. As described in the previous sections, the critical habitat will be at best managed to maintain the status quo conditions currently seen in the action area. The quality of the current conditions of the PBFs for CCV steelhead and sDPS green sturgeon in the action area are poor compared to historical conditions (pre-levees). The habitat does not provide the functionality of the conservation values necessary for the long term survival and recovery of the species. In particular, levees, riprapping, and removal of riparian vegetation have greatly diminished the value of the aquatic habitat in the action area by decreasing rearing area, food resources via food-web degradation, and complexity and diversity of habitat forms necessary for holding and rearing (channel and bathymetry diversity). Perpetuating levee structure with armored riprap on levee surfaces coupled with a "no vegetation" policy under the current ETL criteria will continue the degraded status of the designated critical habitat into the foreseeable future.

The temporary construction impacts to designated critical habitat will negatively affect the ability of CCV steelhead and sDPS green sturgeon to use the action area as rearing habitat and as migratory corridors during the overlap of migration periods and construction as discussed previously. Effects will last for a period of several weeks, but will not permanently modify critical habitat function as noise and turbidity will end after construction ends.

The impacts of the Smith Canal and Fourteenmile Slough flood control gates will permanently create an obstruction to migration through entrapment of fish. However, the flood control structures are not expected to substantially impede overall migration through the main migratory corridors of the Calaveras River and San Joaquin River for listed species. The flood control structures are located either off of the main migratory corridors (Fourteenmile Slough) or to the edge of the main migratory corridor (Smith Canal) and protect non-spawning and non-migratory areas from flooding.

The Corps has estimated that this Project will remove approximately 20,000 lineal feet of SRA out of an estimated 25,000 lineal feet on the waterside of the levees. In addition, approximately 9 acres of woody riparian habitat will be lost. This loss occurs within the Calaveras River, the San Joaquin River, and French Camp Slough and Duck Creek sections of the action area. These areas are the primary migratory and rearing areas for listed salmonids and sDPS green sturgeon in the action area of the Project. A portion of this loss may be protected or replaced through variances to the ETL vegetation policy, allowing SRA and woody vegetation to regrow where the Corps deems it presents an acceptable risk to levee safety and integrity. However, the extent of SRA and/or woody riparian vegetation mitigation through the variances are unknown, but will supposedly have more resolution during the PED discussion prior to construction activities commence. The proposed mitigation gained through the set-back levee construction will theoretically benefit native delta species that may use flood plain habitat during their life cycles, but it will have minimal benefit to listed salmonids and sDPS green sturgeon due to its isolation from habitat currently used by these species and thus is likely to be underutilized or unavailable to these species. In a similar fashion, the mitigation bank credits purchased on the Cosumnes Floodplain Mitigation Bank will benefit native species, including any steelhead or sDPS green sturgeon subadults utilizing the mainstem channels of the Mokelumne and Cosumnes river systems, but will not benefit CCV steelhead or sDPS green sturgeon from the San Joaquin River basin. This is important since the Southern Sierra Nevada Diversity group does not inhabit the Mokelumne or Cosumnes river watersheds.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' Opinion that the proposed action is not likely to jeopardize the continued existence of:

- CCV steelhead,
- CV spring-run Chinook salmon, or
- sDPS green sturgeon.

NMFS has concluded that the Project will affect, but not adversely modify or destroy designated critical habitat for:

- California Central Valley steelhead
- sDPS of North American green sturgeon

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement (ITS). If the Corps: (1) fails to assume and implement the terms and conditions of the ITS; and/or (2) fails to require the agents of the Corps to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and the Corps' agents or permittees must report the progress of the action and its impact on the species to NMFS as specified in this ITS (50 CFR §402.14[i][3]).

2.8.1 Amount or Extent of Take

NMFS anticipates that the proposed action will result in the incidental take of individuals from the CV spring-run Chinook salmon ESU, the CCV steelhead DPS, and the sDPS of North American green sturgeon. Incidental take associated with this action is expected to be in the form of mortality, harm, or harassment of adult and juvenile CV spring-run Chinook salmon, adult and juvenile CCV steelhead and adult and juvenile sDPS of North American green sturgeon, resulting from (1) avoidance and behavioral modification related to construction activities on the levees and associated short term turbidity events; (2) the construction of the Smith Canal flood gate structure and associated sheet pile walls between mid-July and mid-September (2 month construction period each construction season, over two summers) and the Fourteenmile Slough flood gate structures and associated sheet pile walls (mid-July through mid-September over two construction seasons), due to the generation of underwater noise associated with the process of installing sheet pile walls, concrete pilings, and concrete foundations, including noise associated with vibratory and impact pile driving; (3) the entrapment of listed fish within the channels of Fouteenmile Slough and Smith Canal gate locations during the closures of the flood control gates; (4) the predation of fish associated with the presence of the vertical sheet pile walls and the altered flow characteristics; (5) erosion and its associated turbidity related to the long term maintenance of the waterside levee faces, and (6) the removal of riparian vegetation and implementation of the Corps' ETL policy along levees impacted by this Project.

This ITS will use surrogates to establish the expected level of take due to Project actions when direct quantification of take for individuals is not possible. Surrogates are used for this ITS since it is nearly impossible to quantify the number of individuals of listed species exposed to the project's actions, but that it is certain that those individuals that are exposed will incur some level of adverse response to the exposure resulting in take as defined under the ESA. In the ITS, NMFS will explain the causal link between the surrogate and the expected response from the exposed listed species; the reason why quantifying the amount of individuals exposed to the action (*i.e.*, take) is impractical to measure; and finally, establish a clear standard as to when take is exceeded (the surrogate parameter).

1) Levee Construction Activities

San Joaquin River sections

During the levee construction actions, NMFS expects that no construction actions will occur outside of the proposed work windows of mid-July to October 31 for locations adjacent to the San Joaquin River and the Stockton DWSC. NMFS expects these species and life stages to be present during this portion of the Project:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

NMFS does not expect to see any direct mortality or morbidity of these fish due to noise generated by construction equipment and construction actions or by exposure to construction related turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of fish exposed to noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and any precipitation driven "rain on exposed soils" derived turbidity events. NMFS does not expect injury or lethal take from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of levee construction activity in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

Calaveras River and other sloughs

During the levee construction actions, NMFS expects that no construction actions will occur outside of the proposed work windows of mid-April to October 31 for locations adjacent to the Calaveras River and other sloughs identified in the Project description. NMFS expects these species and life stages to be present during this portion of the Project:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

NMFS does not expect to see any direct mortality or morbidity of these fish due to noise generated by construction equipment and construction actions or by exposure to construction related turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of fish exposed to noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and any precipitation driven "rain on exposed soils" derived turbidity events. NMFS does not expect injury or lethal take from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of levee construction activity in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2) Flood Gate construction

During the two years of construction that it will take to complete the installation of the flood control gates, NMFS expects these species and life stages to be present during the pile driving portion of the construction window from mid-July to mid-September for the sheet pile walls and gate:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

Incidental take of adult CCV steelhead, and juvenile and adult sDPS green sturgeon is expected to occur during the 2-month construction period occurring between mid-July and mid-September as a result of exposure to the noise generated by pile driving activities. Quantification of the number of fish exposed to the pile driving associated noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and turbidity. Only the level of acoustic noise generated during the construction phases of the two flood control gates can be accurately and consistently measured, thus providing a quantifiable metric for determining incidental take of listed fish. Therefore, the measurement of acoustic noise generated during the construction phase, and in particular the vibratory and impact pile driving of the sheet pile sections and concrete piles described in the proposed Project, will serve as a physically measurable surrogate for the incidental take of listed fish species. NMFS assumes that the Project proponent will adhere to the Project description provided for the purposes of the section 7 consultation, and will not depart from that description in any meaningful or demonstrable way.

The analysis of the effects of the proposed LSJRFS anticipates that the installation of the flood control gates will use 24-inch wide sheet piles and 24-inch diameter concrete piles for construction and that 10 sheet piles will be driven per work day and 5 concrete piles will be driven per work day. NMFS also estimated that it will take 12 minutes of vibratory hammer pile driving and 5 minutes of impact hammer driving to set each sheet pile to the correct depth and load bearing resistance. NMFS estimated that it will take 20 minutes per concrete pile to drive them to the appropriate tip depth and resistance. The number, size, and material of the pilings will affect the amount of sound energy generated during the driving of the pilings that was analyzed for this Project. Different methodologies or types of pile driving equipment will alter the characteristics of the acoustic noise generated during the installation of the pilings, which in turn affects the physiological and behavioral response of the exposed receptors (*i.e.,* listed fish species) present in the vicinity of the construction activities. Based on the effects analysis conducted for this consultation, and using the data from the CalTrans compendium for steel sheet piles and an impact hammer to populate the NMFS spreadsheet calculator, the amount of generated sound associated with the pile driving actions shall not exceed 206 dB peak at 9 meters (29.5 feet) from the sheet pile being driven at any time, 187 dB $SEL_{accumulated}$ at 710 meters (2,329 feet); 183 dB $SEL_{accumulated}$ at 1000 meters (3,281 feet), and a value of 150 dB RMS as measured at 4,642 meters (15,230 feet) from the pile at any time. For the 24-inch concrete piles driven with the impact hammer, measured sound shall not exceed 206 dB peak at 1 meter from the pile, 187 dB $SEL_{accumulated}$ at 46 meters (151 feet); 183 dB $SEL_{accumulated}$ at 46 meters (151 feet), and a value of 150 dB RMS as measured at 215 meters (705 feet).

Using the values for vibratory hammers (Hastings 2010), the calculated cumulative injury (SEL) noise energy thresholds for non-auditory tissue damage indicate that juvenile sDPS green sturgeon would have to be closer than 1.3 meters (215 dB $SEL_{accumulated}$) to encounter cumulative injury effects for fish larger than 10 grams but less than 102 grams (typical of the juvenile green sturgeon that might be present in the Delta). For adult steelhead or green sturgeon, or fish > 102 grams, a sound exposure level > 234 dB $SEL_{accumulated}$) is needed for both auditory and non-auditory tissue damage. Using the NMFS calculator, vibratory hammers driving 24-inch steel AZ sheet piles should not exceed 201.6 dB $SEL_{accumulated}$ at 10 meters, thus 215 dB $SEL_{accumulated}$ is reached at 1.3 meters (4.3 feet) and 234 dB $SEL_{accumulated}$ is reached at 3 inches.

If any of these proxies (derived from the NMFS spreadsheet values) are exceeded, the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

3) <u>Entrapment of listed Fish due to the operation of flood control gates</u>

NMFS expects that during the operations of the flood gate structures, closures for water elevations greater than +8.0 feet NAVD88 will occur only during the period from November 1 through April 30. NMFS expects these species and life stages to be present during this portion of the Project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to the operations of the Smith Canal flood control structure. It is unlikely that listed species will be exposed to the operations of the Fourteenmile Slough Flood control structure, but incidental take at that facility will be accounted for by using the same surrogates for both structures. NMFS expects that take will be in the form of mortality and morbidity resulting from entrapment of listed fish behind the closed gate. Trapped fish will have an elevated vulnerability to predation and exposure to degraded water quality in the waterbodies upstream of the closed gate structures. Quantification of the number of individual fish exposed to predation and degraded water quality is not currently possible with available monitoring data. Gate closures will only occur for high tides or water elevations exceeding +8.0 feet NAVD88 or required maintenance. Therefore the frequency of gate operations is defined by the water elevation and will be used as a surrogate for the exposure of fish to entrapment behind the gates. Operations of the gates at water elevations below +8 feet NAVD (except for maintenance purposes) will result in more frequent operations of the flood gate structure which will result in more opportunities to entrap fish. NMFS will consider this as creating conditions that have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

4) <u>Predation of listed fish due to the altered hydrodynamics of water flowing through the flood control gates and the presence of vertical sheet pile walls</u>

NMFS expects that the presence of the flood gate structures will create altered flow conditions related to the narrow width of the flood control structure gates. This will enhance predation upon listed fish species. These conditions will be present throughout the year and are created by daily tidal flows. NMFS expects these species and life stages to be present in the waters adjacent to the Project structures:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to the operations of the Smith Canal flood control structure. It is unlikely that listed species will be exposed to the operations of the Fourteenmile Slough Flood control structure, but incidental take at that facility will be accounted for by using the same rational for surrogates as the Smith Canal structure. NMFS expects that take will be in the form of mortality and morbidity resulting from predation of listed fish moving through the open gate or along the face of the flood structure. Listed fish will have an elevated vulnerability to predation due to the hydrodynamic conditions created by the open gate structures and the vertical sheet pile wall structure placed into the open water environment, both of which are expected to attract predators. Quantification of the number of fish exposed to predation is not currently possible with available monitoring data. The level of take is associated with the creation of a high velocity flow through the narrow gate opening, currently designed to be approximately 50 feet wide. The width of the gate is an integral factor in determining the velocity of the water flowing through the open gate, as well as the water elevation differential between the two sides of the flood structure. If the gate opening is made narrower, the velocity increases, thereby creating more adverse conditions for listed fish passing through it. Higher velocities create more turbulence, eddies, and disorientation to the fish caught in the high velocity jet, allowing them to become easier targets for predators. A wider gate opening will have the opposite effect, reducing the velocity of the flow. NMFS will consider that any changes to the gate opening that will make it narrower and thus increases the velocity of water moving through the open gate as exceeding anticipated incidental take as analyzed in this Opinion. The level of take associated with placing a vertical structure in the channel (*i.e.*, the sheet pile wall) is related to the linear length of the wall, and the holding and hiding habitat that it can provide to predators residing in the area. Increasing the length of the wall will increase the potential predator holding habitat. Conversely, shortening the length of the wall will reduce the predator holding habitat. NMFS will consider that any changes to the length of the wall that demonstrably increases its linear length (currently designed to be approximately 800 feet for Smith Canal and 300 feet for Fourteenmile Slough) will exceed the anticipated incidental take of listed fish as assessed in this Opinion.

5) <u>Turbidity events related to erosion from post-construction locations</u>

NMFS expects that during the life time of the Project's levee modifications that exposure to turbidity events will occur during precipitation events related to erosion from the waterside faces of the levees. Post-construction maintenance is considered to be part of the discretionary actions retained by the Corps through issuance of its operations and maintenance manuals to the local non-Federal sponsors of the Project. NMFS expects these species and life stages to be present during the Project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to some proportion of the post-construction levees within the Project's action area during one or more life history phases, such as juvenile rearing, adult upstream migration, and juvenile downstream migration. NMFS does not expect to see any direct mortality or morbidity of these fish due to post-construction erosion and its related increase in local turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of individual fish exposed to post-construction turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during their life history phases may be exposed to precipitation driven "rain on exposed soils" derived turbidity events when fish presence and precipitation events co-occur. NMFS expects a low level of injury or lethal take to occur from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of an erosive post-construction site in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels. Turbidity levels that result in injury or mortality are indicative of non-compliance with the Corps issued operations and maintenance manuals to the non-Federal sponsors of the Project.

6) Removal of riparian vegetation and implementation of the Corps' ETL policy along levees impacted by this Project

NMFS expects that during the life time of the Project's levee modifications that exposure to effects from vegetation removal policies will occur as fish move through the action area along migratory corridors adjacent to the waterside faces of the levees. Removal of riparian vegetation prior to construction activities and continued loss of riparian vegetation functions due to the implementation of the Corps' ETL "no vegetation" policy is considered to be part of the discretionary actions retained by the Corps. NMFS expects these species and life stages to be present during the ongoing Project maintenance operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to some proportion of the post-construction levee ETL vegetation policy within the Project's action area during one or more life history phases, such as juvenile rearing, adult upstream migration, and juvenile downstream migration. NMFS expects that take will be in the form of harm, harassment, morbidity, and mortality resulting from lack of cover along the shoreline, lack of refugia from predators and high flows, lack of functional food webs resulting in decreased growth and physiological condition, and increased predation of listed fish moving through the nearshore habitat. Quantification of the number of individual fish exposed to the degraded riparian habitat is not currently possible with available monitoring data. All fish passing through or otherwise present in these affected areas will be exposed to the lack of riparian vegetation along the shorelines and the environmental impacts previously described in the effects analysis. Therefore NMFS will use the lineal feet of removed SRA vegetation and the lost woody riparian vegetation area as surrogates for the incidental take of listed fish species. The Corps has projected that approximately 20,000 lineal feet of SRA vegetation and 9 acres of woody riparian vegetation will be removed for the Project. If more than the proposed 20,000 linear feet of SRA vegetation, or more than 9 acres of woody riparian vegetation are removed, then NMFS will consider the incidental take of listed species affected by the Project to have been exceeded.

2.8.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that implementation of the Lower San Joaquin Feasibility Study Recommended Plan minimizes, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead, and green sturgeon that are subject to this consultation.

2. Measures shall be taken to maintain, monitor, provide compensatory mitigation and adaptively manage all conservation and compensatory mitigation measures to ensure their effectiveness.

3. Measures shall be taken, when feasible and practicable, to minimize the impacts of construction by implementing the Corps proposed conservation measures and any other required mitigation measures that avoid and minimize adverse effects on growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.

4. Measures shall be taken to ensure that the Recommended Plan is implemented consistent with the biological assessment and this Opinion.

5. Measures shall be taken to minimize project impacts to riparian habitat within the construction footprint of the Recommended Plan for the protection of fish habitat features that are subject of this Opinion to the maximum extent feasible and consistent with public safety requirements.

6. Measures shall be taken to minimize, reduce, or avoid construction impacts relating to turbidity and noise.

7. Measures shall be taken to refine existing conditions data in the Recommended Plan construction footprint during PED.

8. Measures shall be taken to develop post construction remediation/mitigation for lost riparian function.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: "*Measures shall be taken to ensure that implementation of the Lower San Joaquin Feasibility Study Recommended Plan minimizes, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead, and green sturgeon that are subject to this consultation.*"

a. The Corps shall continue to coordinate with NMFS, USFWS, CVRWQCP, CDFW and other agencies as the Recommended Plan designs and the operational criteria are further developed during PED.

b. The Corps shall coordinate with NMFS during PED as the Recommended Plan is designed to ensure conservation measures are incorporated to the extent practicable and feasible and as described in the BA.

c. The Corps shall consider and apply, as necessary, the California Levee Vegetation Research Program Synthesis of Levee Vegetation Research Results (2007-2014), when conducting vegetation risk assessments as the Recommended Plan designs are further developed during PED.

2. The following terms and conditions implement reasonable and prudent measure 2: *"Measures shall be taken to maintain, monitor, provide compensatory mitigation and adaptively manage all conservation and compensatory mitigation measures to ensure their effectiveness."*

    a. The Corps shall develop a habitat mitigation and monitoring plan (HMMP) with an overall goal of ensuring that project impacts on listed species are fully mitigated and which identifies target levels of function to be met and tools for measurement.

    b. The HMMP shall include specific goals and objectives and a clear strategy for maintaining the long-term conservation and mitigation elements for the life of the project.

    c. The Corps shall coordinate with NMFS prior to the onset of any riverside construction, including the placement of in-water revetment or removal of riparian vegetation.

    d. The Corps shall monitor the HMMP for 5 years following construction and shall update the project O&M manual, as appropriate, to ensure that the project, including the conservation measures, is maintained by the local sponsor for the life of the Project.

    e. The HMMP shall include a compensatory mitigation accounting plan to track and document compensatory mitigation performance in relation to the targets identified in the HMMP. The Corps shall require that the maintaining agency be responsible for tracking and documenting mitigation performance once the project is turned over.

    f. The Corps shall include as part of the HMMP, a section with special emphasis on the riparian corridor with the overall goal of documenting the ecological success and the conditions of the corridor within the construction footprint and within the on-site mitigation lands. The Corps shall coordinate the HMMP with NMFS prior to construction of the Recommended Plan.

g. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.

h. The Corps shall host an annual meeting and issue annual reports for five years following completion of Project construction. The purpose is to ensure that conservation features of the Project are developing consistent with the HMMP.

3. The following terms and conditions implement reasonable and prudent measure 3: *"Measures shall be taken, when feasible and practicable, to minimize the impacts of construction by implementing the Corps proposed conservation measures and any other required mitigation measures that avoid and minimize adverse effects on growth and survival conditions for salmonids, and the sDPS of North American green sturgeon."*

   a. The Corps shall ensure that for salmon, steelhead, and green sturgeon, the adverse effects at each seasonal water surface elevation are fully offset through compensatory conservation measures in or adjacent to the project area or through the purchase of credits at a NMFS approved conservation bank (as described in the BA).

   b. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.

   c. The Corps shall ensure that the planting of native vegetation will occur as described in the Corps 2015 BA and within this Opinion. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

   d. The Corps shall, for conservation banking actions, provide mitigation at a 3:1 ratio. This is mainly because the mitigation will occur offsite. This includes habitat improvements adjacent to the Project area, or through conservation bank credit purchase as described in the Corps Biological Assessment Terrestrial and Aquatic Species San Joaquin River Basin Lower San Joaquin River CA Interim Feasibility Study as received by email on November 9, 2015.

4. The following terms and conditions implement reasonable and prudent measure 4: *"Measures shall be taken to ensure that the Recommended Plan is implemented consistent with the biological assessment and this Opinion."*

   a. The Corps is responsible for ensuring that all requirements of the Opinion are met.

   b. The Corps shall ensure the contractor plans and specifications are consistent with the requirements of the Opinion.

c. The Corps shall provide a copy of this Opinion, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the Project as to the requirements of this Opinion. A notification that contractors have been supplied with this information will be provided to the reporting address below.

Assistant Regional Administrator
California Central Valley Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

d. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this Opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.

5. The following terms and conditions implement reasonable and prudent measure 5: *"Measures shall be taken to minimize project impacts to riparian habitat within the construction footprint of the Recommended Plan for the protection of fish habitat features that are subject of this Opinion to the maximum extent feasible and consistent with public safety requirements"*

   a. This Opinion is based on the Recommended Plan, which includes assumptions about the potential suitability of the levees included in the Recommended Plan for a variance to ETL 1110-20583 for vegetation. The Recommended Plan also includes commitments to conduct additional engineering investigations during PED to specifically address variance possibilities. The Corps shall provide updates on the status of these engineering investigations and conclusions regarding the suitability of Recommended Plan levees for an ETL 1110-2-583 vegetation variance. If technically feasible, the Corps shall obtain a vegetation variance to allow for the protection of existing vegetation in place and the planting of new low-risk vegetation on the lower 1/3 slope of the levee system.

   b. The Corps shall, when developing riparian mitigation options, apply the following mitigation hierarchy: (1) onsite planting (along the levee section where riparian vegetation is removed) within anadromous habitat, and within the lower 1/3 of the levee slope; (2) within project area, but not along the specific levee section where riparian vegetation is removed, and within anadromous habitat, within the lower 1/3 of the levee slope; (3) within the project area and within anadromous habitat, but in areas that are not affected by flood risk reduction actions; (4) offsite at NMFS approved conservation banks.

6. The following terms and conditions implement reasonable and prudent measure 6: *"Measures shall be taken that minimize, reduce, or avoid construction impacts relating to turbidity and noise in order to reduce impacts to listed species."*

   a. To prevent sediments from escaping the site and entering water systems where they could adversely affect listed fish species and their habitat, sediment control measures would be installed around the construction sites. The contractor shall be required to obtain a National Pollution Discharge Elimination System permit from the Regional Water Quality Control Board, Central Valley Region. As part of the permit, the contractor shall be required to prepare a Storm Water Pollution Prevention Plan prior to initiating construction activities, identifying BMPs to be used to avoid or minimize any adverse effects during construction to surface waters.

   b. The following BMPs shall be incorporated into the Project to reduce, minimize or avoid turbidity associated with construction activities:

      i. Implement appropriate measures, such as straw wattles and silt fencing, to prevent debris, soil, rock, or other material from entering the water.
      ii. Use a water truck or other appropriate measures to control dust on haul roads, construction areas, and stockpiles. Application of water would not be excessive or result in runoff into storm drains.
      iii. Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, additional erosion and sedimentation control measures would be implemented.
      iv. Maintain sediment and erosion control measures during construction. Inspect the control measures before, during, and after a rain event.
      v. Train construction workers in storm water pollution prevention practices.
      vi. Revegetate disturbed areas in a timely manner to control erosion.
      vii. If vegetation is not growing sufficiently it shall be replanted or provided with irrigation if necessary.
      viii. Erosion BMPs will be monitored for effectiveness during the active construction window and during periods of inactivity following the active construction window for effectiveness, particularly during the rainy season.

   c. To minimize, reduce, or avoid excessive noise levels associated with construction on the Calaveras River the Corps shall:

      i. Minimize activities on the Calaveras River if a hydraulic connection exists between the lower and upper reaches either due to normal flows or rain events.
      ii. If a hydraulic connection does not exist then normal construction activities can resume.

iii. If construction is underway during a hydraulic connection between the lower and upper reaches, noise levels shall be monitored and shall not exceed 150 dB (RMS) within the river channel.

d. To minimize, reduce, or avoid excessive noise levels associated with pile driving for the flood control gates and levee flood wall the Corps shall:

i. The Corps will follow NMFS' recommended sound criteria for pile driving activities described in the Opinion and minimize and reduce the extent of the sound field to reduce injury and mortality to exposed fish in the Project area. For impact pile driving hammers, the Corps shall use a peak sound pressure level of 206 decibels (dB) and an accumulated sound exposure level (SEL) of 187 dB as thresholds for injury to fish. For fish less than 2 g, the accumulated SEL threshold is reduced to 183 dB.

ii. For vibratory hammers, the Corps shall use the following thresholds for injury:

- Non-auditory tissue damage
  - Mass ≤ 0.6 g = 191 dB-SELaccumulated
  - For fish between 0.6 and 102 g mass, cumulative SEL = 195.28 + 19.28*log10(mass)
  - Mass ≥ 102 g = 234 db-SELaccumulated

- Auditory tissue damage
  - Hearing generalists (e.g., salmonids): > 234 dB-SELaccumulated
  - Hearing specialists (e.g., carp): 222 dB-SELaccumulated

- Temporary threshold shift (hearing loss)
  - Hearing generalists: 234 dB-SELaccumulated
  - Hearing specialists: 185 dB-SELaccumulated

iii. The Corps shall minimize the use of impact hammers during pile driving actions. Impact hammers shall only be used on the final portions of the pile driving action to set the concrete piles or sheet piles to final tip depth and load bearing criteria as required by the engineering designs.

iv. The Corps shall use the vibratory hammer to the greatest extent possible during pile driving actions. The Corps shall start driving the concrete piles and sheet piles initially with the vibratory hammer, starting slowly and gradually increasing intensity to reduce effects to fish in the surrounding aquatic habitat. The Corps may switch to the impact hammer to achieve final tip depth and load bearing resistance if necessary if the vibratory hammer is insufficient to achieve these parameters.

v. The Corps shall monitor noise generation in the water surrounding the pile driving activity (10m away, 1m deep as reference location for compliance). These data will be used to ensure that sound pressure levels are compatible with the assumptions made for calculations describing the range of noise effects and that noise levels do not exceed criteria.

7. The following terms and conditions implement reasonable and prudent measure 7: "*Measures shall be taken to refine existing conditions data in the Recommended Plan construction footprint during PED to minimize impacts to listed species.*"

    a. The Corps shall develop a database similar to the 2007 Sacramento River Bank Protection Project Revetment Database (Corps 2007). The database shall be used in the Recommended Plan construction footprint to refine existing conditions data and determine any deficits as measured using tools and targets outlined in the HMMP.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.
2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue land-side levee repairs instead of waterside repairs.
3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.
4. The Corps should investigate ETL vegetation variances for all flood management actions that are adjacent to anadromous fish habitat.
5. The Corps should sponsor an independently facilitated workshop that includes NMFS, USFWS, CDFW, DWR, local maintainers such as Sacramento Area Flood Control Agency, and the authors of the Synthesis of Levee Vegetation Research Results (2007-2014) to discuss the conclusions of this report and how local tree risk models that incorporate the best available science can be used in future risk assessments for levee repair programs.
6. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Lower San Joaquin River Feasibility Study Project.
7. The Corps should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
8. The Corps should seek out opportunities for setback levee and other flood management activities that promote overall riverine system restoration.

9. The Corps should support and promote aquatic and riparian habitat restoration within the San Joaquin River, Delta and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
10. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation of Consultation

This concludes formal consultation for Lower San Joaquin River Feasibility Study. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

Specifically, the Corps shall reinitiate consultation if a variance is not granted or if a variance is granted that does not meet the minimum standards that are described in the proposed action of the BA and this Opinion.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect Essential Fish Habitat (EFH). The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means habitat required to support a sustainable fishery and a healthy ecosystem; and, “spawning, breeding, feeding, or growth to maturity” covers all habitat types used by a species throughout its life cycle.

This analysis is based, in part, on the EFH assessment provided by the United States Army Corps of Engineers (Corps) and descriptions of EFH for Pacific coast salmon as described in Amendment 18 to the Pacific Coast Salmon Plan (Pacific Fisheries Management Council [PFMC], 2014) contained in the fishery management plans (FMP) developed by the PFMC and approved by the Secretary of Commerce.

The proposed Project area is within the region identified as EFH for Pacific salmon in Amendment 18 of the Pacific Coast Salmon FMP. The Corps is receiving this consultation under the MSA for potential impacts to the EFH of Pacific salmon as a result of implementing the Lower San Joaquin Feasibility Study (Project) near the city of Stockton in USGS Hydrologic Unit Codes (HUCs) 1804003 (San Joaquin Delta).

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the USGS HUCs described in Amendment 18.

3.1 Essential Fish Habitat Affected by the Project

he geographic extent of freshwater EFH is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan. In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed Project occurs in the area identified as “freshwater EFH”; as it is above the tidal influence where the salinity is above 0.5 parts per thousand.

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as “habitat areas of particular concern” (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine SAV. No HAPCs occur in the Project area or will be affected by the Project.

3.2 Adverse Effects on Essential Fish Habitat

The proposed Project is considered to have multiple nonfishing activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP. The following actions are considered to have potential adverse effects on the freshwater EFH in the action area of the Project:

1) *Activities causing high intensity underwater acoustic or pressure waves* – The proposed Project entails driving a substantial number of steel sheet piles and concrete piles over the course of two work years to construct the Smith Canal and Fourteenmile Slough Flood control gates and their associated sheet pile walls. The pile driving actions will use both impact pile driving hammers as well as vibratory pile driving hammers. The effects of these actions on listed salmonids and sDPS green sturgeon has already been described in section 2.4.1.1 of the Opinion. NMFS expects that a portion of the pile driving actions undertaken for the Smith Canal gate structure will overlap with the migration of adult fall-run Chinook salmon, an unlisted ESU, into the Calaveras and San Joaquin rivers during the fall. Fish exposed to the impact pile driving hammer are expected to be exposed to sound levels that will exceed the threshold for injury or mortality over a significant proportion of the adjoining San Joaquin River channel. Injuries are expected to the soft tissues surrounding the swim bladder, bruising and hemorrhaging of organs, damage to auditory tissues, and behavioral avoidance and alterations. Some of these injuries may rise to the level of mortality, depending on their severity.

2) *Bank Stabilization and Protection* – The proposed Project has components that will entail bank stabilization and protection activities in the action area which includes freshwater EFH. The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. Human activities removing riparian vegetation, armoring, relocating, straightening and confining stream channels and along tidal and estuarine shorelines influences the extent and magnitude of stream bank erosion and down-cutting in the channel. In addition, these actions have reduced hydrological connectivity and availability of off-channel habitat and floodplain interaction. Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species (Williams and Thom 2001).

3) *Flood Control Maintenance* - The protection of riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitats. Managing flood flows with flood control structures such as levees can disconnect a river from its floodplain eliminating off-channel habitat important for salmon. Floodplains serve as a natural buffer to changes in water flow: retaining water during periods of higher flow and releasing it from the water table during reduced flows. These areas are typically well vegetated, lowering water temperatures, regulating nutrient flow and removing toxins. Juvenile salmon use these off channel areas because their

reduced flows, greater habitat complexity and shelter from predators may increase growth rates and their chance of survival. Artificial flood control structures also have similar effects on aquatic habitat, as does the efforts to stabilize banks and remove woody debris. The function of natural stream channels and associated riparian areas and the effects of flood control structures such as levees has been discussed in section 2.4.1.3 of this Opinion.

4) *Compensatory Mitigation Projects* – Part of the proposed Project includes the construction of 7,000 feet of setback levee along Fourteenmile Slough as part of the mitigation for the impacts of the Project on riparian areas and nearshore habitat. The creation of the setback levee is a significant construction activity that may have short term negative impacts to the local environment and freshwater EFH. Possible impacts include 1) localized nonpoint source pollution from substances like petroleum products, sediment, or nutrients, 2) interference with migration or feeding, 3) direct effects like crushing from equipment operation or materials placement, and 5) fish stranding from poorly draining floodplains. These specific impacts should be addressed as part of the planning process.

5) *Wetland and Floodplain Alterations* – Pacific salmon evolved in the Central Valley with an extensive and complex floodplain adjacent to the river, with many channels and sloughs dissecting the plain and extensive wetlands and marshes fringing the waterways. Most of these floodplains and associated wetlands and marshes have been lost to anthropogenic causes. Floodplains, including side channels, and wetlands throughout the region have been converted through diking, draining, and filling to create agricultural fields, livestock pasture, areas for ports, cities, and industrial lands. The construction of dikes, levees, roads, and other structural development in the floodplain that confine the river have further effects on salmon habitat (PFMC 2014). As described in Amendment 18, a river confined by adjacent development and/or flood control and erosion control structures, can no longer move across the floodplain and support the natural processes that 1) maintain floodplain connectivity and fish access that provide velocity refugia for juvenile salmon during high flows; 2) reduce flow velocities that reduce streambed erosion, channel incision, and spawning redd scour; 3) create side channels and off-channel areas that shelter rearing juvenile salmon; 4) allow fine sediment deposition on the floodplain and sediment sorting in the channel that enhance the substrate suitability for spawning salmon; 5) maintain riparian vegetation patterns that provide shade, large wood, and prey items to the channel; 6) provide the recruitment of large wood and spawning gravels to the channel; 7) create conditions that support hyporheic flow pathways that provide thermal refugia during low water periods; and 8) contribute to the nutrient regime and food web that support rearing and migrating juvenile salmon in the associated mainstem river channels.

3.3 Essential Fish Habitat Conservation Recommendations

The Corps should implement the following conservation measures to offset the adverse effects described in section 3.2 above. In order to avoid or minimize the effects to EFH, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP:

1) *Activities causing high intensity underwater acoustic or pressure waves* **–** the Corps should:

- When possible, avoid driving piles when salmon are present, especially the younger life stages and spawning adults.
- Avoid driving piles with an impact hammer when salmon or their prey are present. Alternatives include vibratory hammers or press-in pile drivers.
- In cases where an impact hammer must be used, drive the piles as far as possible with a vibratory or other method that produces lower levels of sound before using an impact hammer.
- When driving piles in intertidal or shallow subtidal areas, do so during periods of low tide. Sound does not propagate as well in shallow water as it does in deep water.
- Implement measures to attenuate the sound. Such measures include the use of a bubble curtain or a dewatered pile sleeve or coffer dam. Monitor the sound levels during pile driving to ensure that the attenuation measures are functioning as expected.
- Where tidal currents can be strong, drive the piles when the current is reduced (i.e., centered on slack current) to minimize the number of fish exposed to adverse levels of underwater sound. Strong currents can bring more fish into close proximity to the pile than would a weak current.
- Monitor, and report back to NMFS, the sound levels during pile driving to verify that the assumptions in the analysis were correct and to ensure that any attenuation device is properly functioning. Develop the monitoring and reporting protocols according to guidance provided by the Fisheries Hydroaccoustic Working Group (FHWG (2013)). The report should be provided to NMFS according to the individual project requirements, but no later than 60 days after completion of the pile driving.
- Implement terms and conditions 6 (c, d) to reduce noise related impacts from the section 7 Opinion for this Project.

2) *Bank Stabilization and Protection*

- Minimize the loss of riparian habitats as much as possible.
- Bank erosion control should use vegetation methods or “soft” approaches (such as beach nourishment, vegetative plantings, and placement of LWD) to shoreline modifications whenever feasible. Hard bank protection should be a last resort and the following options should be explored (tree revetments, stream flow deflectors, and vegetative riprap.
- Re-vegetate sites to resemble the natural ecosystem community.
- Replace in-stream fish habitat by providing root wads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
- Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.
- Implement term and conditions 1(c), 2 (all), 3 (b, c, d) 5(a) and 8 (all) from the section 7 Opinion for this Project.

3) *Flood Control Maintenance*

Include the conservation measures from the *Bank Stabilization and Protection* section of the Opinion and:

- Retain trees and other shaded vegetation along earthen levees and outside levee toe.
- Ensure adequate inundation time for floodplain habitat that activates and enhances near-shore habitat for juvenile salmon.
- Reconnect wetlands and floodplains to channel/tides.

4) *Compensatory Mitigation Projects*

- Develop and conduct compensatory mitigation activities on a watershed-scale.
- Design compensatory mitigation activities as an experiment, using adaptive management to determine Project success and modify until the success criteria are achieved.
- Protect habitat-forming processes (e.g., riparian community succession, bedload transport, runoff pattern) that maintain the biophysical structure and function of aquatic ecosystems.
- Use BMPs to minimize and avoid all potential impacts to EFH during compensatory mitigation activities. This conservation measure requires the use of BMPs during compensatory activities to reduce impacts from Project implementation. BMPs should include, but are not limited to, the following:

    - Measures to protect the water column such as turbidity curtains, hay bales, and erosion mats should be used.
    - Staging areas should be planned in advance and kept to a minimum size.
    - Buffer areas around sensitive resources such as rare plants, archeological sites, etc., should be flagged and avoided.
    - Invasive species should be removed from the proposed action area prior to commencement of work. Only native plant species should be replanted.
    - Ingress/egress areas should be established prior to compensatory activities to minimize adverse impacts from Project implementation.

- Avoid compensatory work during critical fish windows to reduce direct impacts to important ecological functions such as spawning, nursery, and migration. This conservation measure requires scheduling projects when managed species are not expected in the area. These periods should be determined prior to Project implementation to reduce or avoid any potential impacts.
- Provide adequate training and education to volunteers and project contractors to ensure minimal impact to the compensatory site. Volunteers should be trained in the use of low-impact techniques for planting, equipment handling, and any other activities associated with the compensatory.
- Conduct monitoring before, during, and after Project implementation to ensure compliance with Project design and compensatory criteria. If immediate post-construction monitoring reveals that unavoidable impacts to EFH have occurred, appropriate coordination with NOAA Fisheries should occur to determine appropriate response measures, possibly including mitigation.

- Mitigate fully any unavoidable damage to EFH during Project implementation and accomplish within reasonable period of time after the impacts occurred.

5) *Pesticide Use*

The conservation measure implemented will vary depending on the specific pesticide being applied, the species and life stage in the area, and the time of year. In general, they include:

- Avoid the use of pesticides near aquatic habitats, if possible.
- Use less toxic alternatives to pesticides such as mechanical mowing or hand operated tools.
- Establish a minimum no-application buffer width.
- Maintain healthy riparian zones alongside salmon-bearing waters.
- Restrict applications under certain environmental conditions, such as during periods of high wind, rain, or wet soils.

6) *Wetland and Floodplain Alterations*

- Minimize alteration of floodplains and wetlands in areas of salmon EFH.
- Determine cumulative effects of all past and current floodplain and wetland alterations before planning activities that further alter wetlands and floodplains.
- Promote awareness and use of the USDA's wetland and conservation reserve programs to conserve and restore wetland and floodplain habitat.
- Promote compensatory of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands and invasive species management.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, NMFS ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the Corps. Other interested users could include SJRFCA, USFWS, CDFW, or DWR. Individual copies of this Opinion were provided to the Corps. This Opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.
Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [*and MSA implementation, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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ENVIRONMENTAL ADDENDUM J

MITIGATION, MONITORING, AND ADAPTIVE MANAGEMENT PLAN

LOWER SAN JOAQUIN FEASIBILITY STUDY

Habitat Mitigation, Monitoring, and Adaptive Management Plan

Lower San Joaquin River Feasibility Study

December 2017

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Acronyms and Abbreviations

AAHU	Average Annual Habitat Unit
BA	biological assessment
BO	biological opinion
CE/ICA	cost effectiveness/incremental cost analysis
Corps	U.S. Army Corps of Engineers
DSM	deep soil mixing
DWR	California Department of Water Resources
DWSC	Deep Water Shipping Channel
EIS/EIR	environmental impact statement/environmental impact report
ERDC	Engineer Research and Development Center
ETL	Engineering Technical Letter
GRR	general reevaluation report
GGS	giant garter snake
HEP	Habitat Evaluation Procedures
HMMAMP	Habitat Mitigation, Monitoring, and Adaptive Management Plan
HSI	Habitat Suitability Index
HU	Habitat Units
IEP	Interagency Ecological Program
IWG	Interagency Working Group
IWM	instream woody material
IWR	U.S. Army Corps of Engineers Institute for Water Resources
IWR Plan	Institute for Water Resources Planning Suite
LSJR	Lower San Joaquin River
NMFS	National Marine Fisheries Service
O&M	operation and maintenance
PED	preconstruction engineering and design
ppt	parts per thousand
RD	reclamation district
RM	river mile
SJAFCA	San Joaquin Area Flood Control Agency
SRA	shaded riverine aquatic habitat
SMART	specific, measurable, attainable, realistic, and timely
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
V	variable
VELB	valley elderberry longhorn beetle
WRDA	Water Resources Development Act

1.0 INTRODUCTION

1.1 Purpose and Goals

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 906(d) of the Water Resources Development Act (WRDA) of 1986 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act (ESA) states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts.

The primary purpose of habitat monitoring is to determine the level of ecological function at each mitigation site as a part of an overall plan to create sites that offset the loss of habitat affected by construction of the proposed project. This Habitat Mitigation Monitoring and Adaptive Management Plan (HMMAMP) describes the types of habitats that will be impacted, the potential impacts caused by the project, and the types and amounts of mitigation that would be established in order to compensate for habitat losses. This plan also establishes methods to evaluate the success of these sites and includes adaptive management measures to be implemented if success criteria are not being met to ensure the goals and requirements of the project's mitigation are accomplished. This HMMAMP is a living document and may be modified as part of an adaptive management strategy to allow for goals and requirements to be accomplished in a constantly changing environment. This HMMAMP will accompany the final EIS/EIR as part of the project addenda, and will be updated throughout the project design phase as detailed design efforts allow for finalizing the mitigation plans.

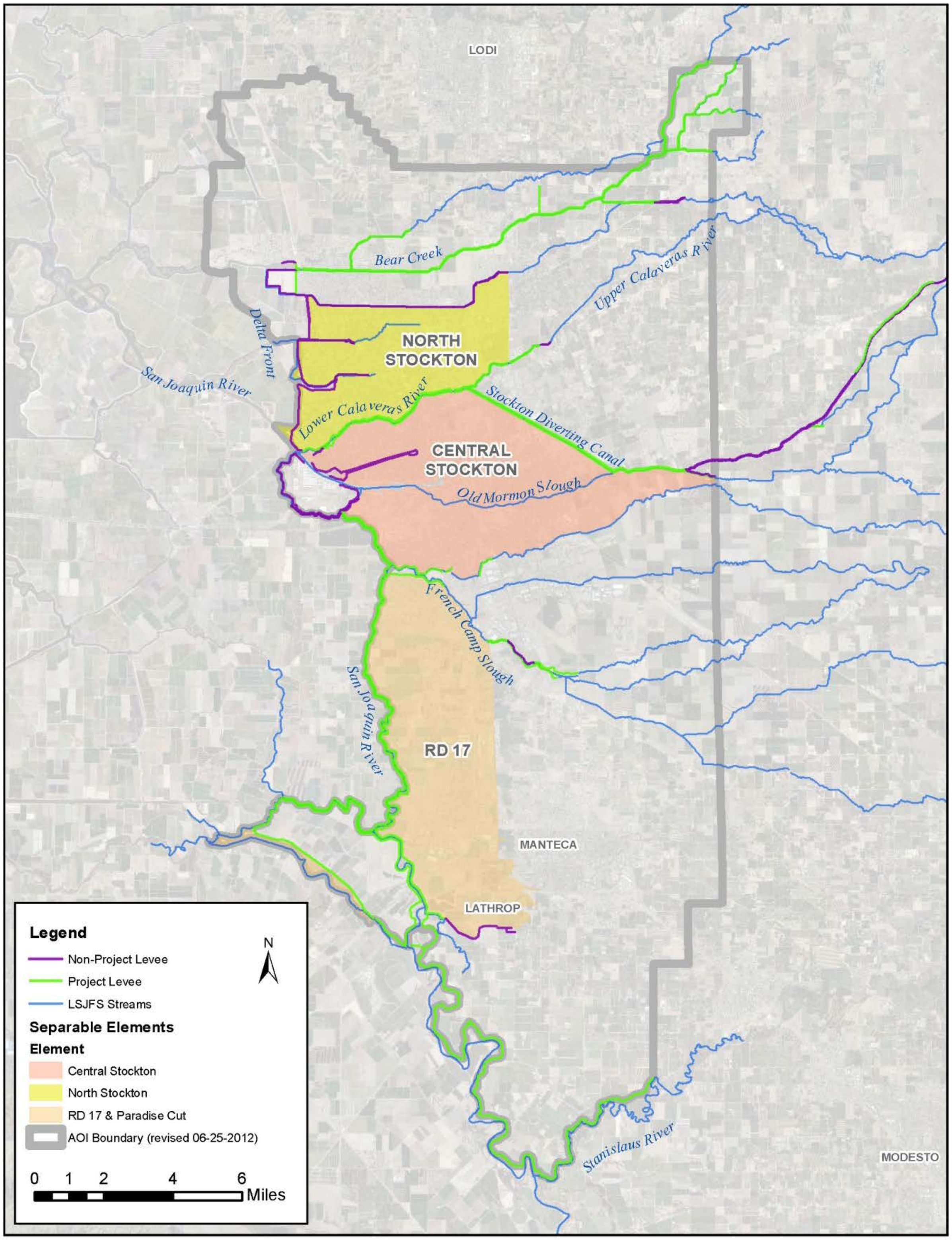
The goal of the HMMAMP is to ensure that the conservation values of the mitigation sites are maintained in good condition in perpetuity. The plan's biological goals are to: (1) preserve the abundance and diversity of native species (particularly special status species) in the established habitats in the project area; (2) protect the habitat features from the effects of indiscriminate land use changes that may adversely impact mitigation habitats; and (3) mitigate any adverse impacts within the project areas. Monitoring would be conducted in a manner compatible with the type of mitigation site. Mitigation requirements are provided by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) through biological opinions (BOs) received through the Endangered Species Act Section 7 consultation process. Additional mitigation recommendations from USFWS are included in the project's Fish and Wildlife Coordination Act Report.

The HMMAMP would be implemented by U.S. Army Corps of Engineers (Corps) staff through coordination with USFWS and NMFS. Monitoring would be conducted by qualified biologists from the Corps, in coordination with the USFWS, the California Department of Water Resources (DWR), and the San Joaquin Area Flood Control Agency (SJAFCA). Upon completion of construction (to include the plant establishment period for the site), the land would be turned over to the non-Federal sponsor to be maintained in perpetuity.

1.2 Project Description

The Lower San Joaquin River (LSJR) study area is located along the lower (northern) portion of the San Joaquin River system in the Central Valley of California. The San Joaquin River originates on the western slope of the Sierra Nevada and emerges from the foothills at Friant Dam. The river flows west to the Central Valley, where it is joined by the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus and Calaveras rivers, and smaller tributaries as it flows north to the Sacramento-San Joaquin Delta.

The study area, as defined in the study authorization, includes the main stem of the San Joaquin River from the Mariposa Bypass downstream to the city of Stockton. The study area also includes the distributor channels of the San Joaquin River in the southernmost reaches of the Delta: Paradise Cut and Old River as far north as Tracy Boulevard and Middle River as far north as Victoria Canal. Based on availability of potential non-Federal sponsors, the study focused on approximately 305 square miles encompassing incorporated areas of Stockton, Lathrop, and Manteca as well as unincorporated portions of San Joaquin County. During the plan formulation process, the study area was divided into three separable elements. The separable elements are considered to be hydraulically separate, meaning that each area could have stand-alone solutions or alternatives proposed to address flood risk. The separable elements are shown on Figure 1 below.



Note: AOI is an acronym for "Area of Interest"

Figure 1. LSJR Study Area Map

The purpose of the LSJR study is to investigate and determine the extent of Federal interest in a range of alternative plans designed to reduce the risk of flooding in the cities of Stockton, Lathrop, Manteca, and surrounding unincorporated portions of San Joaquin County. These areas have experienced multiple flooding events since records have been maintained. The existing levee system within the study area protects over 71,000 acres of mixed-use land with a current population estimated at 264,000 residents and an estimated $21 billion in damageable property.

The study area includes:

- The San Joaquin River between French Camp Slough and the railroad bridge 14 miles below the Stockton Deep Water Shipping Channel (DWSC);
- French Camp Slough from El Dorado Street to the San Joaquin River; the Calaveras River from N. El Dorado Street to the San Joaquin River;
- Portions of the Stockton DWSC between Smith Canal and Fourteenmile Slough;
- The west side of Fourteenmile, Tenmile Slough, and Fivemile Slough to Mosher Slough; and
- The south side of Mosher Slough .41 miles beyond N. Eldorado Street up to the railroad tracks.

The Corps has identified a number of problems associated with the flood risk management system protecting the city of Stockton and surrounding areas. There is a high probability that flows in the lower San Joaquin River, Calaveras River, and the Sacramento-San Joaquin estuary (the Delta) or a seismic event would stress the network of levees protecting Stockton to the point that they could fail. The consequences of such a levee failure would be catastrophic, since the area that would be inundated by flood waters is densely urbanized and the flooding could be up to 18 feet deep.

Most levees in the study area require seepage and slope stability improvements in order to meet Corps levee design criteria. Some levees require slope reshaping, height improvements, and/or erosion protection. The northern portion of the project area is vulnerable to flooding from the west (the Delta). Options to improve existing levees immediately adjacent to the city of Stockton to reduce risk from this threat are constrained due to urban development. Therefore, two in-water closure structures are also proposed. In the southern part of the project area a new levee extension is proposed on Duck Creek.

During Pre-Construction, Engineering, and Design Phase (PED), engineering investigations will be conducted to determine the suitability of the Recommended Plan levees for a vegetation variance to allow some vegetation to remain on the lower portion of the waterside levee slope of the levees and within the waterside easement.

The Recommended Plan (Alternative 7a) for the LSJR study is to improve the levees in the study area to address identified seepage, stability, height, and erosion concerns. The Recommended Plan is composed of different structural measures, or building blocks, to address these problems. The measures are described below in this section. Overall, the Recommended Plan includes: (1) 19.4 miles of seepage cutoff walls; (2) 3.2 miles of geometric improvements consisting of levee slope and crown reshaping to meet Federal standards; (3) 3.5 miles of levee height raises mainly to reestablish the design levee height; (4) 0.5 miles of flood walls/sheet pile walls; (5) 1.1 miles of seismic improvements, (6) 0.75 miles of new levee, and (7) 5 miles of new erosion protection (a majority of the new protection would be on the landside only; however, existing erosion protection disturbed by construction would be replaced). Note that these features overlap one another and cannot be added up to describe the total project extent. The total amount of horizontal flood features (including closure structures) is approximately 24.5 miles. The Recommended Plan is shown below on Figure 2 and described in Table 1.

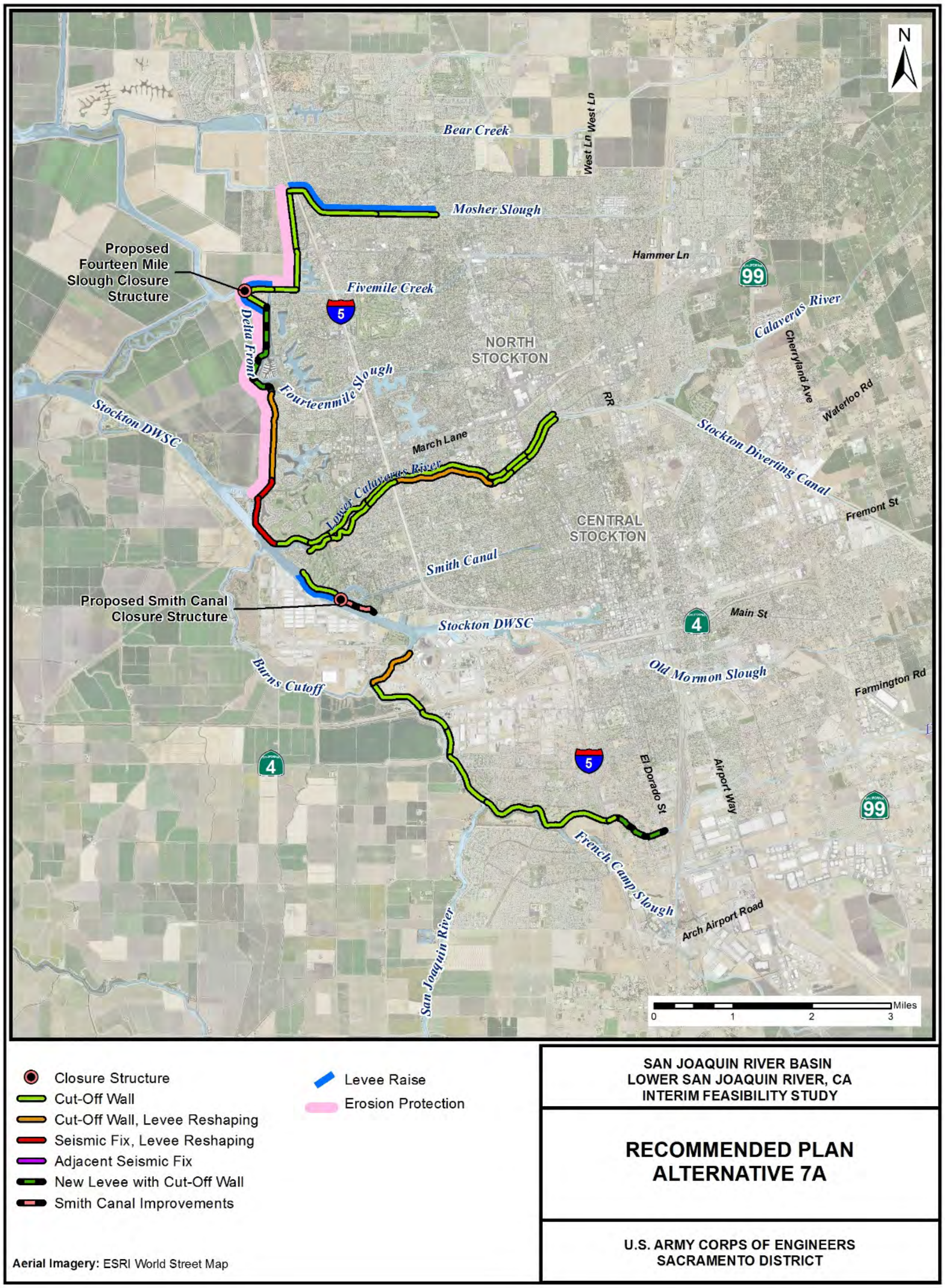


Figure 2. The LSJR Study Recommended Plan.

These measures would be implemented primarily by fixing levees in place. In addition to levee improvements, the Recommended Plan includes two in-water closure structures. Once a levee is modified, regardless of the measure implemented for the alternative, the levee would meet the Corps' levee design criteria. This would include slope reshaping and/or crown widening, where required. The levee crown would be widened to 20 feet minimum on the San Joaquin River and 12 feet minimum on all other levees included in the Recommended Plan. Both landside and waterside slopes of 3H:1V would also be established where possible. If necessary, the existing levee centerline would be shifted landward in order to accommodate levee reshaping and height improvements.

In addition to the structural features, the Recommended Plan also includes several non-structural features to further reduce the consequences of flooding, including Comprehensive Flood Warning Emergency Evacuation Planning and Floodplain Management.

Table 1. Proposed Measures for the LSJR Study Recommended Plan.

Waterway	Reach	Proposed Measure(s)
North Stockton		
Mosher Slough	Thornton Road to UPRR railroad tracks	Cutoff wall
Mosher Slough	Shima Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)
Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)
Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)
Fourteenmile Slough	Fivemile Slough to Proposed Closure Structure	Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	Approximately 1,500 feet west of Fivemile Slough	Closure Structure
Fourteenmile Slough	Approximately 1,250 feet southeast setback out from proposed closure structure	Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	From setback cut south to Tenmile Slough	Adjacent levee Slope Reshaping Erosion protection (landward)
Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope Reshaping Erosion protection (waterside)
Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic Fix Slope Reshaping Erosion protection (waterside)
Tenmile Slough/ Buckley Cove Marina/ San Joaquin River	West March Lane/Buckley Cove Way to Calaveras River	Seismic Fix Slope Reshaping
Calaveras River – Right/North Bank	San Joaquin River to North El Dorado Street	Cutoff wall
Central Stockton		

Waterway	Reach	Proposed Measure(s)
Calaveras River – Left/South Bank	San Joaquin River to approximately I-5	Cutoff wall
Calaveras River – Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping
Calaveras River – Left/South Bank	Approximately North Pershing Avenue to approximately El Dorado Street	Cutoff wall
San Joaquin River	From approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)
Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure Structure
Smith Canal	Dad's Point from the Closure Structure to approximately 375 feet down Monte Diablo Avenue	Floodwall
San Joaquin River	Railroad bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping
San Joaquin River	Burns Cutoff to French Camp Slough	Cutoff wall
French Camp Slough – Right/North Bank	French Camp Slough confluence with the San Joaquin River to approximately 500 feet southwest of I-5	Cutoff wall
Duck Creek	500 feet past I-5 cross to approximately Odell Avenue	New levee
Duck Creek	Approximately Odell Avenue to McKinley Avenue	Cutoff wall Levee reshaping Levee Height Fix

1.3 Description of Proposed Protective Measures

1.3.1 Bank Protection

The new erosion protection included in the Recommended Plan will be placed either on the waterside of the levee or on the landside of the levee. All of this new erosion protection would be placed above the waterline. The purpose of the North Stockton erosion protection is to protect the project levee from wind and wave run-up erosion which could occur if Delta levees to the west of the project levee were to fail allowing flooding of land immediately west of the project levee. The purpose of the Central Stockton erosion protection on Duck Creek is to protect the backside (landside) of the levee from erosion that could occur if floodwaters moving from the south to the northeast were to wrap around the end of the project levee and back up against it. Although this would be the only placement of new erosion protection, any existing riprap disturbed during construction of project features would be replaced. When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In some cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked to the site.

1.3.2 Levee Geometry

Levee reshaping involves grading high areas and or placing additional soil in depressions and compacting it in order to restore the levees to Corps levee design criteria for side slopes and crown width. For the Recommended Plan, the minimum crest width for major tributary levees is 20 feet and the minimum crest width for minor tributary levees is 12 feet. Existing levees with landside and waterside slopes as steep as 2H:1V (i.e., for every 2 feet of horizontal distance, there is a 1 foot increase in height) may be acceptable if slope performance has been good and if the slope stability analyses determined the factors of safety to be adequate, otherwise the landside and waterside slopes should have 3H:1V slopes. This improvement measure addresses problems with slope stability, geometry, and levee toe and crest access and maintenance. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie-in additional embankment fill. The existing levee centerline would be shifted landward where necessary in order to meet the Corps standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe.

1.3.3 Cutoff Walls

To address seepage concerns, a cutoff wall would be constructed through the levee crown (Figure 3. A cutoff wall is a water resistant barrier that is constructed vertically into the levee and is designed to prevent through and underseepage in the levee. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

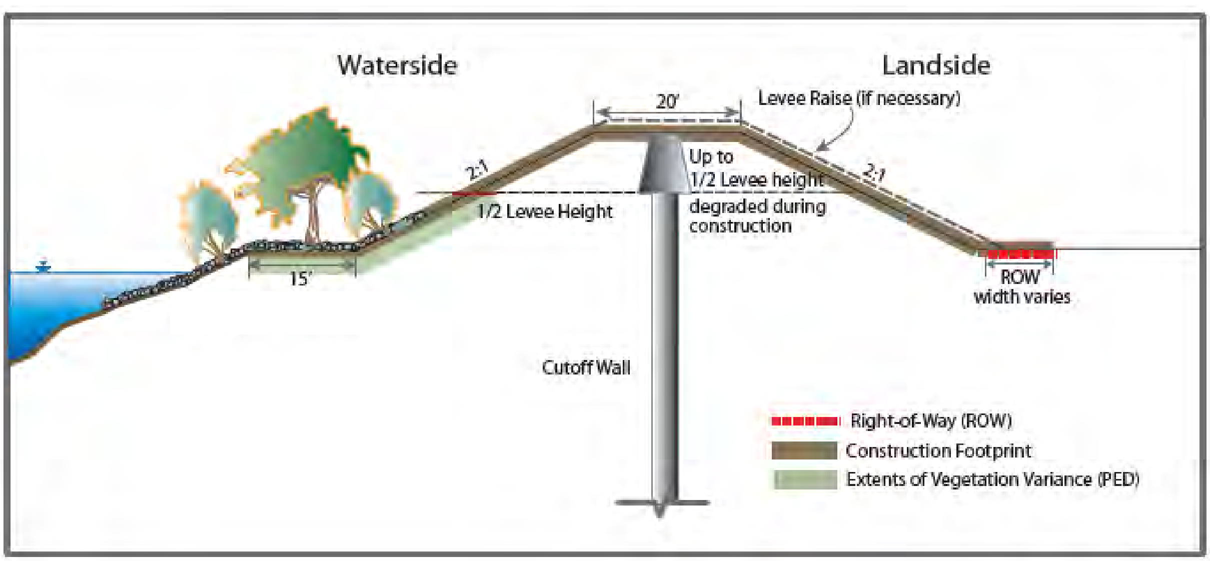


Figure 3. Fix-in-place with Cutoff Wall.

1.3.4 Levee Raise

This measure would be implemented to repair the levee height in locations where the crown has slumped and to raise the existing levee height to reasonably maximize net benefits. To raise the levees, additional borrow material would be added after cutoff walls and levee reshaping improvements are completed. The additional material would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly on the levee and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

In some locations, the levee height could increase up to 5 feet; however, most raises would be 1.5 to 3 feet. An increase in levee height may require additional levee footprint area to meet design requirements for minimum levee slope and crown width.

1.3.5 Flood Walls

This measure consists of construction of about 825 linear feet of sheetpile floodwall from the southern portion of Dad's Point to high ground at Louise Park. The wall height would be an average of three to four feet above the ground surface. A metal cap may be placed on the top of the sheetpile or the sheetpile maybe encased in concrete. The floodwall would be approximately 12 to 18 inches wide. To begin the floodwall construction, the area would be cleared, grubbed, stripped, and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would primarily be constructed from pre-fabricated materials, although it may be cast or constructed in place. The floodwall would be constructed almost completely upright. Floodwalls mostly consist of relatively short elements, making their connections very important to their stability. The floodwalls would be designed to disturb a minimal amount of waterside vegetation.

1.3.6 New Levee

This measure would involve constructing new levees to reduce the flood risk to some areas or to prevent waters from outflanking (i.e., flowing around the ends of the levees and entering the area intended to be protected) the existing levee system during high water events. A new levee is planned for the upstream 0.75 mile of Duck Creek to tie the existing levee into the railroad berm along the north side of Duck Creek. To construct the new levee, the construction footprint area would be cleared and grubbed and a new levee foundation would be excavated. A levee inspection trench would be excavated across the entire proposed centerline of the new levee. The depth of the inspection trench would vary depending upon levee height, as required by Corps guidance and the State's Urban Levee Design Criteria. For the purposes of the impact analysis, a depth of 3 to 6 feet is assumed.

Construction of the new levee section would proceed in accordance with Corps levee design criteria, with suitable material placed in 6- to 8-inch lifts, moistened, and compacted to design specification until the design elevation has been reached. A cutoff wall would be constructed through the center of the new levee, if needed, to prevent through- and under-seepage. For new levees that require erosion protection, quarry stone riprap would next be applied to armor the newly completed levee's waterside slope and provide protection against erosion. Fill material for levee construction would be obtained from local construction borrow areas and commercial sources, and would be delivered to the levee construction sites using haul trucks. A gravel road would be constructed on the crown of the new levees. Following construction, the levee slopes would be reseeded with native grasses to prevent erosion.

1.3.7 Seismic Remediation

This technique is meant to keep the levee from deforming or liquefying during seismic activity. It would be implemented to provide seismic stability to the somelevees of North Stockton that are frequently loaded (due to tidally influenced slough water surface elevations) and that are also subject to potentially significant deformations due to a seismic event. It would involve installation of a grid of drilled soil-cement mixed columns (Figure 4-5 of the Main Report). There would be a series of overlapping, DSM columns aligned longitudinally with and transverse to the alignment of the levee extending beyond the levee prism. This measure would also reduce risk of seepage and provide improved landside slope stability.

The crest of the levee would be reconstructed to comply with the USACE levee design criteria. DSM augers would be used to construct a continuous grouping of cells spaced equally in both longitudinal and transverse directions to the levee alignment. A hose attached to the auger would inject cement bentonite slurry into the soil, allowing for DSM. After construction is completed, the levee crest would be topped with a 6-inch aggregate road and the slopes would be hydro-seeded for erosion control. This effort would occur along 1.1 miles of Tenmile Slough.

1.3.8 Closure Structure

This measure would include construction of closure structures at the mouth of backwater sloughs at Smith Canal and on Fourteenmile Slough to reduce flood risk along those sloughs. The structure would extend from the end of Dad's Point to the right bank of the San Joaquin River at the Stockton Golf and Country Club. The closure structures would control back-flooding from the San Joaquin River and Delta during high water events. The proposed closure structures would consist of a fixed sheet pile wall structure (about 800 feet long) with an opening gate structure sufficiently large to allow for the safe passage of boats and other watercrafts. The opening portion of the closure structure would be an automated gate that may open upward or outward. The gate would be approximately 50-feet wide, and would be constructed of stainless steel. The gate would be attached to a concrete foundation using stainless steel anchor bolts. A small building, about 400 square feet, would be built at the end of Dad's Point on land directly adjacent to the closure structures. The building would be designed to store equipment required to operate the gate. As needed, a sheet pile floodwall would be constructed adjacent to the control structures to tie the structures into the adjacent levee or high ground areas. Construction would not require dredging or draglining.

1.3.9 Operation and Maintenance

Operation and maintenance (O&M) of the levees are the responsibility of the local maintaining agencies. Typical levee O&M includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels would be monitored using the piezometers.

Following construction, the O&M manual for these reaches would be adjusted as needed. Under the adjusted O&M manual, large trees that are protected in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access.

1.4 Types of Habitats Impacted

A variety of different habitat types occur within the study area that would be impacted by the LSJR study and would require mitigation to compensate for project impacts. The habitats include; giant garter snake (GGS) upland habitat, shaded riverine aquatic habitat, riparian communities, and valley elderberry longhorn beetle (VELB) habitat, Delta smelt shallow water habitat, open water habitat, and wetlands. These habitats are briefly described below.

1.4.1 Giant Garter Snake Upland Habitat

The GGS inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of: (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters.

1.4.2 Shaded Riverine Aquatic Habitat

Shaded Riverine Aquatic (SRA) habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. SRA occurs throughout the study area along the riverbanks and levees and is contained within the other identified habitat types in these areas.

1.4.3 Riparian Communities

In general, riparian communities are among the richest community types, in terms of structural and biotic diversity, of any plant community found in California. Riparian vegetation provided important ecological functions, including: wildlife habitat; migratory corridor for wildlife; filters out pollutants and shades waterways, thereby improving water quality; provides connectivity between waterways and nearby uplands; provision of biomass (nutrients, insects, large woody debris, etc.) to adjacent waterways; and, in some situations, reduces the severity of floods by stabilizing riverbanks. Riparian forests and woodlands – even remnant patches – are important wildlife resources because they continue to be used by a large variety of wildlife species and because of their regional and statewide scarcity.

The overstory of the riparian habitat consists of mature, well-established trees, such as: Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo var. californicum*). During the surveys, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The midstory layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle

(*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the San Joaquin River. The following habitat types are included in the Riparian community; however, they are referred to throughout this report as "riparian trees and shrubs". Additionally, shaded riverine aquatic (SRA) habitat is a member of the riparian community.

Riparian Woodland

Riparian woodlands in the project area include cottonwood riparian woodland, valley oak riparian woodland, walnut riparian woodland, and riparian scrub. Riparian habitats are considered to be among the most productive and diverse wildlife habitats in California. In addition to providing important nesting and foraging habitat, they function as wildlife movement corridors.

Larger remnant patches of Great Valley cottonwood riparian forest located within the project area are dominated by large Fremont cottonwood trees and Goodding's willow. Most of the otherwise linear or smaller patchy areas of this community lack Fremont cottonwood and are represented by Goodding's willow, red willow, arroyo willow, narrow leaved-willow, and scattered valley oak, Oregon ash, and buttonbush. Native ground cover species, mainly found in the larger remnant patches of riparian forest, include California blackberry and wild rose. Common nonnative understory species found in most elements include Himalayan blackberry and tree tobacco. Great Valley oak riparian forest is also located within the project area, occurring only on the landside of the levees.

1.4.4 Valley Elderberry Longhorn Beetle Habitat

The VELB is completely dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. These forests consist of several canopy layers with a dense undergrowth (Katibah, 1983). Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), willows (*Salix* spp.), and valley oak (*Quercus lobata*) are common upper canopy species. The midstory layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory.

1.4.5 Delta Smelt Shallow Water Habitat

Delta smelt are endemic to the Sacramento-San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. Delta smelt are typically found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt occur in tidally influenced segments of the Sacramento and San Joaquin rivers, tributaries, and Delta. Delta smelt has the potential to occur in the waterways throughout the study area.

1.4.6 Open Water Habitat

Open water in the project area includes the San Joaquin River, Fourteenmile Slough, Fivemile Slough, Tenmile Slough, Smith Canal, French Camp Slough (perennial drainages), agricultural ditches (ditches), and small artificial ponds (ponds). Open water provides breeding, foraging, and migration habitat for numerous wildlife species. Mammal species commonly known to use perennial aquatic open water habitats include river otter, which uses these areas for foraging and escape cover, and muskrat, which may use deepwater areas as migration corridors between suitable foraging areas. Open water areas also provide essential foraging habitat for wading birds, including great blue heron, great egret, and snowy egret; numerous waterfowl species, including mallard, ruddy duck, and bufflehead; other water birds, including eared grebe, double-crested cormorants, and American white pelicans; and land birds, including black phoebe and belted kingfisher. These areas also provide rearing habitat, escape cover, and foraging habitat for reptiles and amphibians, including common garter snake, bullfrog, Pacific tree frog, and western toad. The vegetated areas below the ordinary high water mark provide nesting habitat for numerous songbirds, including red-winged blackbird and marsh wren, and wading birds such as Virginia rail.

1.4.7 Wetlands

"Wetlands" means areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. For other water features such as rivers, streams, and ditches, the extent of potential Corps jurisdiction is determined by identification of the Ordinary High Water Mark, which is defined as "that line on shore established by the fluctuations of water and indicated by physical character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (33 CFR §328.3[e]).

1.5 Environmental Baseline

Historic native vegetation in the project area has been highly altered and fragmented as a result of flood risk management, land reclamation, urbanization, agriculture, and navigation projects. Flood risk management infrastructure in this area includes levees, river and tributary realignments, constructed channels, erosion protection, and control structures. Vegetation within the project area maintains some remnants of what was historically present, including Great Valley cottonwood riparian forest, Great Valley oak riparian forest, coastal and valley freshwater marsh. It also includes nonnative woodlands, agricultural (row crops, orchards and vineyards), and developed lands like lawns, parks and golf courses. Non-native grasses, forbs, shrubs, trees, and vines are interwoven throughout the landscape. Open water habitat includes rivers, tributaries, canals, and ditches. Ditches may contain water seasonally or year round.

Once, the San Joaquin River and tributaries were framed by dense riparian forest. Today, riparian vegetation consists of narrow linear strips and occasional patches of riparian forest and riparian scrub growing on or adjacent to the levee. Larger areas of riparian forest are present in some areas where the levee is set back from the river or tributary leaving floodplain on the waterside of the levee. More detailed description of the vegetation in the project area is provided below.

The northern portion of the project area includes Mosher Slough, Fivemile Slough, Fourteenmile Slough, Tenmile Slough, Stockton Deep Water Ship Channel. The central and southern part of the project area includes the San Joaquin River and its tributaries, including Calaveras River, Smith Canal, Mormon Slough, French Camp Slough and Duck Creek, the southern part of the project area is comprised of French Camp Slough and the San Joaquin River near the northern end of RD 17. The project area occurs within the Great Central Valley subdivision of the California floristic Province in San Joaquin County (Hickman, Ed. 1993:45). The topography of the portions of the project area adjacent to the levees is relatively level, and elevations in the project area range from less than 5 feet to approximately 38 feet above mean sea level. Throughout the project area, levee crowns are either paved or graveled for access and inspection and are generally devoid of vegetation.

Mosher Slough

Mosher Slough runs through a highly urbanized area. Woody riparian vegetation is most robust near the confluence with Fourteenmile Slough. It is comprised of typical Valley riparian trees and shrubs. Emergent wetland vegetation occurs intermittently at the water's edge. Landside vegetation includes non-native landscape trees and shrubs as well as natives. Typical wetland vegetation lines some stretches of this reach.

Fourteenmile Slough, Fivemile Slough, Tenmile Slough (Delta Front)

Waterward of the levees, some woody riparian trees and shrubs boarder these highly engineered waterways. Within some of the sloughs and canals, aquatic weeds cover much of the water surface. Along the edges of the waterways wetland vegetation is present intermittently. Within Fourteenmile Slough, intertidal vegetation is present on rocky substrate that is exposed during low tides. In Buckley Cove, near the confluence of Tenmile Slough with the Sacramento Deep Water Ship Channel, wetland and subtidal vegetation is present along with aquatic weeds. Landside vegetation is comprised mainly of row crops with some parcels in orchard.

San Joaquin River

On the San Joaquin River, lands waterside of the levees are very narrow and support a remnant riparian forest. Trees and shrubs occur in small patches or may be scattered individuals. Vegetation on the waterside of levee slopes in the project area is highly varied, ranging from ruderal herbaceous vegetation and annual grasses with few shrubs, to dense shrubs with little overstory, to mature riparian forest. Potential Shaded Riverine Aquatic (SRA) cover is found along much of the river in the project area.

Dominant waterside tree species include cottonwood, willow, oak, box elder, and black walnut. In the project area, common shrub species include willow, wild Rose, and blackberry. Elderberry shrubs are also present in some locations. Ruderal herbaceous vegetation is present on levee slopes. In some places the tree overstory along the levee is so dense that the leaf fall and shading, as well as human activity, precludes development of dense understory vegetation. At Does Reis road there is a park on both sides of the levee. Vegetation includes willows, weeping willow, cottonwood, fruitless mulberry, mesquite (thorns), elderberry, mistletoe.

Landside levee slopes are primarily barren or covered with ruderal vegetation. Beyond the base of the levees, riparian vegetation is rare but occasionally present in small isolated patches. Other trees include occasional single or isolated stands of native oaks and nonnative trees planted around farms, agricultural fields, and residential or other types of development. Larger remnant patches of Great Valley cottonwood riparian forest located within the study area are dominated by large Fremont cottonwood, trees and Goodding's willow (AECOM 2011). Most of the otherwise linear or smaller patchy areas of this community lack Fremont cottonwood and are represented by Gooding's willow, red willow, arroyo willow, narrow leaved-willow, and scattered valley oak, Oregon ash, and buttonbush (AECOM 2011). Native ground cover, mainly found in the larger remnant patches of riparian forest, include California blackberry and wild rose. Common nonnative understory species found in most elements include Himalayan blackberry and tree tobacco. Most of the Great Valley cottonwood riparian forest community could also be characterized as Great Valley riparian scrub, which does not include Fremont cottonwood and is characterized by a shorter canopy and more uniform structure; however, this habitat is part of the Great Valley cottonwood riparian forest that was extensive and connected along this entire reach of the San Joaquin River, and this document therefore describes all riparian habitat as such. (AECOM 2011)

Calaveras River

Levees and the lands adjacent to both the waterside and landside of the levees in the reach of the Calaveras River above, and just below, the Stockton Diverting Canal are largely devoid of trees and shrubs. The exception is some orchards landward of the north levee. Moving downstream, more trees and shrubs are present on and adjacent to the levees. In the highly urbanized reaches, many of the landside trees and shrubs are associated with landscape plantings in yards, parks, and public rights of way. Wetland vegetation appears to line the channel in places.

Smith Canal

Smith Canal is surrounded by urban residential areas, including hard-scaping (sidewalks) and some landscape plantings adjacent to the water's edge. Near the confluence of the canal with the San Joaquin River, there is a public park, including a picnic area, boat launch ramp and associated infrastructure. There is an irrigated lawn and a mixture of native and non-native trees and shrubs. Wetland vegetation is prevalent at the water's edge and non-native invasive water plants inhabit the "bay" near the boat launch ramp. Invasive waterweeds occupy much of the inlet in the vicinity of the boat launch ramp.

French Camp Slough and Duck Creek

Levees along Duck Creek are clear of trees and shrubs. Adjacent lands are largely in agriculture with urban development beginning to extend into these lands. French Camp Slough upstream of the confluence with Duck Creek is very similar in character to Duck Creek. Levees are free of trees and shrubs and adjacent lands are in agriculture with urban lands extending towards the levee slough.

The lower reaches of French Camp Slough (between Duck Creek and the San Joaquin River) are surrounded landward by urban development. The Weston Ranch residential development is immediately to the south in the northern portion of RD 17. A municipal golf course extends adjacent to the northern bank/levee of French Camp Slough in Central Stockton. Between the north and south French Camp Slough levees is an "island" of land that is in agriculture. The perimeter of this island contains a fairly thick margin of trees and shrubs.

In the lower French Camp Slough reach, the levee crown includes a paved road. The landside levee slope and toe are mostly devoid of vegetation. There are some annual grasses and herbs. These are largely non-native weedy plants. Where trees and shrubs are present within the landside easement, they are mainly landscape plantings associated with public rights of way and private yards. The waterside levee slope and easement have trees and shrubs throughout their length, being quite dense in some areas. Trees include native valley oak, box elder, cottonwood, black walnut, and willows. Elderberry shrubs, poison oak, patches of dead willow shrubs, and snags are present. In the canal between the RD 17 levee and the mid-channel island to the north, wetland plants are abundant. These include tules, nut sedges, and tule potato. Non-native English walnut trees, water hyacinth, and mistletoe are also present.

1.6 Potential Project Impacts

During PED the levees will undergo intensive engineering evaluation to determine their suitability for a variance to Engineer Technical Letter (ETL) 1110-2-583. A vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. Based upon the information available at this time, and using engineering judgment, it is estimated that 50% of the existing vegetation on the lower waterside slope and within the waterside easement may be allowed to remain and almost none of the vegetation on the landside levee slope or within the landside easement would be allowed to remain. A vegetation variance would reduce adverse project impacts on vegetation and wildlife since without a variance, all woody vegetation would be removed. In addition, existing infestations of invasive weeds has an influence on hydraulic roughness during high-flow events, decreases the capacity of the floodway, and adversely affects bank erosion and sedimentation processes. The Corps would remove the noxious weeds from the various plant communities prior to construction. However, even with the reduced impacts provided by the vegetation variance and the benefits of noxious weed removal efforts, vegetation impacts throughout the project area would occur in the proposed construction footprint.

For this region, impacts to better quality habitat have a much greater effect on ecosystem function because of the degree of degradation and fragmentation present within the system. In many cases the proposed project would be removing the only habitat available for long stretches of the waterways, and proposes compensating for this habitat off site. Permanent removal of this higher quality habitat would also result in the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including threatened and endangered species;
- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;
- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

Additionally, habitat in the lower quality areas may not require as much mitigation, or in some cases no mitigation could be justified at all. For the Recommended Plan, The estimated impacts for the habitats discussed above and special-status species impacts as established in the BOs are shown below in Table 2. The total number of acres affected would be refined during the design phase.

The listed habitat types represent all estimated habitat impacts associated with the project, with the exception of agricultural fields. Agricultural impacts are not included because they are addressed under the project's Real Estate Plan and are not addressed further in this HMMAMP. The habitat types listed in Table 2 are components of habitat for special status species listed under the Federal Endangered Species Act (16 U.S.C. 1531 *et seq.*), and are required compensation established in the USFWS and NMFS Biological Opinions, with the exception of wetland, grassland, and riparian habitat impacts.

Table 2. Habitat Impacts for the LSJR Study Recommended Plan

	GGS Upland[1] (acres)	GGS Aquatic[1] (acres)	Riparian (acres)	SRA Habitat[1] (linear feet)	Elderberry Shrubs[1]	Delta Smelt Shallow Water[1] (acres)	Delta Smelt Open Water[1] (acres)	Wetland (acres)	Grassland (acres)
Mosher Slough		0	21.5	0		0	0	3	
Delta Front		0.5	30.75	0		123	1	4	
Calaveras River		0	52	7,804		0	0	1.75	
San Joaquin River		0	17	6,317		0	1	0	
French Camp Slough		0	15.75	5,509		0	0	0	
Duck Creek		0	2	0		0	0	2	
TOTAL	Permanent 35.12[2] acres Temporary 111.5 acres	Permanent 0.5 acres Temporary 6 acres	139	19,630	44 Shrubs/ 96 stems[3]	123	2	10.75	8.87[4]

[1] Endangered Species Act Compensation per USFWS and NMFS Biological Opinions. See EIS or BO for effects analysis.
[2]Impacts are at Fourteenmile Slough and Duck Creek
[3]Impacts are at Fourteenmile Slough, Calaveras River, and San Joaquin River
[4]Impacts are at Mosher Slough and Delta Front

In order to determine the appropriate level of mitigation for habitat mitigation (wetlands and riparian habitat impacts), a habitat evaluation and cost effectiveness/incremental cost analysis (CE/ICA) were conducted. The habitat evaluation quantifies the relative value and change in value of the habitat impacted by the project, and the CE/ICA evaluates mitigation alternatives to determine the most cost effective plan for the Government. These evaluations are described in Section 1.7 below. It should be noted that during the design phase, HEPs will be conducted on smaller reaches to account for and better quantify variations in habitat quality throughout the project area, and to ensure that the mitigation is applied appropriately throughout the project area.

1.7 Habitat Evaluation

For the purposes of evaluating the impacts of the LSJR study Recommended Plan on fish and wildlife resources in the project area, and in the spirit of SMART Planning, a Habitat Evaluation Procedures (HEP) was produced with a reliance on existing photographic and aerial imagery to establish a reference baseline for the habitat conditions in the study area. The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on riparian, wetland, and grassland habitats were quantified and compensation needs (in terms of acreage) for the project were determined.

The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated. A combination of three Corps Ecosystem Planning Center of Expertise approved “blue book” HSI models were used to best approximate the different habitat types in the study area:

- The yellow warbler HSI model (USFWS 1982) was applied to shrubby riparian and wetland habitats;
- The black shouldered kite HSI model (USFWS 1987) was applied to grassland habitat; and,
- The mink HSI model (USFWS 1986) was applied to woody riparian habitat.

Table 3 describes the habitat variables established within each HSI model, and how the data was collected for these variables. For the LSJR study Recommended Plan, data was estimated visually and using Google Earth.

Table 3. HSI Models, Variables, and Data Collection Methods.

HSI Model and Cover-Type	HSI Model Variables	Data Collection Method
Yellow Warbler Shrubby Riparian Habitat Wetlands and Waters of the U.S.	V1 - % shrub crown cover	Visual and aerial photo estimation
	V2 - Average height of shrub canopy	Visual and aerial photo estimation
	V3 - % of hydrophytic shrub canopy	Visual and aerial photo estimation
Black Shouldered Kite Grasslands	V1 - % of tall grasslands	Visual and aerial photo estimation
	V2 - % of short grasslands	Visual and aerial photo estimation
	V3 - % of rush	Visual and aerial photo estimation
	V4 - % of salt marsh	Visual and aerial photo estimation
Mink Woody Riparian Habitat	V1 - % canopy cover within 100m of waters edge	Visual and aerial photo estimation
	V2 - % shoreline cover within 1m of water’s edge	Visual and aerial photo estimation

1.7.1 HEP Project Impact Assessment

For the purposes of this HEP, each waterway in the study area was evaluated to determine the most prominent habitat types on that waterway. In order to account for variations in habitat quality, the riparian habitat was split into shrubby riparian habitat versus woody riparian habitat; waterways with more mature, woody vegetation were evaluated by the Mink model, while waterways with more shrubby vegetation were evaluated using the yellow warbler model. Table 4 displays the acreages of each habitat type by HSI model. Some of the waterways (Delta Front and Mosher Slough; French Camp Slough and Duck Creek) were combined together from the acreages displayed in Table 2 for the purposes of this analysis.

Table 4. Acreages of Habitat Types in the LSJR Study Area.

Waterway	Shrubby Riparian Habitat (Yellow Warbler)	Wetlands and Waters of the U.S. (Yellow Warbler)	Woody Riparian Habitat (Mink)	Grassland (Black Shouldered Kite)
Mosher Slough, Delta Front	52.25	7	0	8.87
Calaveras River	0	1.75	52	0
San Joaquin River	0	0	17	0
French Camp Slough & Duck Creek	17.75	2	0	0
Total	70	10.75	69	8.87

The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU). The Average Annual Habitat Units (AAHUs) over the period of analysis can then be calculated and used to determine mitigation needs.

Habitat Quantity (acres) x Habitat Quality (HSI) = Habitat Value Unit

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. Four Target Years (TY) were projected over the period of analysis:

- TY0 is the baseline condition prior to impacts/mitigation implementation.
- TY1 is one year following the impact/mitigation implementation.
- TY25 is 25 years following the impact/mitigation implementation.
- TY50 is 50 years following the impact/mitigation implementation, and is considered the end of the period of analysis.

The future HSI values were projected by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the three HSI models based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for each HSI model for the LSJR study area without project can be seen in Tables 5 to 7 below.

Table 5. HSI Variables for the Black Shouldered Kite Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT									
Time	**Variables**				**Suitability Index**				**Output**
	V1	**V2**	**V3**	**V4**	**SI-V1**	**SI-V2**	**SI-V3**	**SI-V4**	**HSI**
TY0	10%	65%	25%	0%	1	.5	.3	.25	.5
TY1	10%	65%	25%	0%	1	.5	.3	.25	.5
TY25	10%	65%	25%	0%	1	.5	.3	.25	.5
TY50	10%	65%	25%	0%	1	.5	.3	.25	.5
HSI = 1(V1) + .5(V2) + .3(V3) + .25(V4)									

Table 6. HSI Variables for the Yellow Warbler Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	60%	3	40%	1	1	.5	.83
TY1	60%	3	40%	1	1	.5	.83
TY25	60%	4	40%	1	1	.5	.83
TY50	60%	4.5	40%	1	1	.5	.83
HSI = (V1*V2*V3)^1/3							

Table 7. HSI Variables for the Mink Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	
TY0	40%	60%	.4	.6	.5
TY1	40%	60%	.4	.6	.5
TY25	45%	65%	.45	.65	.55
TY50	50%	70%	.5	.7	.6
HSI = (SIV1*SIV2)^1/2					

The without project condition tables (Tables 5 to 7 above) on average show medium existing habitat quality for grassland and woody riparian habitat (0.50 and 0.54 respectively) while shrubby riparian habitat quality was relatively high at 0.83. However, there is substantial variability in habitat quality along each waterway within the project area. For the purposes of this habitat evaluation, an average overall habitat value was calculated for each waterway.

The assumptions for each HSI model for the LSJR study with project impacts can be seen in Tables 8 to 10 below.

Table 8. HSI Variables for the Black Shouldered Kite Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT									
Time	**Variables**				**Suitability Index**				**Output**
	V1	**V2**	**V3**	**V4**	**SI-V1**	**SI-V2**	**SI-V3**	**SI-V4**	**HSI**
TY0	8%	67%	25%	0%	1	.5	.3	.25	.49
TY1	8%	67%	25%	0%	1	.5	.3	.25	.49
TY25	10%	65%	25%	0%	1	.5	.3	.25	.5
TY50	10%	65%	25%	0%	1	.5	.3	.25	.5
HSI = 1(V1) + .5(V2) + .3(V3) + .25(V4)									

Table 9. HSI Variables for the Yellow Warbler Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	30%	2	30%	.5	1	.38	.62
TY1	35%	2.5	30%	.55	1	.38	.64
TY25	50%	4	38%	.8	1	.44	.75
TY50	60%	4.5	40%	1	1	.5	.83
HSI = (V1*V2*V3)^1/3							

Table 10. HSI Variables for the Mink Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	25%	45%	.25	.45	.35
TY1	25%	50%	.25	.5	.375
TY25	40%	60%	.4	.6	.5
TY50	50%	70%	.5	.7	.6
HSI = (SIV5*SIV6)^1/2					

The with project condition tables (Tables 8 to 10 above) on average show a reduction in habitat quality for all habitats in the study area following project construction. Tables 11 through 14 below applies the HSI values from the tables above to each habitat type with the resulting habitat units (HUs) under the with and without project conditions.

Table 11. Target Year Habitat Conditions for Shrubby Riparian Habitat.

Condition	**Target Year**	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	70	.62	43.4
	TY 1	0	0	0
	TY 25	35	.75	26.25
	TY 50	50	.83	41.5
Without Project Condition	TY 0	70	.83	58.1
	TY 1	70	.83	58.1
	TY 25	70	.83	58.1
	TY 50	70	.83	58.1

Table 12. Target Year Habitat Conditions for Wetlands.

Condition	**Target Year**	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	10.75	.62	6.66
	TY 1	0	0	0
	TY 25	1.5	.75	1.12
	TY 50	3	.83	2.49
Without Project Condition	TY 0	10.75	.83	8.92
	TY 1	10.75	.83	8.92
	TY 25	10.75	.83	8.92
	TY 50	10.75	.83	8.92

Table 13. Target Year Habitat Conditions for Woody Riparian Habitat.

Condition	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	69	.35	24.15
	TY 1	0	0	0
	TY 25	0	0	0
	TY 50	0	0	0
Without Project Condition	TY 0	69	.5	34.5
	TY 1	69	.5	34.5
	TY 25	69	.55	37.95
	TY 50	69	.6	41.4

Table 14. Target Year Habitat Conditions for Grassland.

Condition	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	8.87	.49	4.35
	TY 1			

50The net impact represents the total estimated value for the impacted acreage in the study area.

Table 15. HEP Results – Net Project Impacts.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian	Grassland
AAHUs With Project	23.67	1.24	0.24	24.67
AAHUs Without Project	58.1	8.92	37.91	4.43
Net Impact (AAHUs)	-34.43	-7.68	-37.67	+20.24

The HEP results in Table 15 show a net benefit to grasslands within the project area. This is primarily because the negative impacts to riparian habitat result in a transition of levee slope habitat within the project area from riparian habitat to grassland. Since there would be an increase in grassland acreages within the project area, and the costs for reseeding the levee slopes are a construction cost rather than a mitigation cost, grasslands will not be discussed further in this habitat assessment. However, the monitoring requirements for GGS Upland habitat, which consists of grasslands within 200 feet of GGS Aquatic habitat, are discussed in Section 2.1 below.

1.7.2 HEP Mitigation Site Assessment

In order to determine the appropriate quantities of mitigation justified for the LSJR Study, an assessment was conducted to assess the value of the habitat available from a mitigation bank and habitat created at a potential nearby offsite mitigation area. For the purposes of project planning, it is assumed that credits would be purchased from the Cosumnes Floodplain Mitigation Bank. Credits are currently available at the Cosumnes Floodplain Mitigation Bank in the quantities needed for project impacts, and the impacts are within the approved service area of the bank. Based on the California Department of Fish and Game's (CDFG) Report to the Legislature on California Wetland Mitigation Banking (CDFG 2012), it was reported that there is a total of 471.71 total acres of habitat at the Cosumnes Floodplain Mitigation Bank, which equates to 458.74 total credits available. Based on the estimates in the CDFG report, it is assumed that the habitat at the bank has a baseline HSI value of 0.97. Tables 16 through 18 below project the change in HSI value at the mitigation bank over the period of analysis and calculates the total HUs for the target years during the period of analysis.

The acreage displayed in Tables 16 through 18 were calculated by running the HEP on a variety of scenarios in order to come up with a solution that was equivalent to the impact in AAHUs. Only the equivalent results are shown below.

Table 16. Target Year Habitat Conditions for Shrubby Riparian Habitat at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	34.88	.97	33.83
TY 1	34.88	.97	33.83
TY 25	34.88	.99	34.53
TY 50	34.88	1.0	34.88

Table 17. Target Year Habitat Conditions for Wetlands at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	7.78	.97	7.55
TY 1	7.78	.97	7.55
TY 25	7.78	.99	7.70
TY 50	7.78	1.0	7.78

Table 18. Target Year Habitat Conditions for Woody Riparian Habitat at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	38.16	.97	37.01
TY 1	38.16	.97	37.01
TY 25	38.16	.99	37.77
TY 50	38.16	1.0	38.16

The total AAHUs for the mitigation bank are shown in Table 19 below. The results in Table 19 demonstrate that the project impact in AAHUs would be fully mitigated through the purchase of 34.43 mitigation bank credits of shrubby riparian habitat (riparian floodplain habitat at the bank), 7.68 credits of wetland habitat, and 37.67 credits of woody riparian habitat (riparian forest habitat at the bank).

Table 19. HEP Results – Mitigation Bank.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian
AAHUs	34.43	7.68	37.67
*Net Impact**	-34.43	-7.68	-37.67

* Net impact as displayed in Table 17

Additionally, a HEP was conducted on a potential off-site mitigation site to determine the cost effectiveness of different mitigation alternatives. The off-site mitigation site was assumed to be located within the Delta Front region of the project area on the landside of the levees with a baseline condition of fallow farm fields. There are multiple properties in this portion of the study area that include these characteristics. If this mitigation alternative is selected, real estate negotiation would occur to determine the specific location of the off-site mitigation area. Tables 20 and 21 display the projected HSI calculations for the future without project condition of the potential mitigation site.

Table 20. HSI Variables for the Yellow Warbler Without Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITHOUT-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	15%	1	0%	0.2	0.5	.1	0.22
TY1	15%	1	0%	0.2	0.5	0.1	0.22
TY25	15%	1	0%	0.2	0.5	0.1	0.22
TY50	15%	1	0%	0.2	0.5	0.1	0.22
HSI = (V1*V2*V3)^1/3						Average	0.22

Table 21. HSI Variables for the Mink Without Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITHOUT-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	15%	5%	.25	.05	0.11
TY1	15%	5%	.25	.05	0.11
TY25	15%	5%	.25	.05	0.11
TY50	15%	5%	.25	.05	0.11
HSI = (SIV5*SIV6)^1/2					

Tables 22 and 23 display the projected HSI calculations for the mitigation site projected for the period of analysis.

Table 22. HSI Variables for the Yellow Warbler With Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	15%	1	0%	.2	0.5	.1	0.22
TY1	20%	1.5	15%	.25	0.8	.2	0.34
TY25	60%	4	40%	.85	1	.45	0.73
TY50	65%	4.5	45%	.9	1	.5	0.77
HSI = (V1*V2*V3)^1/3							

Table 23. HSI Variables for the Mink With Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITH-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	15%	5%	.25	.05	0.11
TY1	20%	10%	.3	.1	0.17
TY25	65%	65%	.8	.6	0.69
TY50	75%	75%	1.0	.7	0.84
HSI = (SIV5*SIV6)^1/2					

Tables 24 through 26 below projects the change in HSI value for the mitigation site over the period of analysis and calculates the total HUs for the target years during the period of analysis.

Table 24. Target Year Habitat Conditions for Shrubby Riparian Habitat for Off-Site Mitigation.

	Target Year	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	82.48	0.22	18.14
	TY 1	82.48	0.34	28.04
	TY 25	82.48	0.73	60.21
	TY 50	82.48	0.77	63.51
Without Project Condition	TY 0	82.48	0.22	18.14
	TY 1	82.48	0.22	18.14
	TY 25	82.48	0.22	18.14
	TY 50	82.48	0.22	18.14

Table 25. Target Year Habitat Conditions for Wetlands for Off-Site Mitigation.

	Target Year	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	18.37	0.22	4.04
	TY 1	18.37	0.34	6.24
	TY 25	18.37	0.73	13.41
	TY 50	18.37	0.77	14.14
Without Project Condition	TY 0	18.37	0.22	4.04
	TY 1	18.37	0.22	4.04
	TY 25	18.37	0.22	4.04
	TY 50	18.37	0.22	4.04

Table 26. Target Year Habitat Conditions for Woody Riparian Habitat for Off-Site Mitigation.

	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	78.18	0.11	8.60
	TY 1	78.18	0.17	13.29
	TY 25	78.18	0.69	53.94
	TY 50	78.18	0.84	65.67
Without Project Condition	TY 0	78.18	0.11	8.60
	TY 1	78.18	0.11	8.60
	TY 25	78.18	0.11	8.60
	TY 50	78.18	0.11	8.60

The total AAHUs with and without project for the mitigation site are shown in Table 27 below. Table 27 shows that the project impacts would be fully mitigated through the off site creation of 52.57 acres of shrubby riparian habitat, 11.71 acres of wetland habitat, and 46.26 acres of woody riparian habitat.

Table 27. HEP Results – Off-Site Mitigation Creation.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian
AAHUs With Project	52.57	11.71	46.26
AAHUs Without Project	18.14	4.04	8.60
Net Habitat Increase	34.43	7.67	37.66
Net Impact (AAHUs)*	*-34.43*	*-7.68*	*-37.67*

* Net impact as displayed in Table 17

1.7.3 Cost Effectiveness/Incremental Cost Analysis

To determine whether the proposed mitigation amounts were cost effective, a Cost Effectiveness/Incremental Cost Analysis (CE/ICA) was conducted on habitat mitigation that is not associated with threatened and endangered species, which includes the riparian and wetland impacts described in Table 2 above. The CE/ICA report is included with this document as Appendix A. The HEP results shown in Tables 15, 19, and 27 above were incorporated into the CE/ICA.

The cost for off-site mitigation site creation and mitigation bank credits were calculated to replace the value of the impacted habitat in AAHUs in kind. The total cost of the mitigation implementation was then annualized, and the CE/ICA was conducted using the Corps certified IWR Plan to analyze the AAHUs and annual cost of each habitat type under the mitigation bank and off-site mitigation scenarios.

IWR Plan generated 27 alternatives using different combinations of the six increments of mitigation inputted into the model. The CE/ICA determined that four of these alternatives were the Government's Best Buy alternatives. These four alternatives included:

- No action;
- Implementing only woody riparian mitigation at a mitigation bank;
- Implementing only woody riparian and shrubby riparian mitigation at a mitigation bank; and,
- Implementing all three habitats at a mitigation bank.

All three off-site mitigation site creation alternatives were found to not be cost effective for the Government. This was primarily due to the increased costs associated with the acquisition of real estate to create the off-site mitigation area.

The LSJR Study proposes to mitigate for impacts to shrubby riparian, woody riparian, and wetland habitats through the purchase of credits at a mitigation bank to replace the value of the habitat lost in kind, as displayed in the above HEP analysis. The proposed habitat mitigation described above was determined to be justified, based on the significance of the riparian and wetland habitat resources being impacted by the proposed project, and the results of the CE/ICA.

1.8 Proposed Mitigation Measures

The preparation of mitigation plans, including objectives, plan design, determination of success criteria, and monitoring needs would be coordinated with Federal and State resource agencies to the greatest extent practicable. Mitigation objectives are specific actions to be taken to avoid and minimize adverse affects, such as best management practices, compliance with Federal and State regulatory laws, and environmental commitments. Mitigation objectives include the identification of specific amounts of mitigation justified to compensate for remaining unavoidable losses.

Items below present a summary of environmental commitments that the Corps would implement as part of the LSJR study Recommended Plan to mitigate by avoiding and minimizing impacts and to meet the requirements, terms and conditions specified in the BOs.

- During PED, the Corps Sacramento District will conduct appropriate engineering investigations to determine the suitability of Recommended Plan levees for a variance to ETL 1110-2-583 in order to retain some woody vegetation on the lower waterside levee slope and within the waterside easement. All woody vegetation would be removed from the landside levee slopes and easement. It is estimated that 50% of the existing woody vegetation on the lower waterside slope and within the waterside easement may be allowed to remain. This estimate serves as the basis for the Section 7 ESA consultations and BOs. The variance approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well documented approaches. Disturbance or removal of trees or larger woody vegetation would be replaced with native riparian species, outside of the vegetation free zone, as established in the ETL.
- Vegetation removal, particularly tree removal, would be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.
- Construction would be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May or June through October, depending on the species present on a site-specific basis. If construction needs to extend into the timeframe that species are present, the Corps would coordinate with the resource agencies.

In addition to the mitigation measures described above, the Corps would implement compensatory mitigation for the impacts to ESA species shown in Table 2. The mitigation acreages for LSJR study were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types for ESA compensatory mitigation include: SRA, GGS, VELB, and Delta smelt shallow and open water.

Table 28. Proposed Mitigation for the Recommended Plan.

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/ Compensation (Acres/Linear Feet)	Mitigation Cost
GGS Upland GGS Aquatic	111.5 Acres 6 Acres	Single Construction Season	111.5 acres site restoration 6 acres site restoration	Hydroseeding/ Relocation of drains – Construction Cost
GGS Upland GGS Aquatic	12.5 Acres 0.5 Acres	Permanent	35.12 acres bank credit 1.5 acres bank credit	$2,107,200 $90,000
Riparian	139 Acres	Permanent	72.13 bank credits	$5,409,750
Shaded Riverine Aquatic Habitat (ESA Fish Species)	19,630 LF	Permanent	58,890 bank credits	$5,594,550
Shallow Water Habitat (ESA Fish Species)	234 Acres	During operation of closure structure	123 acres bank credit	$15,990,000
Elderberry Shrubs	41 Shrubs/ 96 stems	Permanent	14 Acres created onsite, plus monitoring and adaptive management[1]	$2,292,000[3]
Open Water	4 Acres	Temporary	2 acres bank credits	$260,000
Wetlands	10.75 Acres	Permanent	7.68 bank credits	$998,400
			Total	**$32,742,000**
			Total w/ Contingency [2]	**$45,184,000**

[1] Monitoring and adaptive management costs are detailed in Chapter 3 of this HMMAMP.
[2] As displayed in Total Project Cost Summary
[3]Elderberry mitigation includes real estate acquisition for 14 acres at $18,000 per acre

Table 28 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation in total acreage per the USFWS and NMFS BOs and the recommendations of the USFWS Coordination Act Report, and projected costs as estimated according to existing mitigation prices. Currently, permanent impacts to GGS uplands and aquatic habitat, riparian, SRA, Delta smelt shallow water, open water, and wetland habitats are proposed to occur at a mitigation bank. Valley elderberry longhorn beetle mitigation is proposed to occur on site, as well as restoration of single season temporary impacts to GGS habitats. Further details of the costs per acre for each habitat type are included in Appendix A.

Restoration of GGS upland habitat for single season temporary impacts includes hydroseeding of disturbed soil surfaces such as levee slopes to prevent erosion and restore upland habitat for giant garter snake. USFWS recommends a mix of at least 20 to 40 percent native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.); 2 to 10 percent native forbs; 5 percent rose clover (*Trifolium hirtum*); and 5 percent alfalfa (*Medicago sativa*). Approximately 40 to 68 percent of the mixture may be non-aggressive European annual grasses such as wild oats (*Avena sativa*), wheat (*Triticum* ssp.), and barley (*Hordeum vulgare*). The Corps will not include aggressive non-native grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix (USFWS 1997).

1.9 Location of Mitigation and Compensation Sites

WRDA 2007 Section 2036(c) directs the Corps to, where appropriate, first consider the use of an approved mitigation bank to compensate for wetland impacts. Credits for additional habitat types, including riparian zones, is also permitted, if credits are available and the use of them is deemed appropriate. As discussed above, the Corps proposes to purchase credits at a local mitigation bank for permanent impacts to GGS uplands and aquatic habitat, riparian, SRA, Delta smelt shallow water, open water, and wetland habitats. As a result, the mitigation bank would be responsible for all site establishment, monitoring, adaptive management measures, and for achieving mitigation success. Therefore, this mitigation plan addresses only the habitat types currently proposed for habitat creation: valley elderberry longhorn beetle habitat and its associated riparian habitat, and restoration of onsite temporary impacts to GGS upland habitat.

The proposed mitigation site for VELB and associated riparian habitats is a 14 acre site along Fourteenmile Slough. This site consists of the acreage created by the proposed levee setback. Proposed plantings for this site would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Since this mitigation site is associated with ESA mitigation for the Federally-threatened VELB, it is not included in the above HEP analysis. However, since it will be habitat created and monitored by USACE, it is evaluated in the Monitoring and Adaptive Management sections of this HMMAMP below.

The Corps is committed to implementing project conservation and mitigation as detailed in the BOs, however site selection and real estate coordination has not occurred at this time for onsite and offsite mitigation and would be determined during the design phase of the project. This HMMAMP will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans. The HMMAMP will be coordinated with USFWS and NMFS during the design phase per the terms and conditions of the Biological Opinions and updated as needed.

1.10 Compensation Timing

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to targeted species from designated compensation sites. For example, compensation time would be the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment to provide habitat for fish species. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283). Additionally, ER 1105-2-100, Appendix C states that authorized ecological resource mitigation activities and features should occur before construction of the project, concurrent with the acquisition of lands, or concurrent with the physical construction of the project.

2.0 MITIGATION AND MONITORING STRATEGY

The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Conceptual mitigation proposals are based on the habitat impacts described above. Performance standards are established below for each habitat type, and monitoring would be conducted with the intent of meeting those standards. Over the 3 to 5 year site establishment period, improvements in field and analytic techniques may lead to changes in the monitoring methodology. While this vegetation and habitat monitoring methodology protocol builds on past years' experiences, it is likely that other opportunities for improvement will be identified in the future that should be incorporated into the protocol. In the future, there may be a determination that specific performance standards have been met and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation.

Monitoring must be closely integrated with the adaptive management. The application of adaptive management principles to mitigation projects by modifying mitigation objectives during the monitoring period is a reasonable and foreseeable alternative. Unrealistic expectations or inaccurate assumptions can lead to the establishment of inappropriate project objectives. It is possible that a decision to modify success criteria might be reached based on results after several years of monitoring. In addition to modifying project objectives, there is a potential for changes to or adaptation of management actions based on monitoring results. The purpose of adaptive management is to enable strategic changes to improve the mitigation sites to functioning habitat.

Vegetation and habitat variable monitoring and data collection would occur by a qualified biologist, botanist, or habitat restoration specialist using the protocol described below and shown in Table 29 to determine the success of riparian revegetation plantings and overall habitat development. In accordance with WRDA 2007 Section 2036(a), monitoring shall continue until it has been demonstrated that the mitigation has met the ecological success criteria, as documented by the District Engineer and determined by the Division Commander.

Table 29. Summary of On-site Habitat Types and Monitoring Recommendations.

Habitat	Monitoring Variable	Method to be Used	Spacing/number of Samples	Data to be Collected	Success Criteria
GGS Upland	Total Herbaceous Species Cover	Visual estimates of cover within 1 square meter (m^2) sampling quadrats	One quadrat randomly located in each planting zone	Herbaceous species composition, total cover, and observation of GGS	Meeting 75% native species present and 95% overall cover onsite within 1 year
Riparian Habitat	Vegetation Species Cover (Ground, Midstory, and Canopy)	Line-intercept estimates of ground and overhead canopy cover with visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
Elderberry	Elderberry and Native Vegetation Health and Vigor, survival of elderberry shrubs (VELB habitat)	Visual assessment of vegetation health and vigor; census of VELB and exit holes	Total census of elderberry shrubs and native vegetation, census of VELB and exit holes	Total survival of elderberry and native vegetation, census of VELB and exit holes	Survivability of 60% of shrubs*

*60% survivability is the established survival criteria for elderberry shrubs in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (1999)

The project's compensation objective is to directly mitigate for the loss of habitat value and function that results from construction impacts. This plan focuses on establishing successful and diverse habitats that provide an ecological value consistent with mature existing habitat conditions in the study area. The specific habitats focused on within the sections below are the habitats that would be created by the Corps on-site or off-site, including GGS upland habitat and habitat for VELB. In addition, mitigation sites would be created which present a combination of riparian, oak woodland, and SRA habitats, which are highly related and provide value to a number of listed species, including VELB, Western yellow-billed cuckoo, and fish species.

2.1 GGS Uplands Mitigation

2.1.1 Objectives and Implementation Strategy

The primary objective of upland habitat mitigation is to restore upland refugia habitat for the giant garter snake (*Thamnophis gigas*) (GGS) in a manner consistent with adjacent equitable habitat. Upland refugia habitat is generally considered native grasslands with space appropriate for basking, cover, and retreat sites for GGS. Upland refugia is also considered higher elevation areas for cover and refuge from flood waters. Upland refugia restoration would take place on grasslands adjacent to GGS wetland habitat as well as levee slopes for higher elevation refuge. These conservation and restoration measures are taken from the Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat (USFWS, 1997).

Restoring GGS habitat includes minimizing the potential impacts of project activities to the existing habitat. Use of silt fencing and protective mats to prevent runoff and reduce the possibility of individual GGS from entering the project area is recommended. Designation of environmentally sensitive areas and providing worker awareness training is also recommended. Construction activities should be 200 feet from GGS aquatic habitat, and should occur between May 1 and October 1. Project areas should be surveyed for GGS 24 hours prior to ground disturbing activities, and surveys should be repeated if a lapse in construction activity of two weeks or greater has occurred. If aquatic habitat must be removed as part of the construction activities, any dewatering would occur after April 15 and dewatered habitat would be left dry for at least 15 consecutive days.

Upon the completion of construction, the area would be regraded to the preexisting contour. Upland refugia would be hydroseeded with native grasses. USFWS recommends a mix of native grass seeds such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Additional native plant seeds consistent with adjacent habitat may be used at the discretion of USFWS. Permanent irrigation would not need to be established for this habitat type, however the site would require periodic watering in drought conditions (USFWS 1997).

2.1.2 Success Criteria

Monitoring of GGS upland habitat would focus on: (1) the percentage cover of native species, and (2) the percentage of overall vegetative cover. The restored habitat would be considered successful if 75 percent of the vegetation on site consists of native species. Additionally, the overall vegetative cover on site must be 95 percent.

2.1.3 Mitigation Monitoring Strategy

Restored habitat should be monitored for one year following implementation. Surveys would involve a general overview of the condition of the site, an estimate of ground cover, and a passive (observation only) GGS survey to determine potential habitat use. A ground cover survey would occur to determine the ground cover percent of native and non-native species. Ground cover surveys, if determined by the Corps to be needed to evaluate the success of the mitigation area, would involve the use of a one square meter quadrat placed haphazardly in the restored areas. Once placed, all herbaceous vegetation within the quadrat would be recorded to species level. The percent of cover by native and non-native species would be determined in addition to the percent of total cover.

Monitoring reports documenting the restoration effort would be submitted to USFWS upon completion of the restoration implementation and one year from restoration implementation. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, plantings (if specified), and justification of any substitutions to USFWS recommended guidelines. Monitoring reports would also include recommendations for additional remedial actions, if necessary.

2.1.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of GGS upland habitat.

  Trigger: 95% cover is not achieved within one year.

- Desired Outcome: Decrease percent of non-native invasive species that outcompete natives.

  Trigger: Non-native percent cover of more than 25% within one year.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for GGS upland habitat in order to adaptively manage the site for success.

- If the performance criteria are not met within one year, additional plantings and monitoring would be implemented in order to ensure that the site is successful.
- If non-native species are outcompeting the native species, measures would be implemented to manage presence of invasive species, including mowing and selective removal of non-native species at optimal times for native growth.
- If non-native species are outcompeting the native species and targets for overall cover are not being met, then revegetation of native species would occur.
- Supplemental watering if targets for overall cover are not being met.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

2.2 Riparian Habitat

2.2.1 Objectives and Implementation Strategy

The primary objective of riparian habitat mitigation is to compensate for impacted habitat types and community types, and reduce erosion rates within the alluvial floodplain. Native plant communities and streambank vegetation would be represented in species density appropriate to the surrounding area. As native vegetation matures, it helps to stabilize stream banks and shorelines; provides food, shelter, shade, and access to adjacent habitats; nursery habitat; pathways for movement by resident and nonresident aquatic, semi-aquatic, and terrestrial organisms; and improves and protects water quality by reducing the amount of sediment and other pollutants such as pesticides, organic materials, and nutrients in surface runoff. The long term goal of riparian mitigation is to provide habitat similar to the habitat that was impacted by project construction. These improvements would enhance nesting opportunities for native bird species, and provides opportunities to satisfy VELB compensation.

Riparian vegetation would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus spp.*), redbud (*Cercis Canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Native trees and shrubs provide a buffer to adjacent urban and industrial land uses, and provide habitat structure for wildlife. Leaf litter and large organic debris would create a variety of microhabitats, increasing species diversity and potentially creating a prey base for larger predators.

The riparian mitigation site would likely require fencing to protect establishing habitats from recreation, wildlife, and other potential damages. The site would have irrigation during the establishment period, and would be watered as needed until the vegetation is established and self-sustaining. Mowing would occur periodically to ensure that weed species do not shade out new plantings.

2.2.2 Success Criteria

Monitoring of riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; (3) percentage of canopy cover over water; and (4) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an qualitative inventory of wildlife species would be recorded during annual monitoring. Table 30 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

Table 30. Riparian Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent cover of native plant species	75%
Structural diversity	At least five native species contributing to 75% canopy and 50% shrub cover
Percent of canopy cover over water per LF	75%
Percent cover of non-native species	Less than 15%

2.2.3 Mitigation Monitoring Strategy

The following monitoring procedures will provide the information necessary to evaluate the success of riparian habitat mitigation. Vegetation sampling will occur annually for the duration of the monitoring period. Sampling will occur during spring months, at the peak of growing season, and will consist of permanent field monitoring plots along one or more transects either perpendicular to the river or parallel to the floodplain slope. Plots will be located randomly within each site, and the distance between plots and along transects will be site specific. Woody species with overhead canopy cover that falls along the vegetation monitoring transect, including those that were planted, have recruited naturally to the site, or were existing at the site prior to planting efforts would be recorded. Monitoring will measure percent cover of native and non-native plant species, structural diversity, and percent cover over water. Photograph stations are also important for documenting vegetation conditions. All plots and photograph stations will be documented via Global Positioning System (GPS) coordinates to maintain consistency throughout the monitoring period.

Additionally, field personnel would visually estimate the height (+/- 2 feet) of each tree and shrub that provides overhead canopy cover. Exact heights are not necessary, since there is no tree height criterion included in this protocol. Rather, approximate tree heights would be visually assessed to monitor tree growth over time. Data collected would include species name, location (feet) along the vegetation monitoring transect (upper extent of canopy and lower extent of canopy), whether the tree or shrub is planted (P), recruited (R), or existing (E), height (feet), and vigor as determined using the metric outlined in Table 31, below.

Table 31. Estimation of General Health and Vigor for Plant Species.

Visual Estimate of Foliage	Vigor Category	Value
81 percent (or greater) of foliage appears to be healthy	Excellent	4
51 to 80 percent of foliage appears to be healthy	Good	3
25 to 50 percent of foliage appears to be healthy	Fair	2
Less than 25 percent of foliage appears to be healthy	Poor	1
Dead	Dead	0

General observations, such as fitness and health of plantings, native plant species recruitment, and signs of drought stress would be noted during the surveys. Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified. A visual check of irrigation infrastructure and fencing would also be conducted. A general inventory of all wildlife species observed and detected using the mitigation site would be documented. Nesting sites and other signs of wildlife use of the newly created habitat would be recorded.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). Monitoring reports would also include recommendations for additional adaptive management measures, if necessary. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

2.2.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Increase percent vegetative cover over water per linear foot to support native fish.

  Trigger: If percent cover over water is not 30% within 3 years, and 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for riparian habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover, vegetative cover over water, and/or structural diversity are being met. Monitoring results should be used to assess the underlying cause of inadequate cover, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting varieties of species that are exhibiting the greatest growth and survival, or planting at elevations that are exhibiting the greatest growth and survival.

- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or structural diversity are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

2.3 Elderberry Shrubs

2.3.1 Objectives and Implementation Strategy

The primary objective of elderberry shrub mitigation is to compensate for the adverse effects of the project on habitat important to the Federally listed valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). Where possible, conservation areas would connect with adjacent habitat in order to prevent isolation of beetle populations. Removal, transplanting, and establishment of elderberry shrubs would be coordinated with USFWS and would follow the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999).

Elderberry shrubs with one or more stems measuring one inch or greater in diameter at ground level must be transplanted if they cannot be avoided by the proposed project. Elderberry shrubs should be transplanted when they are dormant, typically from November to the first two weeks in February. Transplanting during the non-growing season would reduce shock to the plant and increase transplantation success. Most transplants require watering through the first summer.

Elderberry stems measuring greater than one inch in diameter are habitat for the VELB, therefore trimming or removing stems would require coordination and mitigation. Each elderberry stem that is adversely affected must be replaced in the conservation area with elderberry seedlings or cuttings as specified by USFWS. Seedlings and cuttings should be obtained from local sources. If the project is in the vicinity of the conservation area, cuttings may be obtained from elderberry shrubs to be transplanted

Mitigation site planting areas must be at least 1,800 square feet for each elderberry transplant. As many as five additional elderberry plantings (cuttings or seedlings) and up to five associated native species plantings may also be planted within the 1,800 square foot area with the transplant. Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native riparian species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), box elder (*Acer negundo*), white alder (*Alnus rhombifolia*), and California button willow (*Cephalanthus occidentalis californica*) would be planted along with the elderberry shrubs. Stock of saplings, cuttings, and seedlings would be obtained from local sources. Planting or seeding the area with native herbaceous species is also encouraged. Weeds and other non-native plants would be removed by mechanical means at least once a year or at the discretion of USFWS.

No pesticides, herbicides, fertilizers, or other chemical agents would be used in or within 100 feet of the conservation area. Fencing would be placed around the conservation area during the establishment period of the elderberry shrubs. Signs would be posted on the fence stating the status of the VELB and the purpose of the habitat. The conservation area would be protected in perpetuity as habitat for the VELB. Conservation areas may be transferred to resource agencies or appropriate private organizations for long term management. Biologists and law enforcement personnel from the California Department of Fish and Wildlife and USFWS must be given complete access to the project site to monitor transplanting activities. Personnel from these agencies must also be given complete access to the conservation area to monitor the beetle and its habitat in perpetuity.

2.3.2 Success Criteria

After the first year, it is anticipated that the sites would be evaluated to determine the level of project success and apply adaptive management, if necessary. If the habitat meets the below performance standards for three consecutive years, depending on physical site characteristics, conditions should be consistent enough to estimate community composition and general success of planting efforts. Three consecutive years of success should indicate that the project sites are self-sustaining and should not require supplemental irrigation or intensive weed control. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

Monitoring of elderberry habitats would focus on a minimum survival rate of at least 60 percent of the elderberry shrubs. Within one year of discovery that survival has dropped below 60 percent, additional plantings would be installed to bring survival above this level. Monitoring of associated riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; and (3) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 32 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

Table 32. Elderberry and Associated Riparian Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent survivability of elderberry shrubs	60%
Percent cover of native riparian species	75%
Structural diversity	At least 5 native species contributing to 75% canopy and 50% shrub cover
Percent cover of non-native species	Less than 15%

2.3.3 Mitigation and Monitoring Strategy

Monitoring would be conducted annually per the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999). Two surveys would be conducted by qualified biologists between February 14 and June 30 of each year until the mitigation has met the success criteria. Surveys would include:

1. An evaluation of the elderberry plants and associated native plants on the site, including the number of plants, their size and condition.
2. Presence of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations.
3. Presence of beetle exit holes in elderberry stems, noting their locations and estimated ages.
4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.
5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

A written report presenting and analyzing the data from the project monitoring would be prepared following the surveys, and would be submitted by December 31 of the same year to USFWS. The report would address the status and progress of the transplanted and planted elderberry shrubs, associated native plants and trees, and any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area would be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed would also be included. The survival rate, condition, and size of the elderberry and associated native plants would be analyzed in the report. Real and likely future threats would be addressed along with suggested remedies and preventative measures (such as limiting public access, more frequent removal of invasive non-native vegetation, etc.).

2.3.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent survivability of elderberry shrubs.

  Triggers: If 60% survivability is not achieved during the monitoring period.

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives including elderberry shrubs.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for VELB habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover and/or survivability are being met. Monitoring results should be used to assess the underlying cause of inadequate cover or survival, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species including elderberry shrubs. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or survivability are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

3.0 ADAPTIVE MANAGEMENT COSTS

This section outlines the feasibility level adaptive management costs for the LSJR study Recommended Plan. The adaptive management plan for this project reflects a level of detail consistent with the project Feasibility Study. The primary intent is to develop adaptive management costs appropriate for and specific to the project's adaptive management measures and monitoring strategies, as described in Section 2.0 of this document. The specified management actions allow estimation of the adaptive management program costs for the project.

3.1 Monitoring and Adaptive Management Costs

The cost for implementation of this plan are provided at October 2015 price levels and prior to contingency. The cost for implementing the monitoring plan proposed above is approximately $250,000 and is shown on Table 33 below. These costs are proposed to be cost-shared rather than an O&M cost, because the mitigation being created is associated with requirements of the USFWS BO that was issued to the Corps. The conservation measures identified in the BO include monitoring requirements that the Corps proposes to implement at the cost displayed in Table 33 below.

Table 33. Monitoring Costs for the LSJR Study Recommended Plan.

Monitoring	Assumed Tasks for Monitoring	Frequency	Cost Assumptions	Total Cost for 5 Years
Vegetation Monitoring	Assume monitoring of mitigation site, including transects for percent cover of natives and non-natives, structural diversity, and canopy cover over water using transect/plot monitoring. Assume vegetation mapping, inventories of general wildlife, and observations of damage to habitat would be recorded. Assume monitoring of all parameters would be done concurrently during each monitoring event.	Annually for 5 Years	Monitoring: Cost estimate based on standard establishment contract, including monitoring cost and annual report from contractor. Assume $50,000 per year for 4 biologists to survey mitigation site	$250,000
			TOTAL MONITORING	**$250,000**

The cost for the adaptive management plan is approximately $600,000 and is shown on Table 34 below.

Table 34. Adaptive Management Costs for the LSJR Study Recommended Plan.

Adaptive Management Measures	Assumed Tasks for Adaptive Management	Cost Assumptions	Total Cost for 5 Years
Irrigation/Supplemental Water	Apply supplemental irrigation to water stressed plants	Assuming $900 per acre per year for 5 years	$63,000
Re-planting	Assume that assume 25% of vegetation may require replanting over 5 years.	Cost of vegetation was estimated at $5,000 per planted acre	$260,700
Plant Protection & Fencing	Assume 400 plant cages and 11,500 feet of fencing may be needed to surround 14 acres.	Assume $10/plant cage; $3/linear foot for fencing; plus $50,000 installation. Costs referenced from existing restoration contracts.	$88,500
Annual Report	Produce annual report	Assume $37,500 per report, annually for 5 years	$187,500
		TOTAL ADAPTIVE MANAGEMENT	**$599,700**
		TOTAL MONITORING AND ADAPTIVE MANAGEMENT	**$849,700**

The combined monitoring and adaptive management costs at October 2015 price levels, as included in the certified total project cost summary under the 06 “fish and wildlife facilities” account, total $849,000 for the Recommended Plan.

4.0 REFERENCES

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ENVIRONMENTAL ADDENDUM K

AIR QUALITY

LOWER SAN JOAQUIN FEASIBILITY STUDY

Appendix Air. Summary of RECM Results for Each Alternative

Alternative 7A -Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.3	8.8	17.7	0.3	6.7	1.9	3,661	3,487
2020	1.2	8.8	15.3	0.3	6.7	1.8	3,614	3,442
2021	1.1	8.9	12.0	0.3	6.6	1.8	3,606	3,435
2022	1.7	16.5	14.6	0.3	5.7	1.7	5,132	4,887
2023	1.4	14.1	11.6	0.3	5.4	1.5	3,535	3,367
2024	0.7	8.2	5.3	0.2	4.7	1.1	1,759	1,675
2025	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2026	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2027	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2028	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2029	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	71.19260
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 665,650.78

Alternative 7a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.1
2020	7.7
2021	6.7
2022	8.7
2023	7.5
2024	3.8
2025	3.9
2026	3.9
2027	3.9
2028	3.9
2029	3.9
SJVAPCD Threshold	10

Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
43.4%	$ 71,781.36	
34.5%	$ 49,324.53	
16.9%	$ 18,982.96	
31.6%	$ 43,285.75	
13.6%	$ 14,776.19	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 198,150.78	

	Tier 3			
	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 7B Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2026	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2027	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2028	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2029	0.6	5.9	5.0	0.3	5.3	1.3	1,812	1,726
2030	0.4	4.3	3.3	0.3	5.8	1.3	1,021	972
2031	0.4	4.0	3.0	0.2	4.7	1.1	857	816
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	94.3
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 882,163.70

Alternative 7b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.2
2026	8.2
2027	8.2
2028	8.2
2029	4.1
2030	3.3
2031	3.0
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No

Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,031.78	
40.1%	$ 62,574.95	
25.6%	$ 32,233.38	
38.8%	$ 59,172.61	
32.8%	$ 45,681.53	
28.1%	$ 36,469.46	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

	$ 321,163.70

Alternative 8A
Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,414	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	17.8	16.0	0.3	6.1	1.8	5,932	5,649
2023	1.8	17.7	14.6	0.3	6.0	1.8	5,924	5,642
2024	1.3	14.1	10.8	0.3	5.4	1.5	3,536	3,367
2025	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2026	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2027	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2028	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2029	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	90.7
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 848,062.44

Alternative 8a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.6
2023	9.5
2024	7.6
2025	5.0
2026	5.0
2027	5.0
2028	5.0
2029	5.0
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10

Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,027.94	
40.1%	$ 62,571.11	
25.6%	$ 32,229.54	
37.7%	$ 56,532.33	
31.7%	$ 43,342.13	
7.3%	$ 7,359.39	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 287,062.44	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 8B Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2026	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2027	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2028	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2029	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
2030	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
2031	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2024	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2024	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA

Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	135.0
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$1,262,584.76

Alternative 8b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.4
2026	8.4
2027	8.4
2028	8.4
2029	4.5
2030	4.5
2031	4.5
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,031.78	
40.1%	$ 62,574.95	
25.6%	$ 32,233.38	
38.8%	$ 59,172.61	
32.8%	$ 45,681.53	
28.1%	$ 36,469.46	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 327,584.76	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%
2030	61%	17%	7%	-1%
2031	61%	17%	7%	-1%

Alternative 9A Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.3	8.8	17.7	0.3	6.7	1.9	3,661	3,487
2020	1.2	8.8	15.3	0.3	6.7	1.8	3,614	3,442
2021	1.1	8.9	12.0	0.3	6.6	1.8	3,606	3,435
2022	1.7	16.5	14.6	0.3	5.7	1.7	5,132	4,887
2023	1.4	14.1	11.6	0.3	5.4	1.5	3,535	3,367
2024	0.7	8.2	5.3	0.2	4.7	1.1	1,759	1,675
2025	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2026	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2027	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2028	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2029	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	

Total Unmitigated Nox Exceeding 10 tons per year	71.2
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 665,650.78

Alternative 9a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.1
2020	7.7
2021	6.7
2022	8.7
2023	7.5
2024	3.8
2025	3.9
2026	3.9
2027	3.9
2028	3.9
2029	3.9
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox

Tier 3

	ROG	Nox	PM10	PM2.5

43.4%	$ 71,781.36
34.5%	$ 49,324.53
16.9%	$ 18,982.96
31.6%	$ 43,285.75
13.6%	$ 14,776.19
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
	$ 198,150.78

2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 9B
Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2026	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2027	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2028	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2029	0.6	5.9	5.0	0.3	5.3	1.3	1,812	1,726
2030	0.4	4.3	3.3	0.3	5.8	1.3	1,021	972
2031	0.4	4.0	3.0	0.2	4.7	1.1	857	816
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA

Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	94.3
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 882,163.70

Alternative 9b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.2
2026	8.2
2027	8.2
2028	8.2
2029	4.1
2030	2.8
2031	2.5
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10

Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
82.6%	$ 147,437.52	
80.1%	$ 124,980.70	
75.3%	$ 94,639.13	
79.6%	$ 121,578.36	
77.7%	$ 108,087.28	
76.1%	$ 98,875.21	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 695,598.19	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%
2030	61%	17%	7%	-1%
2031	61%	17%	7%	-1%

ENVIRONMENTAL ADDENDUM L

HTRW SUMMARY REPORT

LOWER SAN JOAQUIN FEASIBILITY STUDY

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9. Summary Table - South Stockton (RD-17), EDR Report
10. Phase I ESA: Lower Mormon Slough Corridor Study
11. AsbestosMap_MS59_Plate.pdf: Reported Historic Asbestos Mines, Historic Asbestos Prospects, and Other Natural Occurrences of Asbestos in California, USGS
12. Asbestos Sites Table
13. Alternative 8
14. Alternative 9
15. Alternative 10
16. EDR GIS data are available upon request

Acronym List

ASTM	American Society of Testing and Material
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREC	Controlled Recognized Environmental Condition
DTSC	Department of Toxic Substances Control (California environmental regulatory agency for soil)
DWR	CA Department of Water Resources
EDR	Environmental Data Resources (private environmental data search record storehouse)
ER	Engineering Regulation (USACE internal regulation)
ESA	Environmental Site Assessment
FS	Feasibility Study (CERCLA step)
HTRW	Hazardous, Toxic, Radiological Waste
LSJRFS	Lower San Joaquin River Feasibility Study
LUST	Leaking Underground Storage Tank
NEPA	National Environmental Policy Act (federal environmental law)
NOA	Naturally Occurring Asbestos
NPL	National Priority List (list of USEPA Superfund sites)
RCRA	Resource Conservation and Recovery Act (federal environmental law)
REC	Recognized Environmental Condition
SWRCB	State Water Resources Control Board (California environmental regulatory agency for water
TSCA	Toxic Substances Control Act (federal environmental law)
USACE	United States Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency (federal environmental regulatory agency)
UST	Underground Storage Tank

1. Introduction

This Summary Report summarizes the Hazardous, Toxic, and Radiological Waste (HTRW) sites located at or near project levees associated with Lower San Joaquin River Feasibility Study (LSJRFS). The United States Army Corps of Engineers (USACE) is conducting a Feasibility Study for three alternatives designated as Alternatives 8, 9 and 10 (Attach 13-15). This report will provide an overview of known HTRW sites located at or in the vicinity of the existing or proposed project levees which may affect the levee work.

The Study Area for this report is defined as buffered areas within 0.25 miles along 40 miles of the proposed levees identified in Alternatives 8, 9 and 10 excluding the Lower Mormon Slough Section (See Alternative 9for the location of Mormon Slough). Lower Mormon Slough section was excluded from the study area as a Phase I Environmental Site Assessment (ESA) was completed in March 2014 (Attachment 10). The levees are located near Stockton, San Joaquin County, California. Proposed levee work sites are shown in Fig 1. For the purpose of finding HTRW sites which may affect the levee construction activities including new levee and cut-off wall construction, seepage berm and seismic fixes, the HTRW study area is defined as areas within 0.25 miles from the subject levees as shown in Fig 2a.

Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects requires that a site investigation be conducted to identify and evaluate existing and potential HTRW issues. This HTRW Site Summary report was conducted in accordance with ER 1165-2-132 and ASTM 1526-05, Phase I ESA as a supplemental guidance. Regulatory database search reports and regulatory agencies' websites were reviewed and assessed for HTRW sites in the Study Area, along the 40 miles long levees proposed for new levee construction, modification and upgrades to the existing levees.

In order to identify HTRW sites in the Study Area, USACE:

a. Reviewed Federal, State, and local environmental databases;
b. Reviewed hazardous waste sites and clean-up sites in EnviroStor of California (CA) Department of Toxic Substances Control (DTSC) and GeoTracker of CA State Water Resources Control Board and ;
c. Reviewed information about Naturally Occurring Asbestos in the CA Department of Conservation website.

The author of this report assumes the data supplied by the data sources are reasonably accurate as of May 2014. The status of HTRW sites are constantly changing and new HTRW sites may be added to the regulatory databases over time. Currently unknown HTRW sites may also be located within the study area but would not be included in this report. Land or facility uses, site conditions, regulations, and other factors change over time. This report should not be relied on after 180 days of the report date. Site inspections, interviews, property records searches, and review of topographical maps and aerial photographs were not completed as part of this report but would be required after an alternative is selected.

LSJRFS Project Levees, Stockton, California Fig 1

Fig 2a

LSJRFS HTRW Study Area, Stockton, California

2. Purpose of HTRW Site Summary Report

The purpose of the HTRW Summary report is to identify known past, existing or potential HTRW sites which may affect the proposed levee construction activities at and near the project levee sites (Fig 1). Levees construction activities include but not limited to construction of new levees, improvements to the existing levees (cut-off walls, seismic fixes, seepage berms), and sea level rise protection measures to the proposed levees. The LSJRFS evaluates three proposed alternatives, Alternatives 8, 9 and 10 (See attachments 13-15).

3. Procedure of HTRW Summary Report

This HTRW Summary Report was prepared in general following ER 1165-2-132, USACE HTRW Guidance for Civil Works Projects as a guideline and ASTM 1526-05, Phase I ESA as a supplemental guidance. According to ER 1165-2-13 HTRW includes any material listed as a "hazardous substance" under the Comprehensive Environmental Response, Compensation and Liability Act, 42U.S.C. 9601 et seq (CERCLA). (See 42 U.S.C. 9601 (14).) Hazardous substances regulated under CERCLA include "hazardous wastes" under Sec.3001 of the Resource Conservation and Recovery Act, 42 U.S.C. 6921 et sew; "hazardous substances" identified under Section 311 of the Clean Air Act, 33 U.S.C. 1321, "toxic pollutants" designated under Section 307of the Clean Water Act, 33 U.S.C. 1317, "hazardous air pollutants "designated under Section 112 of the Clean Air Act, 42 U.S.C. 7412; and "imminently hazardous chemical substances or mixtures" on which EPA has taken action under Section 7 of the Toxic Substance Control Act, 15 U.S.C. 2606; these do not include petroleum or natural gas unless already included in the above categories. (See 42 U.S.C. 9601(14).) For this report, HTRW is defined in Section 4 of ER 1165-2-132 also petroleum products which often contain hazardous and toxic constituents and naturally occurring asbestos (NOA) which is often found in many counties of California.

In order to consider and evaluate three proposed alternatives (Alternative 8, Alternative 9 and Alternative 10), the HTRW Study Area was divided into three sections; NW Stockton, NE Stockton and South Stockton as shown in Fig 2b. The database search reports were obtained based on those three sections so that HTRW sites in each alternative can be easily quantified. The sections are included in the Alternatives as follows:

- **Alternative 8:** Includes all three sections: NE Stockton, NW Stockton and South Stockton sections.
- **Alternative 9:** Includes both NW Stockton and South Stockton sections (Lower Mormon Slough section is not included in this report). However, if the number of HTRW sites in the Lower Mormon Slough were included in Table 1, the total number of HTRW sites in Alternative 9 will be much greater.
- **Alternative 10:** Includes both NE Stockton and NW Stockton sections.

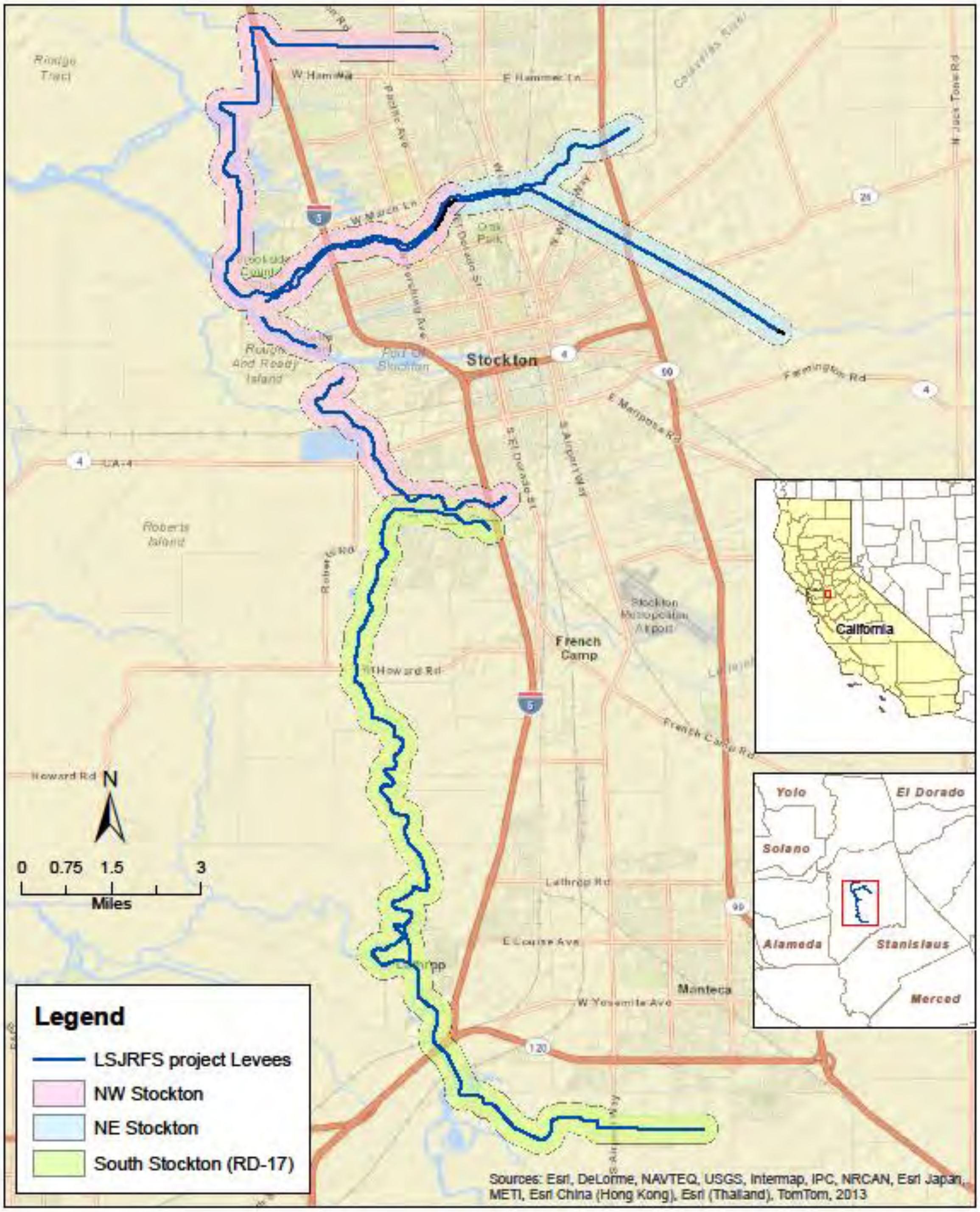


Fig 2b

LSJRFS HTRW Study Area Sections

The following sources were reviewed for HTRW sites in the HTRW Study Area (Fig 2).

1. Environmental Data Resources (EDR) Database Search Reports (included in Attachments 1-6)
2. EnviroStor website (http://www.envirostor.dtsc.ca.gov/public)
3. GeoTracker web site (http://geotracker.waterboards.ca.gov)
4. Department of Conservation (http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/index.aspx)

3.1 EDR Database Search Reports

The EDR Database Search Reports provided regulatory agency database search reports. Regulatory database search records include the following but not limited to:

Federal Records

1. TSCA (Toxic Substances Control Act)
2. CERCLIS Comprehensive Environmental Response, Compensation, and Liability Information System
3. CERC-NFRAP CERCLIS No Further Remedial Action Planned
4. COAL ASH DOE Steam-Electric Plant Operation Data
5. CONSENT Superfund (CERCLA) Consent Decrees
6. CORRACTS Corrective Action Report
7. DEBRIS REGION 9 Torres Martinez Reservation Illegal Dump Site Locations
8. Delisted NPL National Priority List Deletions
9. DOD Department of Defense Sites
10. DOT OPS Incident and Accident Data
11. EPA WATCH LIST
12. FEDERAL FACILITY Federal Facility Site Information listing
13. FEMA UST Underground Storage Tank Listing
14. FTTS FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide
15. FUDS Formerly Used Defense Sites
16. HIST FTTS FIFRA/TSCA Tracking System Administrative Case Listing
17. HMIRS Hazardous Materials Information Reporting System
18. ICIS Integrated Compliance Information System
19. LEAD SMELTERS Lead Smelter Sites
20. LIENS 2 CERCLA Lien Information
21. LUCIS Land Use Control Information System
22. MLTS Material Licensing Tracking System
23. NPL LIENS Federal Superfund Liens
24. NPL National Priority List
25. ODI Open Dump Inventory
26. PADS PCB Activity Database System
27. PCB TRANSFORMER PCB Transformer Registration Database
28. PL National Priority List
29. Proposed NPL Proposed National Priority List Sites
30. PRP Potentially Responsible Parties
31. RAATS RCRA Administrative Action Tracking System
32. RADINFO Radiation Information Database

33. RCRA-CESQG RCRA - Conditionally Exempt Small Quantity Generator
34. RCRA-LQG RCRA - Large Quantity Generators
35. RCRA-SQG RCRA - Small Quantity Generators
36. RCRA-TSDF RCRA - Treatment, Storage and Disposal
37. RMP Risk Management Plans
38. ROD Records Of Decision
39. SCRD DRYCLEANERS State Coalition for Remediation of Drycleaners Listing
40. SSTS Section 7 Tracking Systems
41. TC3923799.4s EXECUTIVE SUMMARY 2
42. TRIS Toxic Chemical Release Inventory System
43. TSCA Toxic Substances Control Act
44. UMTRA Uranium Mill Tailings Sites
45. US AIRS Aerometric Information Retrieval System Facility Subsystem
46. US BROWNFIELDS A Listing of Brownfields Sites
47. US CDL Clandestine Drug Labs
48. US ENG CONTROLS Engineering Controls Sites List
49. US FIN ASSUR Financial Assurance Information
50. US HIST CDL National Clandestine Laboratory Register
51. US INST CONTROL Sites with Institutional Controls
52. US MINES Mines Master Index File
53. 2020 COR ACTION 2020 Corrective Action Program List

State and Local Records

1. CA BOND EXP. PLAN Bond Expenditure Plan
2. CA FID UST Facility Inventory Database
3. Cortese "Cortese" Hazardous Waste & Substances Sites List
4. CUPA Listings CUPA Resources List
5. DEED Deed Restriction Listing
6. DRYCLEANERS Cleaner Facilities
7. HAULERS Registered Waste Tire Haulers Listing
8. HIST Cal-Sites Historical Calsites Database
9. HIST CORTESE Hazardous Waste & Substance Site List
10. HWP EnviroStor Permitted Facilities Listing
11. HWT Registered Hazardous Waste Transporter Database
12. LDS Land Disposal Sites Listing
13. LDS Land Disposal Sites Listing
14. LIENS Environmental Liens Listing
15. LUST Geotracker’s Leaking Underground Fuel Tank Report
16. MCS Military Cleanup Sites Listing
17. MWMP Medical Waste Management Program Listing
18. Notify 65 Proposition 65 Records
19. PROC Certified Processors Database
20. RESPONSE State Response Sites
21. RGA LF Recovered Government Archive Solid Waste Facilities List
22. RGA LUST Recovered Government Archive Leaking Underground Storage Tank
23. SCH School Property Evaluation Program
24. SLIC Statewide SLIC Cases
25. SWF/LF Solid Waste Information System
26. SWRCY Recycler Database

27. Toxic Pits Toxic Pits Cleanup Act Sites
28. VCP Voluntary Cleanup Program Properties
29. WIP Well Investigation Program Case List
30. WMUDS/SWAT Waste Management Unit Database

Tribal Records

1. INDIAN RESERV Indian Reservations
2. INDIAN ODI Report on the Status of Open Dumps on Indian Lands
3. INDIAN LUST Leaking Underground Storage Tanks on Indian Land
4. INDIAN UST Underground Storage Tanks on Indian Land
5. INDIAN VCP Voluntary Cleanup Priority Listing

Brief explanations of the above data sources are explained in Attachments 7-9.

3.2 EnviroStor

According to the EnviroStor (http://www.envirostor.dtsc.ca.gov/public/), the Department of Toxic Substances Control (DTSC) lists Cleanup Sites including Federal Superfund Sites, State Response Sites, Voluntary Cleanup Sites, School Cleanup Sites, Corrective Action Sites, Tiered Permit Sites, Evaluation/Investigation Sites, Hazardous Waste Facilities: Permitted – Operating, Post-Closure Permitted and Historical Non-Operating. EnviroStor continues to provide all existing information on permits and corrective action at hazardous waste facilities, as well as site cleanup projects. EnviroStor will now allow searches for information on completed facility inspection and enforcement actions, in addition to site investigation, site cleanup, permitting, and planned, current or completed corrective actions under DTSC's oversight. This website also provides detailed information on inspections and enforcement actions of permitted hazardous waste facilities in California since 2009.

3.3 GeoTracker

GeoTracker is CA State Water Resources Control Board's data management system for managing sites that impact groundwater, especially those that require groundwater cleanup (Leaking Underground Storage Tanks, Department of Defense, Site Cleanup Program) as well as permitted facilities such as operating Above or Underground Storage Tanks and land disposal sites.

3.4 Naturally Occurring Asbestos Data

CA Department of Conservation provides information about naturally occurring asbestos in California. Reported Historic Asbestos Mines, Historic Asbestos Prospects, and Other Natural Occurrences of Asbestos in California (ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/MS59_Plate.pdf) and an Asbestos Sites table (ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/asbestos_sites.pdf) were also reviewed for this report.

4. HTRW Sites Summary

4.1 EDR Database Search Records

EDR search reports identified the following HTRW sites in the regulatory agency databases and are summarized by sections (Attachments 7-8). Those summary tables, Attachments 7, 8 and 9 show Agency databases, # of HTRW sites and the date of data retrieval for North East Stockton section, Northwest Stockton and South Stockton section respectively. Table 1 summarizes the number of HTRW sites in Agency databases, by sections and Alternatives 8, 9 and 10.

Table 1: HTRW Summary by Study Area Sections and Alternatives

Databases	NW	NE	South	Alt_8	Alt_9*	Alt_10
	HTRW Study Sections			Alternatives		
	# of Sites					
FEDERAL RECORDS						
NPL	0	0	0	0	0	0
Proposed NPL	0	0	0	0	0	0
Delisted NPL	0	0	0	0	0	0
NPL LIENS	0	0	0	0	0	0
CERCLIS	1	1	0	2	1	2
CERC-NFRAP	0	1	0	1	0	1
LIENS 2	0	0	0	0	0	0
CORRACTS	0	0	0	0	0	0
RCRA-TSDF	0	0	0	0	0	0
RCRA-LQG	7	1	0	8	7	8
RCRA-SQG	8	14	0	22	8	22
RCRA-CESQG	0	0	0	0	0	0
RCRA NonGen / NLR	7	5	3	15	10	12
US ENG CONTROLS	0	0	0	0	0	0
US INST CONTROL	0	0	0	0	0	0
ERNS	82	17	3	102	85	99
HMIRS	1	6	0	7	1	7
DOT OPS	1	0	0	1	1	1
US CDL	2	0	0	2	2	2
US BROWNFIELDS	0	0	0	0	0	0
DOD	1	0	0	1	1	1
FUDS	0	0	0	0	0	0
LUCIS	0	0	0	0	0	0
CONSENT	0	0	0	0	0	0
ROD	0	0	0	0	0	0
UMTRA	0	0	0	0	0	0
DEBRIS REGION 9	0	0	0	0	0	0
ODI	0	0	0	0	0	0

Databases	NW	NE	South	Alt_8	Alt_9*	Alt_10
US MINES	2	0	0	2	2	2
TRIS	1	6	0	7	1	7
TSCA	0	0	0	0	0	0
FTTS	4	6	0	10	4	10
HIST FTTS	4	6	0	10	4	10
SSTS	2	0	8	10	10	2
ICIS	1	0	0	1	1	1
PADS	0	0	0	0	0	0
MLTS	0	0	0	0	0	0
RADINFO	0	0	0	0	0	0
FINDS	69	50	11	130	80	119
RAATS	0	0	0	0	0	0
RMP	3	3	0	6	3	6
LEAD SMELTERS	0	0	0	0	0	0
2020 COR ACTION	0	0	0	0	0	0
PRP	0	0	0	0	0	0
US AIRS	3	0	0	3	3	3
US FIN ASSUR	0	0	0	0	0	0
FEMA UST	0	0	0	0	0	0
COAL ASH EPA	0	0	0	0	0	0
SCRD DRYCLEANERS	0	0	0	0	0	0
COAL ASH DOE	0	0	0	0	0	0
US HIST CDL	1	0	0	1	1	1
PCB TRANSFORMER	0	0	0	0	0	0
EPA WATCH LIST	0	0	0	0	0	0
STATE AND LOCAL RECORDS						
HIST Cal-Sites	1	0	0	1	1	1
CA BOND EXP. PLAN	0	0	0	0	0	0
SCH	1	0	3	4	4	1
Toxic Pits	0	0	0	0	0	0
SWF/LF	1	0	2	3	3	1
UIC	1	1	11	13	12	2
WDS	9	7	1	17	10	16
NPDES	19	6	4	29	23	25
WMUDS/SWAT	0	0	0	0	0	0
Cortese	3	0	1	4	4	3
HIST CORTESE	18	19	2	39	20	37
SWRCY	1	0	0	1	1	1
LUST	20	21	0	41	20	41
CA FID UST	31	34	0	65	31	65
SLIC	19	3	0	22	19	22
UST	40	40	2	82	42	80
HIST UST	28	27	5	60	33	55

Databases	NW	NE	South	Alt_8	Alt_9*	Alt_10
LIENS	0	0	0	0	0	0
CUPA Listings	0	0	0	0	0	0
SWEEPS UST	31	34	1	66	32	65
CHMIRS	95	34	7	136	102	129
LDS	2	0	2	4	4	2
AST	10	2	0	12	10	12
MCS	6	0	0	6	6	6
Notify 65	1	1	0	2	1	2
DEED	5	0	0	5	5	5
VCP	3	2	0	5	3	5
DRYCLEANERS	0	0	0	0	0	0
WIP	0	0	0	0	0	0
ENF	5	0	1	6	6	5
CDL	21	13	3	37	24	34
RESPONSE	1	0	0	1	1	1
HAZNET	140	119	8	267	148	259
EMI	49	0	6	55	55	49
ENVIROSTOR	9	7	3	19	12	16
HAULERS	0	0	0	0	0	0
RGA LUST	27	0	0	27	27	27
RGA LF	1	0	0	1	1	1
PROC	0	0	0	0	0	0
HWP	0	0	0	0	0	0
HWT	1	0	1	2	2	1
MWMP	0	0	0	0	0	0
AST	10	0	2	12	12	10
TRIBAL RECORDS						
INDIAN RESERV	0	0	0	0	0	0
INDIAN ODI	0	0	0	0	0	0
INDIAN LUST	0	0	0	0	0	0
INDIAN UST	0	0	0	0	0	0
INDIAN VCP	0	0	0	0	0	0
Total Sites	**809**	**486**	**90**	**1385**	**899**	**1295**

* does not include sites in the Lower Mormon Slough section.
NW: North West Stockton
NE: North East Stockton
South: South Stockton

Large numbers of HTRW sites were found throughout the HTRW Study Area and each of the Alternatives. Most of those HTRW sites were found in North East (NE) and North West (NW) Stockton sections. There were approximately forty Underground Storage Tank (UST) sites in NE Stockton and NW Stockton sections and 20 known Leaking Underground Storage Tanks (LUST) in both the NE and NW sections. The EPA's ERNS records show incidents of releases of oil and hazardous substances and there are large numbers of such incidents throughout the Study Area, especially in NE and NW Stockton sections. Similar to ERNS records, the California Hazardous Material Incident Report System (CHMIRS) kept by the California Office of Emergency Services contains information on reported hazardous material incidents of accidental releases or spills. Most sites listed in ERNS and CHMIRS records were found throughout NE and NW Stockton sections. Hazardous wastes have been generated at facilities located throughout the Study Area and all Alternatives according to the DTSC 2012 records. There were 140 Haznet sites in the study area in 2012. It is predicted that similar numbers of Haznet sites may exist in the study area in coming years as the project levees are located near the large industrial city of Stockton. Although no sites located in the Study Area were include on the National Priorities List for Superfund, two sites in the NE and NW sections were listed in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), potentially indicating a large scale hazardous release and remediation effort. One of these two CERCLIS sites would in Alternative 9, with both being locating in Alternatives 8 and 10. Many of the known HTRW with hazardous waste releases have the potential to affect levee repair work including endangerment construction works or encountering and removing hazardous waste during repair work in all Alternatives.

The locations of these HTRW sites are shown on the following maps (Fig 3a-3d) and many sites are in multiple databases. Fig 3d shows selected sites from the EDR GIS data.

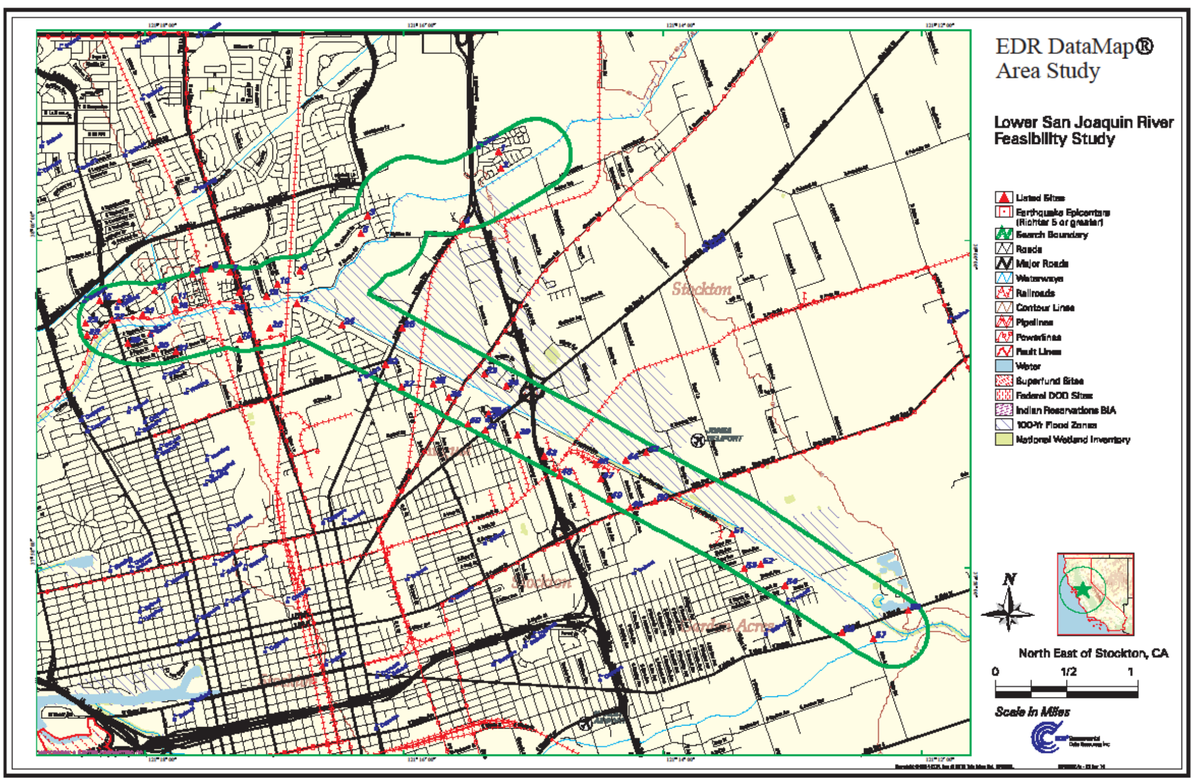


Fig 3a: North East Stockton Section

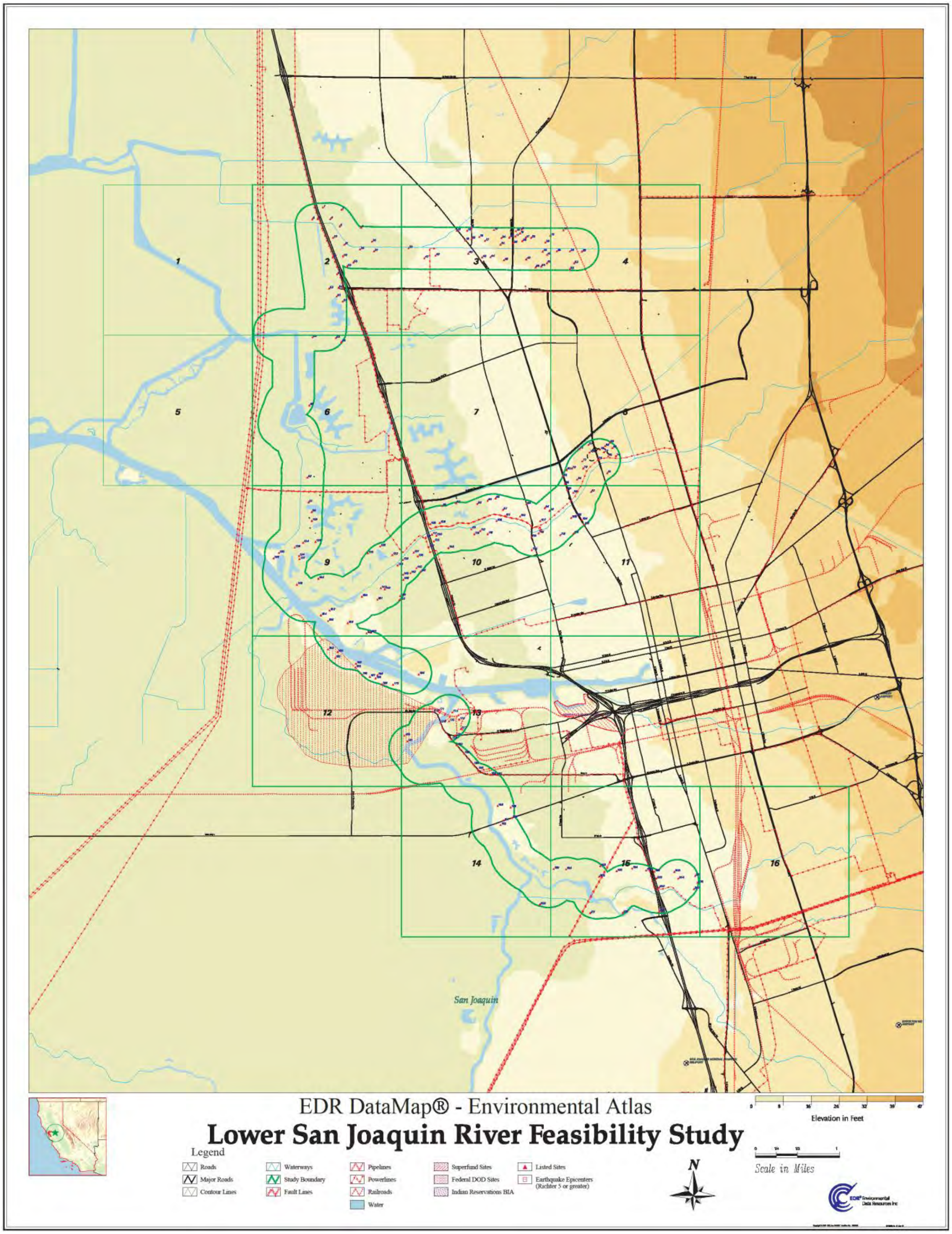


Fig 3b: North West Stockton Section

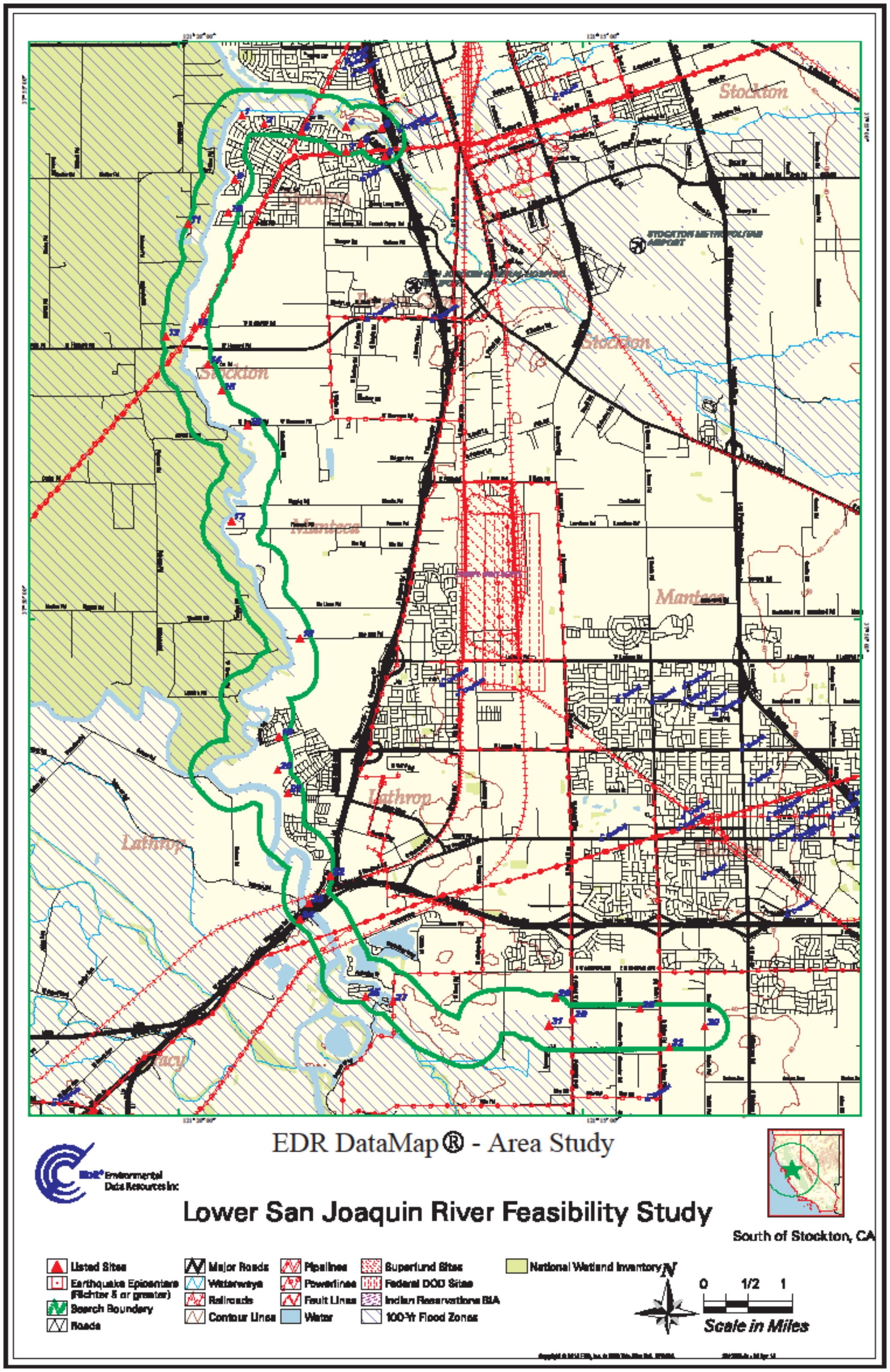


Fig 3c: South Stockton Section

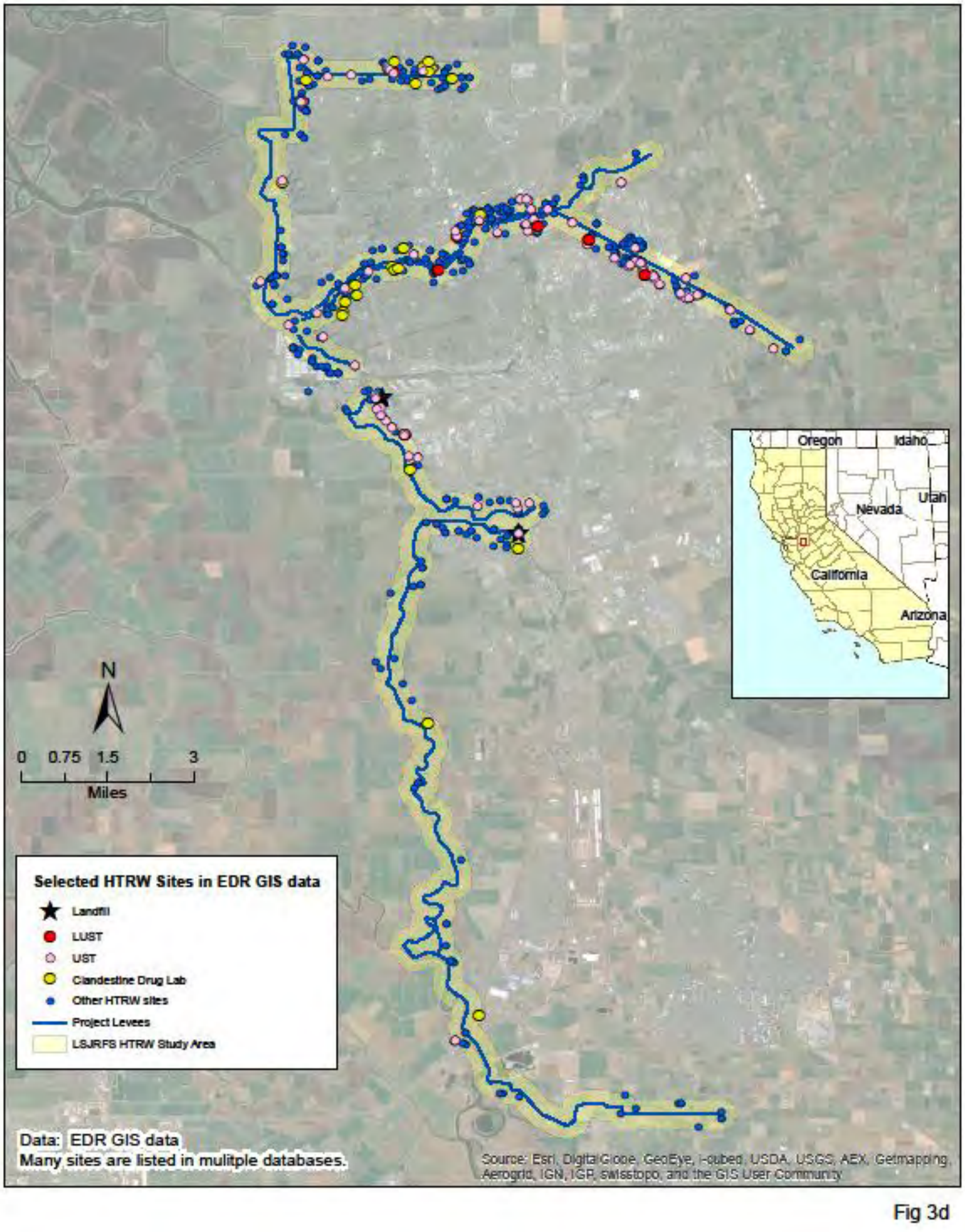


Fig 3d: Selected HTRW sites from EDR GIS data.

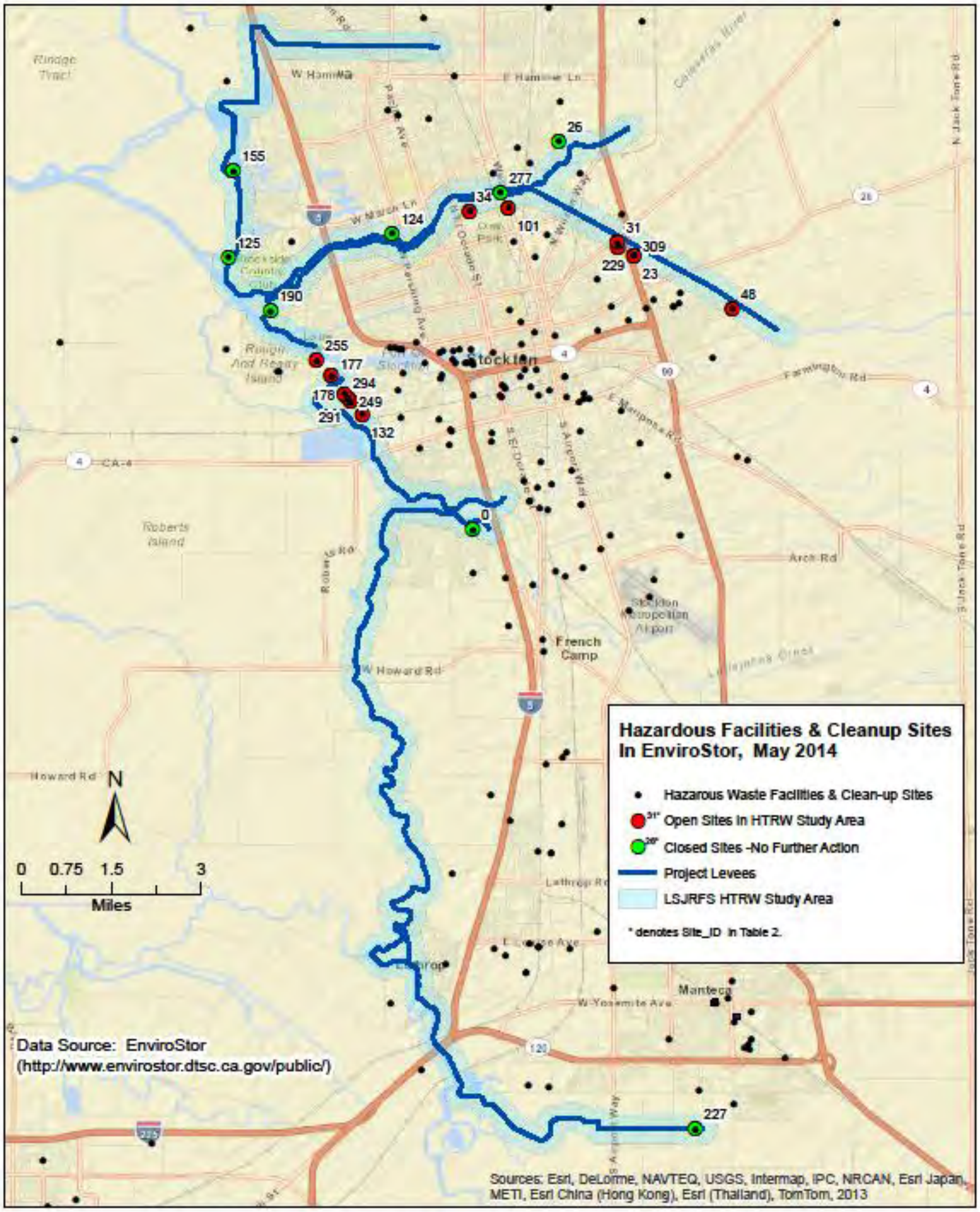
4.2 EnviroStor Data

EnviroStor lists hazardous waste facilities and clean-up sites in CA overseen by DTSC. There are 22 sites found in the HTRW Study Area, which are listed in the EnviroStor website as of May 2014. Table 2 lists sites in the HTRW Study Area. Those sites are shown in green (Closed sites) and Red (Open sites) in Fig 4. Eight of the 22 sites are in "No Further Action" status and the rest are still open (in red). The numbers besides red and green circles in Fig 4 indicate the Site_ID in Table 2.

Table 2: Sites Overseen by CA DTSC and listed in EnviroStor web site

Site_ID	SITE___FAC	ENVIROSTOR	STATUS	ADDRESS_DE	CITY
0	3RD ELEM SCHOOL - WESTON RANCH SITE	39010013	NO FURTHER ACTION	CAROLYN WESTON BOULEVARD	MANTECA
23	BEAVER CHEMICAL COMPANY, INC	39280002	REFER: RWQCB	1448 SHAW ROAD	STOCKTON
26	BLOSSOM RANCH ELEMENTARY SCHOOL	39010026	NO FURTHER ACTION	5247 NORTH HOLMAN ROAD	STOCKTON
31	BREA AGRICULTURAL SERVICE #2	39280016	REFER: RWQCB	1905 NORTH BROADWAY	STOCKTON
34	CABRAL - MCADAMS PROPERTY	60000317	INACTIVE - NEEDS EVALUATION	4204 - 4208 NORTH SUTTER STREET	STOCKTON
48	COLON PROPERTY	60000470	ACTIVE	5681 EAST MARSH ROAD	STOCKTON
101	HF HAWLEY CHEMICAL COMPANY	39280015	REFER: OTHER AGENCY	3909 NORTH WESTLANE	STOCKTON
124	KOHL ELEMENTARY SCHOOL	39010043	NO FURTHER ACTION	4131 CROWN AVENUE	STOCKTON
125	LADD'S STOCKTON MARINA	39760007	NO FURTHER ACTION	4911 BUCKLEY COVE WAY	STOCKTON
132	LEARNER COMPANY, THE	39500016	ACTIVE	2711 NAVY DRIVE	STOCKTON
155	MARINA WEST MARINE SERVICES	39750011	NO FURTHER ACTION	6649 EMBARCADERO DRIVE	STOCKTON
177	NAVCOMTELSTA SAN DIEGO DET STOCKTON CA	80001243	REFER: SMBRP	305 FYFFE AVE/CODE 43	STOCKTON
178	NAVCOMTELSTA SAN DIEGO DET STOCKTON CA	0	CLOSED	305 FYFFE AVE/CODE 43	STOCKTON
190	NSC ROUGH & READY ISLAND (J09CA1060)	80000657	NO FURTHER ACTION		STOCKTON
227	PROPOSED SOUTH MANTECA HIGH SCHOOL	60000456	NO FURTHER ACTION	21143 S. TINNIN ROAD	STOCKTON
229	PUREGRO CO. (2) (STOCKTON)	39520003	REFER: RWQCB	1755 N BROADWAY	STOCKTON
249	SANTA FE PACIFIC PIPELINE LP	71003522	REFER: OTHER AGENCY	2947 NAVY DRIVE, STOCKTON TERMINAL	STOCKTON
255	SHELL OIL CO. - STOCKTON PLANT	71002128	REFER: OTHER AGENCY	3515 NAVY DRIVE	STOCKTON
277	STO DIV CAN & CAL (J09CA0961)	80000612	NO FURTHER ACTION		STOCKTON
291	TESORO REFINING MARKETING & COMPANY	71003499	REFER: OTHER AGENCY	3003 NAVY DRIVE	STOCKTON
294	TIME OIL COMPANY	39510030	REFER: OTHER AGENCY	3015 NAVY DRIVE	STOCKTON
309	US CHEMICAL	71003289	INACTIVE - NEEDS EVALUATION	1448 SHAW ROAD	STOCKTON

The EnviroStor website shows a total of 22 hazardous waste and clean-up sites in the HTRW Study Area and in all Alternatives. These sites in EnviroStor are mostly chemical companies, petroleum companies, schools (which would likely be investigation only sites) and located in NE and NW Stockton sections. Eight of 22 sites were in "No Further Action" status and the rest are either open or referred to other agencies.   Several of the sites that are referred to the Regional Water Quality Control Board likely contain contaminated groundwater onsite and potentially offsite. These groundwater HTRW sites would affect worker safety, dewatering operations, or excavation work depending on the depth to groundwater and magnitude of the groundwater plumes. Site_ID in Table 2 is used as a label in Fig 4 below to locate a site in the table.



Hazarous Waste Facilities & Clean-up Sites from EnviroStor Fig 4

4.3 GeoTracker Data

GeoTracker is the SWRCB data management system for managing sites that impact groundwater, especially those that require groundwater cleanup (Underground Storage Tanks, Department of Defense, Site Cleanup Program) as well as permitted facilities such as operating USTs and land disposal sites. Table 3 shows sites overseen by SWRCB (from GeoTracker) and Fig 5 shows sites in the HTRW Study Area and other areas.

Table 3: Sites overseen by SWRCB and listed in GeoTracker

Site_ID	GEOTRACKER	SITE_NAME	CLEANUP_ST	ADDRESS	CITY
11		TIME OIL CO		3015 NAVY DR	STOCKTON
12		QUIK STOP MARKETS #132		3555 HAMMER LN	STOCKTON
21		BOBCAT CENTRAL INC		1113 SHAW RD	STOCKTON
60		TESORO		3003 NAVY DR	STOCKTON
108	DOD100314800	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - SITE 48 FORMER SOLVENT TANK	OPEN - SITE ASSESSMENT	CROMWELL AVENUE	STOCKTON
109	DOD100314900	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #016-1, 2, 3 UST	OPEN - SITE ASSESSMENT	NAVY DRIVE	STOCKTON
124	DOD100398500	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - SITE 06 FORMER WASH RACK / ASSOCIATED STORM DRAIN	OPEN - SITE ASSESSMENT	NORTHEAST CORNER OF GILMORE AVENUE AND BOONE DRIVE	STOCKTON
127	DOD100398900	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - SITE 30 SPILL AREA	OPEN - SITE ASSESSMENT	305 FYFFE AVENUE	STOCKTON
171	L10005102006	FRENCH CAMP LANDFILL-2	OPEN	MANTHEY RD/I-5	STOCKTON
180	L10008252269	FRENCH CAMP LANDFILL	OPEN	3335 MANTHEY	STOCKTON
192	SL0607725004	LESCO, INC. (FORMER TRI DELTA FERTILIZER)	OPEN - REMEDIATION	2829 WEST WASHINGTON STREET	STOCKTON
205	SL0607767410	MARINA WEST MARINE SERVICES	OPEN - INACTIVE	6651 EMBARCADERO DRIVE	STOCKTON
208	SL0607775997	LADD'S STOCKTON MARINA	COMPLETED - CASE CLOSED	4911 W. MARCH LN	STOCKTON
209	SL0607779456	RICE TERMINALS	OPEN - SITE ASSESSMENT	PORT OF STOCKTON	STOCKTON
211	SL0607782612	THE LEARNER COMPANY	OPEN - INACTIVE	2711 NAVY DRIVE	STOCKTON
231	SL205843044	CROP PRODUCTION SERVICES - STOCKTON	OPEN - SITE ASSESSMENT	1905 NORTH BROADWAY AVE	STOCKTON
233	SL373513623	KMEP - STOCKTON TERMINAL	OPEN - VERIFICATION MONITORING	2947 NAVY DRIVE	STOCKTON
245	SLT5S0573098	BRIDGES SPECIALTY CENTER	OPEN - INACTIVE	2233 GRAND CANAL BLVD.	STOCKTON
257	SLT5S1623202	HYDROAGRI NORTH AMERICA	OPEN - INACTIVE	3019 NAVY DRIVE	STOCKTON
317	T0607700032	SUPPLY TERMINAL SERVICES	COMPLETED - CASE CLOSED	2941 NAVY DR	STOCKTON
337	T0607700060	BEACON #27 (CARDLOCK 610)	COMPLETED - CASE CLOSED	3300 WATERLOO RD	STOCKTON
340	T0607700065	WASTE WATER TREATMENT PLANT	COMPLETED - CASE CLOSED	2500 NAVY DR	STOCKTON
359	T0607700087	PG&E STOCKTON SERVICE CENTER	COMPLETED - CASE CLOSED	4040 WEST LN N	STOCKTON
363	T0607700092	FISCO WAREHOUSE	COMPLETED - CASE CLOSED	1648 SHAW RD	STOCKTON

Site_ID	GEOTRACKER	SITE_NAME	CLEANUP_ST	ADDRESS	CITY
376	T0607700121	BLUE MAGIC PRODUCTS INC	COMPLETED - CASE CLOSED	4445 FREMONT ST E	STOCKTON
386	T0607700139	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #508-1 OWS	OPEN - SITE ASSESSMENT	EMBARCADERO	STOCKTON
410	T0607700180	STAGGS HIGH SCHOOL	COMPLETED - CASE CLOSED	1621 BROOKSIDE RD	STOCKTON
429	T0607700211	US POSTAL SERVICE	COMPLETED - CASE CLOSED	4245 WEST LN N	STOCKTON
430	T0607700212	STEPHEN'S ANCHORAGE	COMPLETED - CASE CLOSED	4950 BROOKSIDE RD W	STOCKTON
502	T0607700316	BREA AGRICULTURAL SERVICE	COMPLETED - CASE CLOSED	1905 BROADWAY	STOCKTON
529	T0607700366	LARGINS SERVICE	COMPLETED - CASE CLOSED	2235 CHEROKEE RD	STOCKTON
567	T0607700427	STOCKTON GOLF & COUNTRY CLUB	COMPLETED - CASE CLOSED	3800 COUNTRY CLUB BLVD	STOCKTON
570	T0607700431	COIT DRAPERY CLEANERS	COMPLETED - CASE CLOSED	1146 ENTERPRISE ST	STOCKTON
601	T0607700474	DON'S BUGGY SHOP	COMPLETED - CASE CLOSED	3245 WILSON WAY N	STOCKTON
611	T0607700487	VAN BUSKIRK GOLF COURSE	COMPLETED - CASE CLOSED	1740 HOUSTON AVE	STOCKTON
619	T0607700500	PORT OF STOCKTON ROUGH & READY ISLAND - NAVAL RESERVE CENTER	COMPLETED - CASE CLOSED	3100 MONTE DIABLO AVE	STOCKTON
653	T0607700550	UNOCAL #0950	COMPLETED - CASE CLOSED	2835 NAVY DR	STOCKTON
654	T0607700551	VILLAGE WEST MARINA	COMPLETED - CASE CLOSED	6649 EMBARCADERO DR	STOCKTON
659	T0607700559	PACIFIC CAR WASH	OPEN - REMEDIATION	4405 PACIFIC AVE	STOCKTON
663	T0607700568	CANTEEN CORPORATION	COMPLETED - CASE CLOSED	1500 SHAW RD N	STOCKTON
686	T0607700599	RIVERSIDE CEMENT CO	COMPLETED - CASE CLOSED	2825 WASHINGTON ST W	STOCKTON
710	T0607700641	CERTIFIED GROCERS OF CALIF	COMPLETED - CASE CLOSED	1990 PICCOLI ST N	STOCKTON
731	T0607700679	SPRINT	COMPLETED - CASE CLOSED	3807 CORONADO AVE	STOCKTON
767	T0607700747	THE LEARNER COMPANY	COMPLETED - CASE CLOSED	2711 NAVY DR	STOCKTON
779	T0607700775	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #024	COMPLETED - CASE CLOSED	24 ROUGH & READY ISLAND	STOCKTON
782	T0607700778	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #210	COMPLETED - CASE CLOSED	210 ROUGH & READY ISLAND	STOCKTON
786	T0607700783	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #605-1 UST	OPEN - SITE ASSESSMENT	ROUGH & READY ISLAND	STOCKTON
787	T0607700784	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #607	COMPLETED - CASE CLOSED	607 ROUGH & READY ISLAND	STOCKTON
788	T0607700786	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #707	COMPLETED - CASE CLOSED	707 ROUGH & READY ISLAND	STOCKTON
789	T0607700787	PORT OF STOCKTON ROUGH & READY ISLAND - ROUGH AND READY ISLAND - BLDG #803	COMPLETED - CASE CLOSED	803 ROUGH & READY ISLAND	STOCKTON
801	T0607700806	CAREER AVIATION	OPEN - SITE ASSESSMENT	6250 LINDBERGH ST	STOCKTON
807	T0607700813	WATERLOO FOOD & FUEL	OPEN - REMEDIATION	3032 WATERLOO RD	STOCKTON
840	T0607700862	COMMERCIAL PROPERTY	COMPLETED - CASE CLOSED	3012 WATERLOO RD E	STOCKTON
885	T0607762007	ARMOUR & BONNIE SMITH 2003 TRUST	COMPLETED - CASE CLOSED	1610 BROADWAY, NORTH	STOCKTON
894	T0607780091	PG&E	COMPLETED - CASE CLOSED	4040 WEST	STOCKTON
901	T0607791623	PG&E STOCKTON SERVICE CENTER (CASE #2)	COMPLETED - CASE CLOSED	4040 WEST LN N	STOCKTON

Site_ID	GEOTRACKER	SITE_NAME	CLEANUP_ST	ADDRESS	CITY
915	T0607793681	ARROYO'S SMOG SHOP	COMPLETED - CASE CLOSED	3012 WATERLOO	STOCKTON
929	T0607799511	WASTE WATER TREATMENT PLANT (CASE #2)	COMPLETED - CASE CLOSED	2500 NAVY DRIVE	STOCKTON
933	T10000000687	HJ BAKER & THE PORT OF STOCKTON-SULFUR BULK TERMINALS SITE	OPEN - REFERRED	PO BOX 2089	STOCKTON
939	T10000001236	MAARTIN OPERATING PARTNERSHIP	OPEN - REFERRED	2717 WEST WASHINGTON	STOCKTON
993	T10000004301	PORT OF STOCKTON ROUGH & READY ISLAND - LOUIS PARK SPIT	OPEN - INACTIVE	1 MONTE DIABLO AVE	STOCKTON

There are a total of 61 sites in the HTRW Study Area listed in the GeoTracker website as of May 2014. Most of the sites in the HTRW Study Area are petroleum companies, petroleum service stations, schools, landfills, and spill sites likely containing contaminated groundwater plumes which extend offsite. Thirty-six of the 61 sites are in the "Completed - Case Closed" status and the majority of those open sites are undergoing remediation or being assessed by CA Water Board. Fig 5 shows the sites found in the HTRW study Area. Green circles represent "Completed-Case Closed" and the red circle are still being assessed or monitored by CA Water Board. The locations of the sites listed in Table 3 can be found by Site_ID numbers in Table 3 and Fig 5. The majority of open sites in GeoTracker are located in NE and NW Stockton sections and a limited number in South Stockton section. Groundwater HTRW sites could affect worker safety, dewatering operations, or excavation work depending on the depth to groundwater and magnitude of the groundwater plumes.

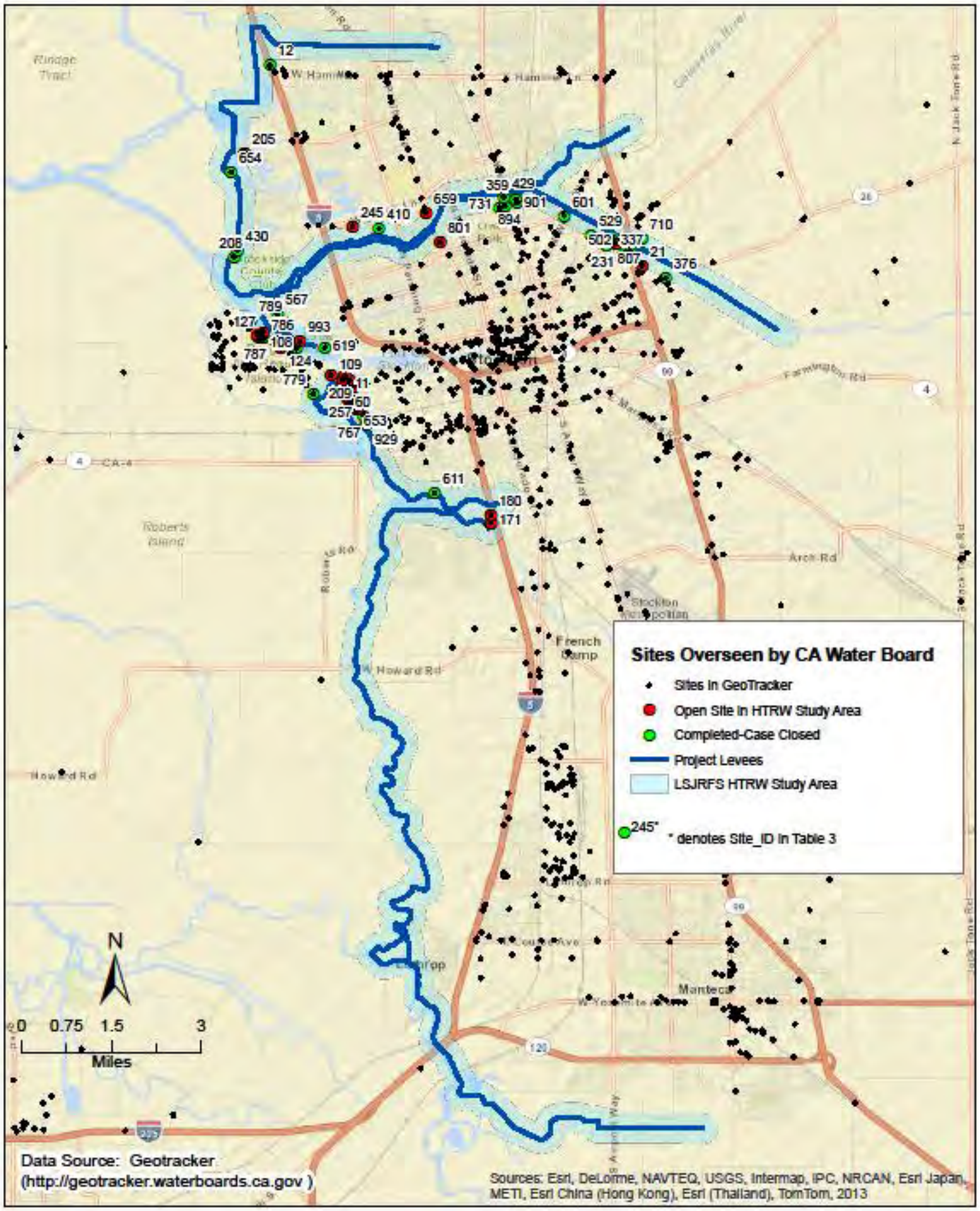


Fig 5

Sites overseen by CA Water Board

4.4 Naturally Occurring Asbestos

Naturally Occurring Asbestos (NOA) is usually found in forms of rocks and soil in areas including mines, prospects, and asbestos bearing talc deposit can be found throughout California. CA Department of Conservation websites were reviewed for NOA in the HTRW Study Area (http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/index.aspx).

The following documents were reviewed for NOA in the HTRW Study Area, San Joaquin County, California:

- Map of NOA Sites in CA: Reported Historic Asbestos Mines, Historic Asbestos Prospects, and Other Natural Occurrences of Asbestos in California (ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/MS59_Plate.pdf (Plate).....(Attach 11)
  The plate shows locations of Former asbestos mines, former asbestos prospects, reported asbestos occurrences, asbestos-bearing talc deposit sites, reported fibrous amphibole and ultramafic rock in outcrops In california. There is no NOA related sites in the HTRW Study Area .

- NOA sites in CA: Asbestos Sites Table (ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/asbestos_sites.pdf (Attach 12). This table lists NOA related sites by counties in California.

Review of the information on the plate and the table, no known NOA sites were found in San Joaquin County where the HTRW Study Area is located. It is unlikely NOA will be encountered during the levee work.

5. HTRW Sites Assessment and Recommendations

Based on our review of Federal, state, and local environmental databases, historical research and regulatory agency's websites, there are many HTRW sites within the HTRW Study Area and each of the Alternatives. The extent and degree of HTRW contaminations are beyond the scope of this HTRW sites study. Tables 1.1 – 1.3 (Attachs 7-9), Table 1, Table 2 and Table 3 are summaries from EDR database search reports, EnviroStor data from CA DTSC and GeoTracker from SWRCB respectively. Many sites (shown in Fig 3a – 3d) are listed in multiple databases and counted numerous times. i.e., an HTRW site is listed in multiple databases such as CERLIS, UST, LUST, AST, ENVIROSTOR, NPDES, CHMIRS, etc.). Many HTRW sites listed in Tables 1-3 have already been investigated and remediated and some sites have been placed in the status of "No Further Action". Many sites in San Joaquin County (Table 2 and Table 3) are currently being investigated and remediated by responsible parties, and/or are overseen by CA DTSC and CA Water Board.

Numerous known releases of hazardous waste and hazardous materials are located throughout the Study Area, particularly concentrated the NE and NW sections. One or both of these sections of the Study Areas are located in all three Alternatives, with a greater accumulation of HTRW sites found in Alternatives 8 and 10. However, Alternative 9 still contains hundreds of HTRW sites located adjacent to the project levees. Releases from these sites could result in contaminated soil, groundwater, surface water, or soil gas which could impact levee repair work and construction workers.

Whichever alternative is selected, similar numbers of HTRW issues may have to be addressed and further researched with each alternative.   Since the project levees are in the vicinity of a large industrial area with the city of Stockton and agricultural areas, the following sites in the HTRW Study Area need to be further assessed in the future;

- Storage and agricultural use of pesticides, herbicides and rodenticides,
- Landfills and known groundwater contamination sites,
- Leaking underground storage tanks, and
- All other sites currently undergoing investigation and/or remediation especially “in Open Status” monitored by CA DTSC and CA Water Board.

Existing and potential HTRW sites, land or facility uses, on and off-site conditions, regulations, other factors likely change over the time. The status of HTRW sites will change over the time and new HTRW sites may emerge at the HTRW Study Area. Therefore, this report should not be relied upon after 180 days of the date of this report.

When an alternative is selected, additional environmental investigation in accordance with ASTM Phase I Environmental Site Assessment (E1525) is recommended prior to commencement of levee construction/modification activities. Additional investigation includes but not limited to recognized environmental conditions, historical aerial photo review, Sanborn map review, site reconnaissance and interview with knowledgeable persons about the chosen project site. Further investigation of the nature and extent of contaminations at HTRW sites may be required if warranted by the Phase I ESA.

6. References

1. ER 1165-2-132, Water Resource Policies and Authorities Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Project, Department of the Army, U.S. Army Corps of Engineers, 1992

2. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, E 1527-05, American Society of Testing and Material, 2005

3. EnviroStor (http://www.envirostor.dtsc.ca.gov/public/), California Department of Toxic Substances Control, May 2014

4. GeoTracker (http://geotracker.waterboards.ca.gov/), California State Water Resources Board, May 2014.

5. CA Department of Conservation, Naturally Occurring Asbestos (A plate: Reported Historic Asbestos Mines, Historic Asbestos Prospects, and Other Natural Occurrences of Asbestos in California, ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/asbestos_sites.pdf and Asbestos Sites Table by county, ftp://ftp.consrv.ca.gov/pub/dmg/pubs/ms/59/MS59_Plate.pdf)