

Project name:
CVFPP Update – Levee Fragility Curves

Project ref:
Contract Number 4600013352

From:
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Date:
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To:
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Technical Memorandum

1. Introduction

The Department of Water Resources (DWR) is currently working on 2022 Central Valley Flood Protection Plan (CVFPP) update and DWR Small Communities Flood Risk Reduction Study. This is an update to the plans developed in 2017. AECOM is tasked to provide engineering support services for this effort, which includes developing a work plan (Task 1), updating, validating, and developing fragility curves (Tasks 2 and 3), and attending consultation meetings (Tasks 4). This memorandum summarizes the approach and assumptions considered in updating and validating the fragility curves for Project levees and in development of Hazard Level Classifications for non-Project levees.

2. Update and Validate Fragility Curves (Task 2)

This task involved evaluation of index points and associated fragility curves on Project levees in the Central Valley that have been upgraded repaired/upgraded since the 2017 CVFPP (URS, 2015). Additionally, under a sub task, Project levees within Sacramento County has been evaluated even though no improvements were completed on the levees based on supplemental investigation completed in 2019-2020. The following assumptions were considered for the update and validation of fragility curves at Index points on Urban Project and on-Urban Project levees, within the Sacramento and San Joaquin basins.

Project Levees in Central Valley with Improvements:

1. Multiple Index points were established on the Central Valley levees during the 2017 CVFPP effort. But, only the Project levees with either remediation construction projects completed post 2014 to date or planned to be completed by 2022, were considered in the current evaluation. Fragility curves at Index points on these Project levees were selected for review and if appropriate, revised. Fragility curves at the rest of the 2017 Index points, without improvements, were not reviewed during the current effort except as noted below for the Sacramento County levees. Fragility curves for these non-improved Index point locations from the 2017 CVFPP were assumed to be valid.
2. Details regarding the remediation construction projects were validated with appropriate stakeholders (DWR, USACE, and Local Levee Agencies).
3. Project levees with improvements were assumed to have been remediated for under-seepage, stability, through-seepage and erosion failure modes. If the levees are due for ULDC/FEMA certification by 2022, the improvements were considered to be comprehensive. Where information on erosion was not available, a conservative assumption on Hazard Level categorization was made based on available historic information.

4. For Urban Project levees that have been repaired, the levees were assumed to have been improved to 200-year protection level. The fragility curves for the subject index points have been validated and updated considering a 0.5% probability of failure at the 200-year water surface elevation and 2% probability of failure at 200-year+3 feet water surface elevation (URS, 2015).
5. For Project levees that have been repaired, fragility curves were revised considering a Hazard Level “A “ categorization (URS, 2009 and 2010) for the under-seepage, stability, and through-seepage failure modes. A subjective assessment was made for the erosion failure mode based on discussions with local stakeholders and available historical information (URS, 2011a).
6. A map book highlighting the Index points where fragility curves have been updated for completed and in progress (to be completed by 2022) levee improvements was generated. A summary table of Index points, updated fragility curves, and the map book are included in Appendix A of this document.
7. Updated fragility curves at a total of 26 Index points on Urban Project, and at 7 Index points on the Project levee segments have been prepared and presented in Appendix A.

Project Levees in Sacramento County without Improvements:

Supplemental investigations have been performed recently on Project and non-Project levees in Sacramento County as a part of the DWR Small Communities Flood Risk Reduction Study. This additional exploration data enabled an update of the “Without Project” fragility curves developed during the 2017 CVFPP effort. Based on the stakeholder request, “With Project” fragility curves were also developed, assuming a comprehensive repair of the under-seepage, stability, through-seepage, and erosion distress that could be implemented sometime in the future. The preliminary list of Project levee segments considered for the evaluation were listed in the Table 1. A summary table of Index points considered in Sacramento County, updated “Without Project” (current conditions) and “With Project” (future remediated condition) fragility curves at 20 Index points were included in Appendix B of this document.

Table 1. Index Points on Project Levees in Sacramento County

Index Point Count	Impact Area/Name	NULE Segment	Assessment WSE (ft)	NULE Station (ft)		Length (feet)
1	SAC 45 Hood – Sac River – MA9	106	23.7	301210	347900	46690
2	SAC 47 RDs 551 & 755 – Sac River	131	22.2	291500	301200	9700
3	SAC 48 Courtland within RD 551 – Sac R.	126-1	20.7	276500	291500	15000
4	SAC 48 Courtland within RD 551 – Sac R.	126-2	20.4	255653	276500	20847
5		113-1	15.2	141500	160140	18640
6	SAC 50 Grand Island – Steamboat Slough	113-2	16.3	132000	141500	9500
7		113-3	17.6	101500	132000	30500
8		113-4	18	100000	101500	1500
9		384-1	13	184171	232500	48329
10	SAC 50a Grand Island – Sac River	384-2	17.9	232500	261000	28500
11		384-3	20.6	261000	275791	14791
12	SAC 51 RD 369 – Locke – Sac River	121	18.9	251549	255652	4103
13		127	17	250608	251548	940

14	SAC 52 RD 554 – E. Walnut Grove – Sac River	128	16.9	247093	250238	3145
15	SAC 53 RD 563 – Tyler Island – Georgiana Sl.	130	12	100000	164111	64111
16	SAC 54 Brannan Andrus Levee Maintenance District (BALMD) – Georgiana Sl.	129	14	131742	160678	28936
17		40	12	100000	131798	31798
18		390-1	14.75	216421	246680	30259
19	SAC 54a RD 556 – Upper Andrus – Sac River, upstream of BALMD	390-2	14.75	216421	246680	30259
20		378	13	155439	216420	60981

3. Development of New Fragility Curves (Task 3)

This task involved development of Hazard Level Categorizations for up to 5 non-Project levees, dividing them into sub-reaches, as applicable, to support Sacramento County in development of new fragility curves.

1. A preliminary list of Index points along additional exploration and laboratory information was provided by the Sacramento County representative. The list of Index points was summarized in Table 2.
2. Hazard Level categorizations (URS, 2009 and 2010) that are currently available for the Sacramento County segments 1040, 1041, 1049, 1050, 1051, 1052, and 1054 were reviewed taking into account the supplemental field exploration data. Non-Project levee segments 1040 and 1041 were divided into sub-reaches, based on discussions with Sacramento County representatives. Levee Assessment Tool (URS, 2009 and 2010) has been updated for existing levee segments with previous Hazard Level categorizations. Hazard Level categorizations were developed for new non-Project levee segments and sub-reaches.
3. The draft Hazard Level categorizations were reviewed with DWR and Sacramento County stake holders (DWR, Walnut Grove, BALMD, and GEI) and updated based on the comments.
4. The critical cross section locations at which the Hazard Level categorizations were developed were highlighted on Figure 6 of the map book, included in Appendix A. A summary table of the Hazard Level categorizations for 20 non-Project levee segments and sub-reaches was included in the Appendix C of this document.

Table 2. Preliminary List of Index Points on non-Project Levees

Index Point Count	Impact Area/Name	NULE Segment	Assessment WSE (ft)	NULE Station Start	NULE Station End	Segment Length (feet)
1	SAC 44/45 -Stone Lakes-Hood – MA9	None/ HDERR		0	13125	13125
2	SAC 51 – RD 369 – Locke	1054	22.5	SDSS-R 1145+00 TMXS-R 1000+00	SDSS-R 1175+00 TMXS-R 1081+43	SDSS-R 3000 TMXS-R 8143
3	SAC 52 – RD554 – East Walnut Grove	1051	15.5/19.5	102500	108880	6380
4	SAC 54 (south within BALMD for Isleton)	1050	9.5	100000	116500	16500
5	SAC 54 (south within BALMD for Isleton)	1049	9.5	194000	208000	14000
6	SAC 52 – RD 554 – East Walnut Grove	1052	20.5	100000	104200	4200
7	SAC 53 - RD 563 - Tyler Island – portion of East Walnut Grove	1051	15.5/19.5	102500	108880	6380
8	SAC 47 – RD 551 – Courtland Study Area	1041-1	26.5	100000	138000	38000

9	SAC 47 – RD 551 – Courtland Study Area	1041-2	26.5	138000	149000	11000
10	SAC 47 – RD 551 – Courtland Study Area	1040-1	26	100000	105000	5000
11	SAC 47 – RD 551 – Courtland Study Area	1040-2	26	105000	107300	2300

Note: Index points 1 through 11 have data from new CPTs and soils lab data

References

URS, Technical Memorandum - Levee Assessment Tool, Non-Urban Levee Evaluations Project Task Order No. U100, July 16, 2009.

URS, Technical Memorandum - Levee Assessment Procedures Update, Non-Urban Levee Evaluations Project Task Order No. U100, January 26, 2010.

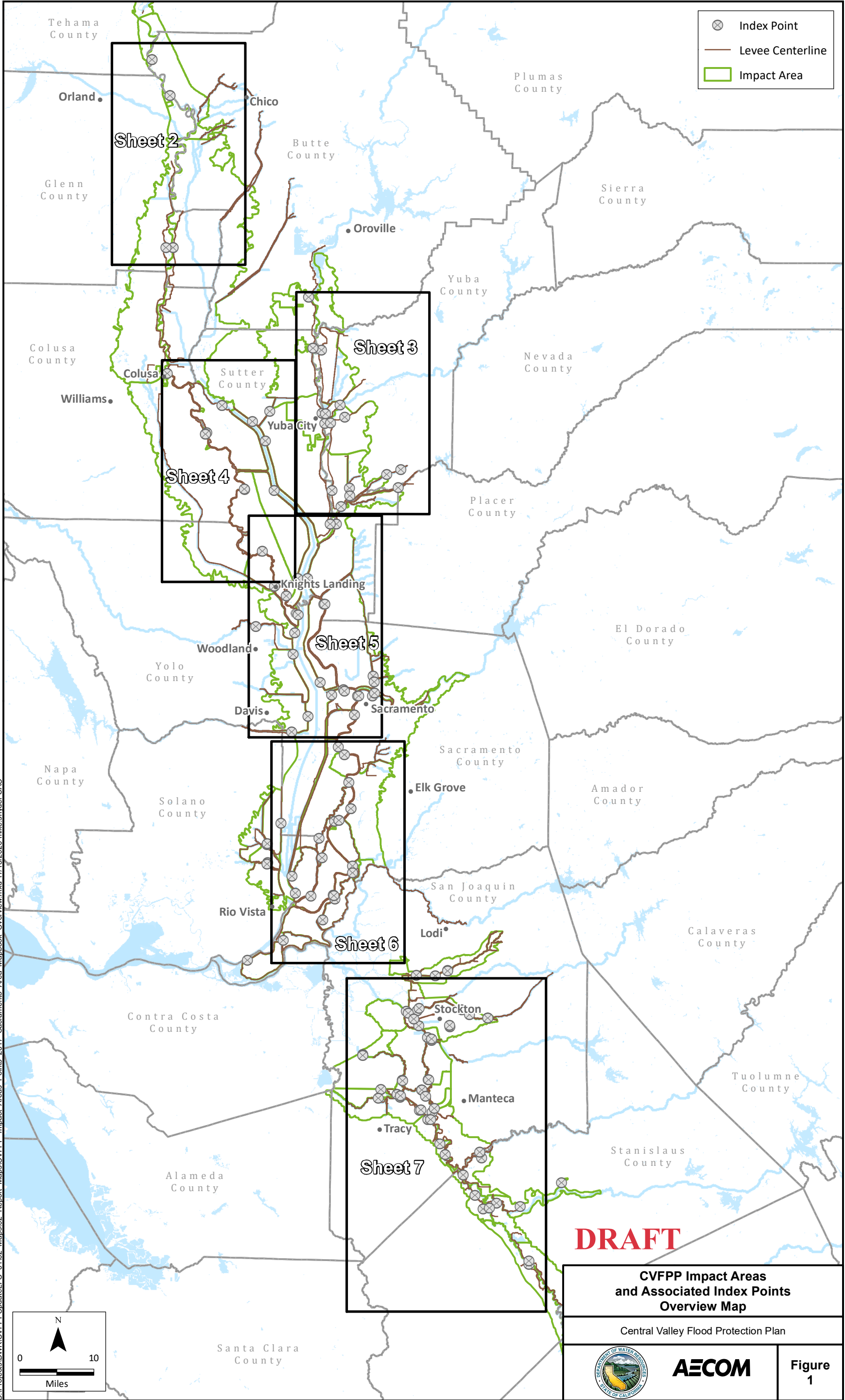
URS, Geotechnical Assessment Report, Non-Urban Levee Evaluations Project Task Order No. U104, April, 2011a.

URS, Technical Memorandum – Fragility Curve Development, Non-Urban Levee Evaluations Project Task Order No. U108, November 28, 2011b.

URS, Technical Memorandum – 2014 Performance Curve Development, Non-Urban Levee Evaluations Project Task Order No. U119, January 28, 2015.



Appendix A

1. Map Book
2. Summary Table of **Urban** Project Segments with completed/planned repairs
3. “With Project” Fragility Curves for **Urban** Project Segments
4. Summary Table of **Non-Urban** Project Segments with completed/planned repairs
5. “With Project” Fragility Curves for **Non-Urban** Project Segments










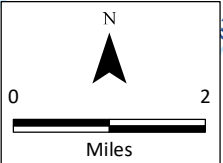
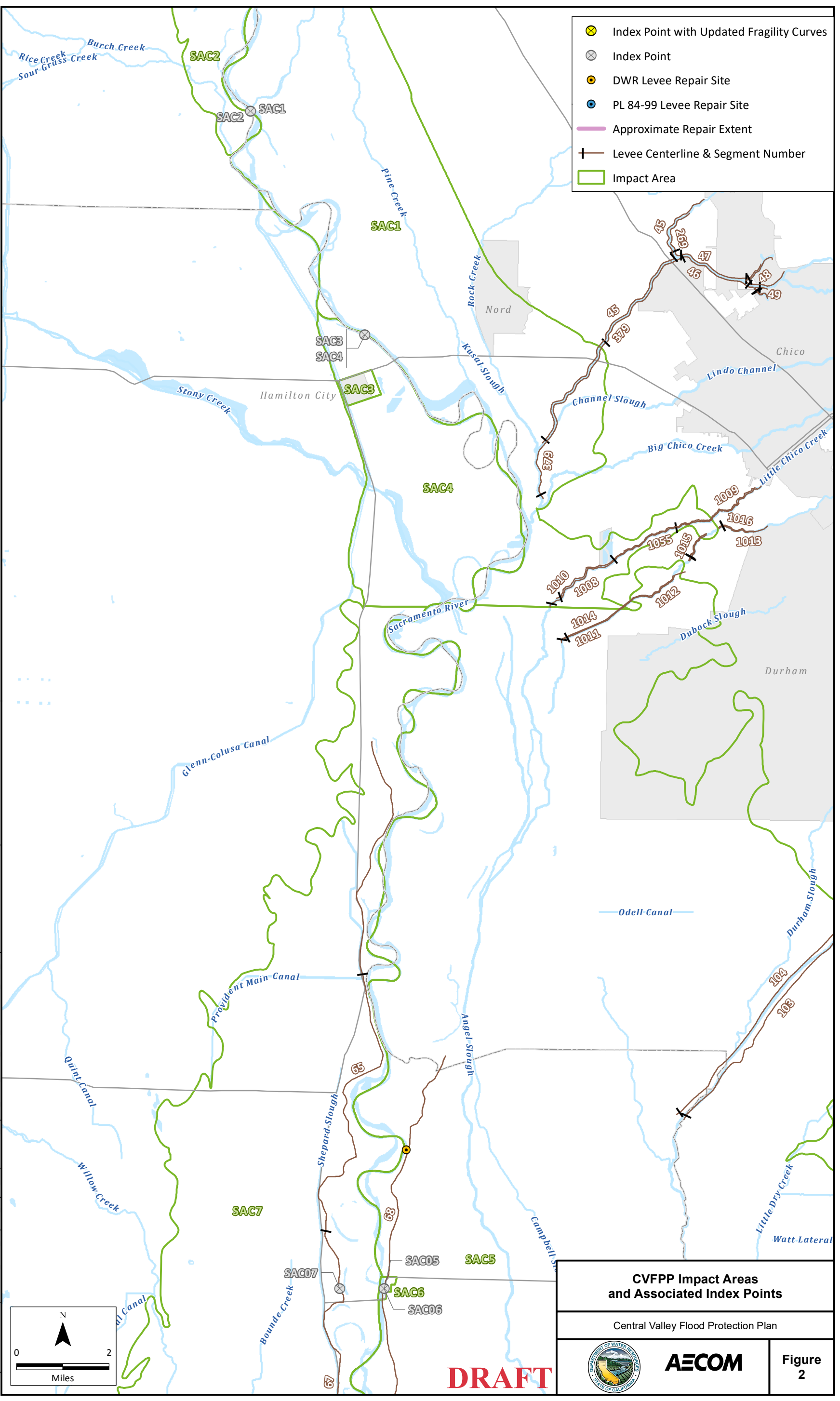
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CVFPP Impact Areas and Associated Index Points Overview Map	
Central Valley Flood Protection Plan	
	
Figure 1	

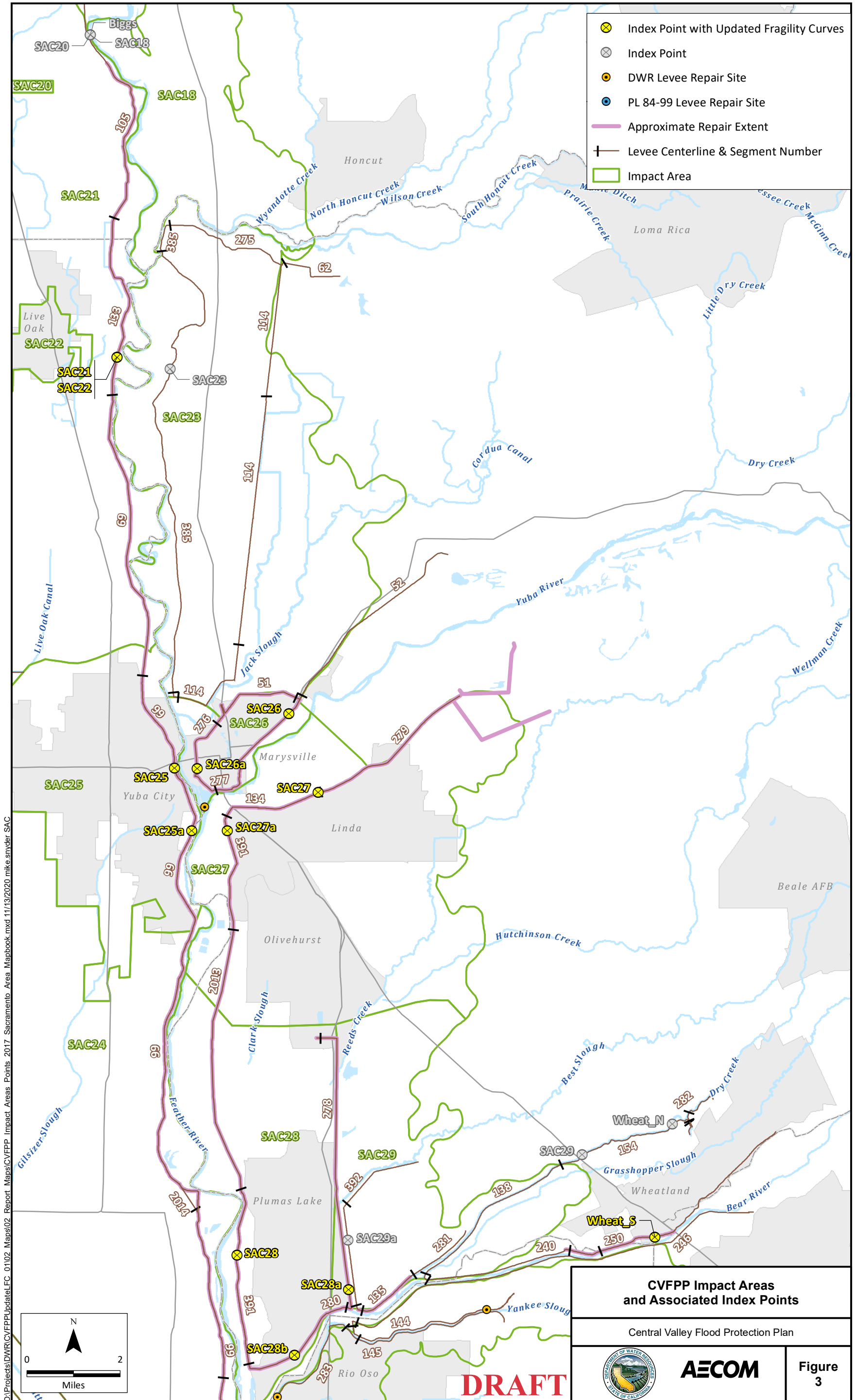
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-  Index Point with Updated Fragility Curves
-  Index Point
-  DWR Levee Repair Site
-  PL 84-99 Levee Repair Site
-  Approximate Repair Extent
-  Levee Centerline & Segment Number
-  Impact Area



CVFPP Impact Areas and Associated Index Points	
Central Valley Flood Protection Plan	
	
Figure 2	

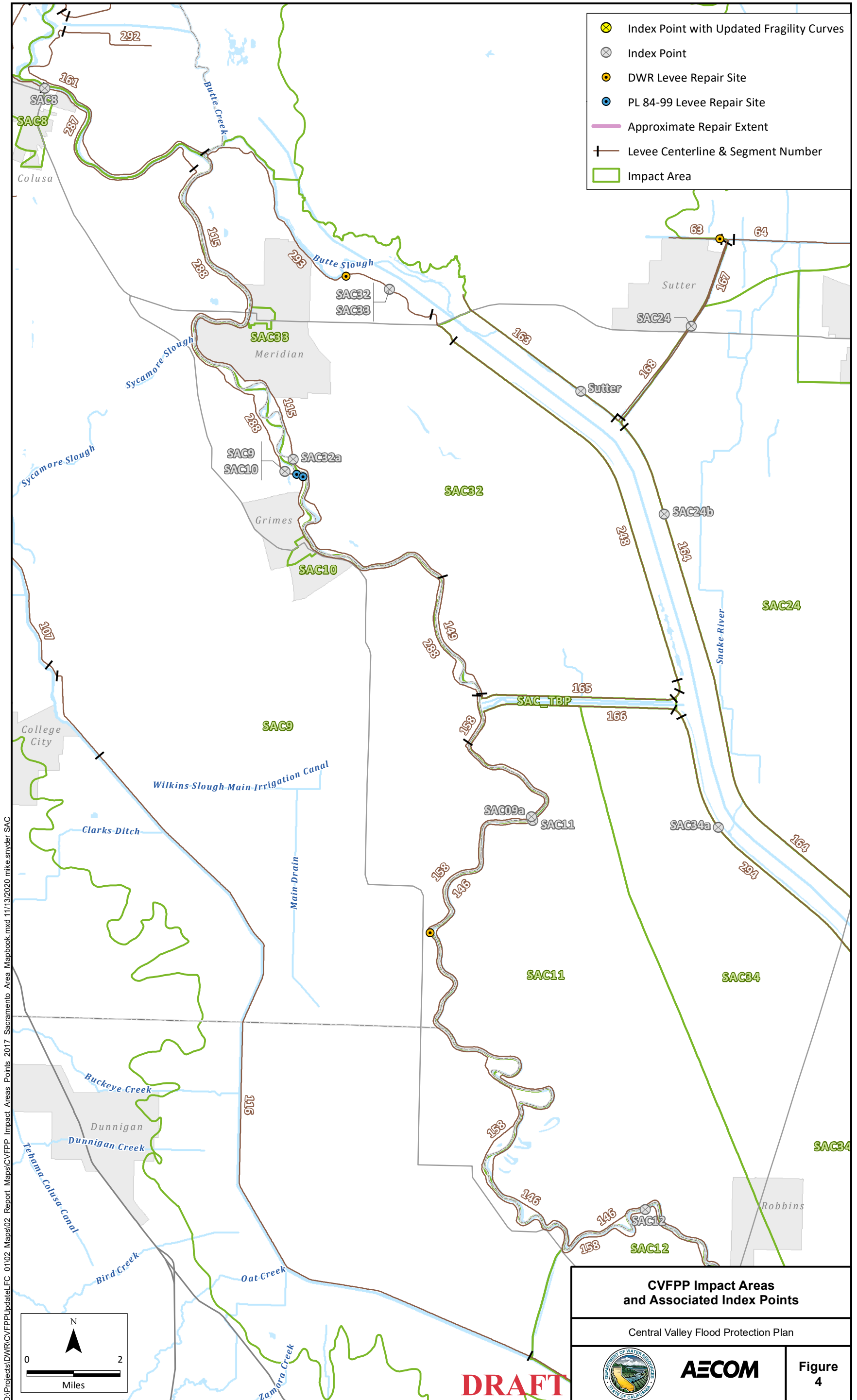
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- ⊗ Index Point with Updated Fragility Curves
- ⊗ Index Point
- DWR Levee Repair Site
- PL 84-99 Levee Repair Site
- Approximate Repair Extent
- Levee Centerline & Segment Number
- Impact Area

CVFPP Impact Areas and Associated Index Points	
Central Valley Flood Protection Plan	
Figure 3	

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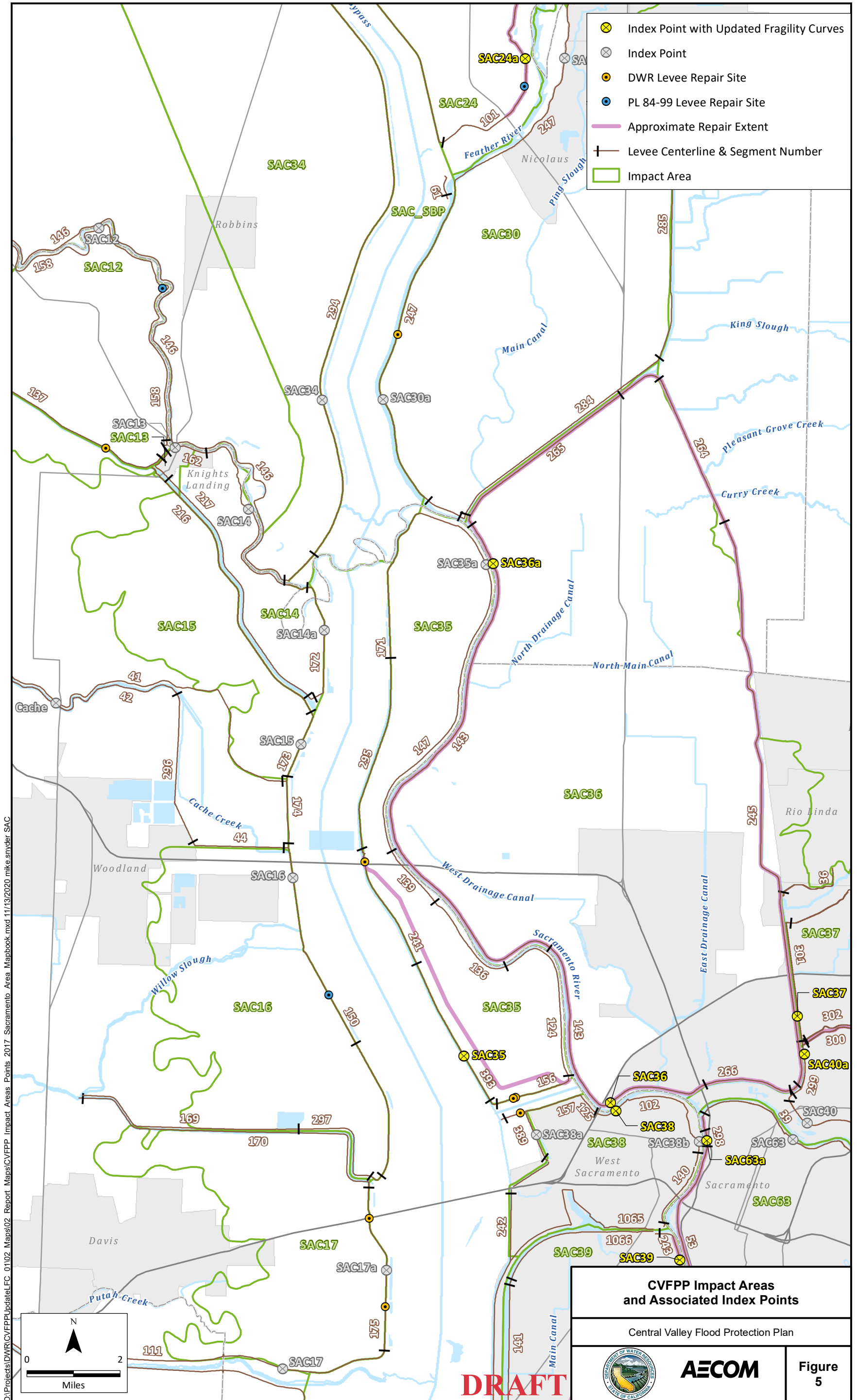


- ⊗ Index Point with Updated Fragility Curves
- ⊗ Index Point
- DWR Levee Repair Site
- PL 84-99 Levee Repair Site
- Approximate Repair Extent
- Levee Centerline & Segment Number
- Impact Area

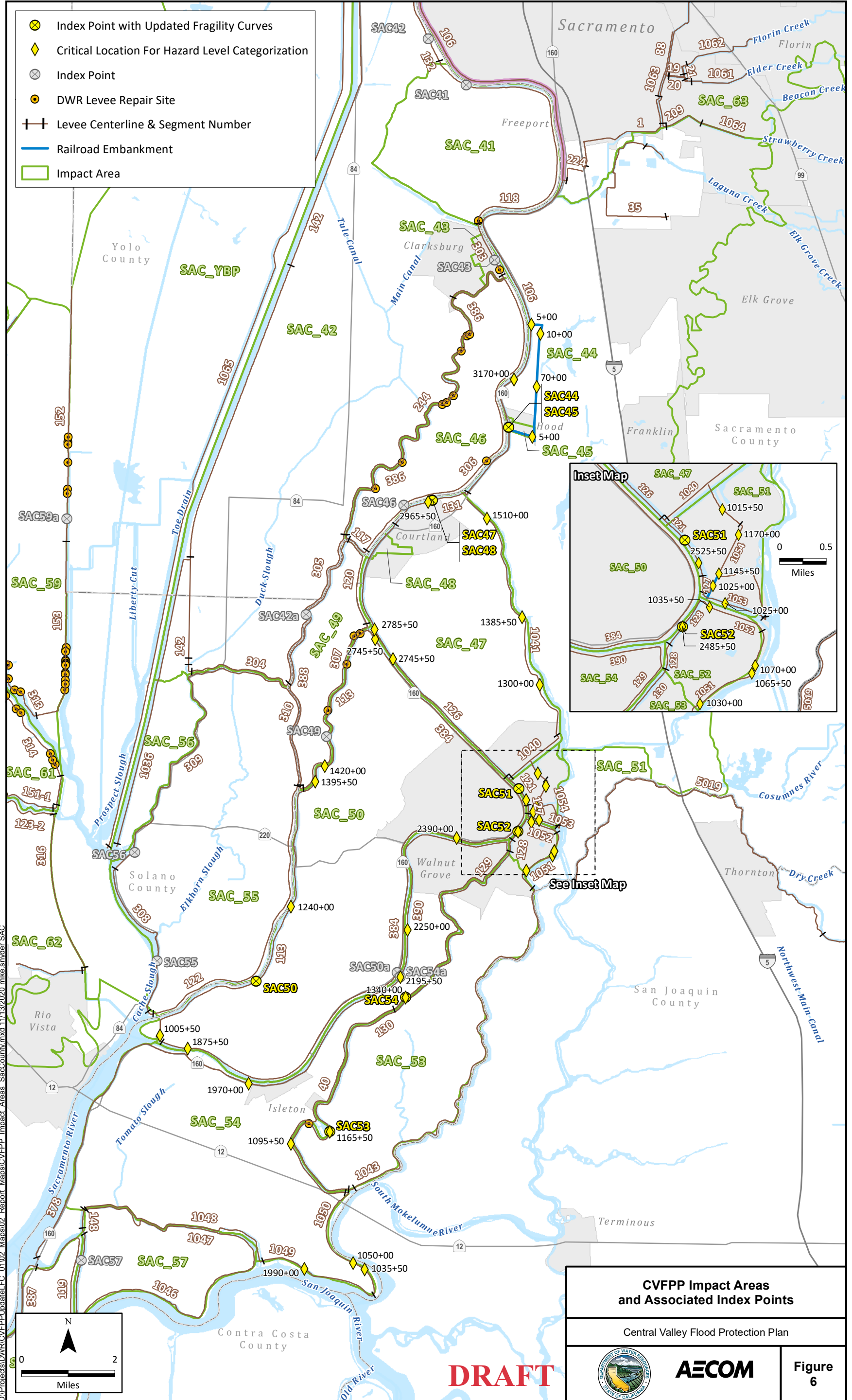
CVFPP Impact Areas and Associated Index Points	
Central Valley Flood Protection Plan	
Figure 4	

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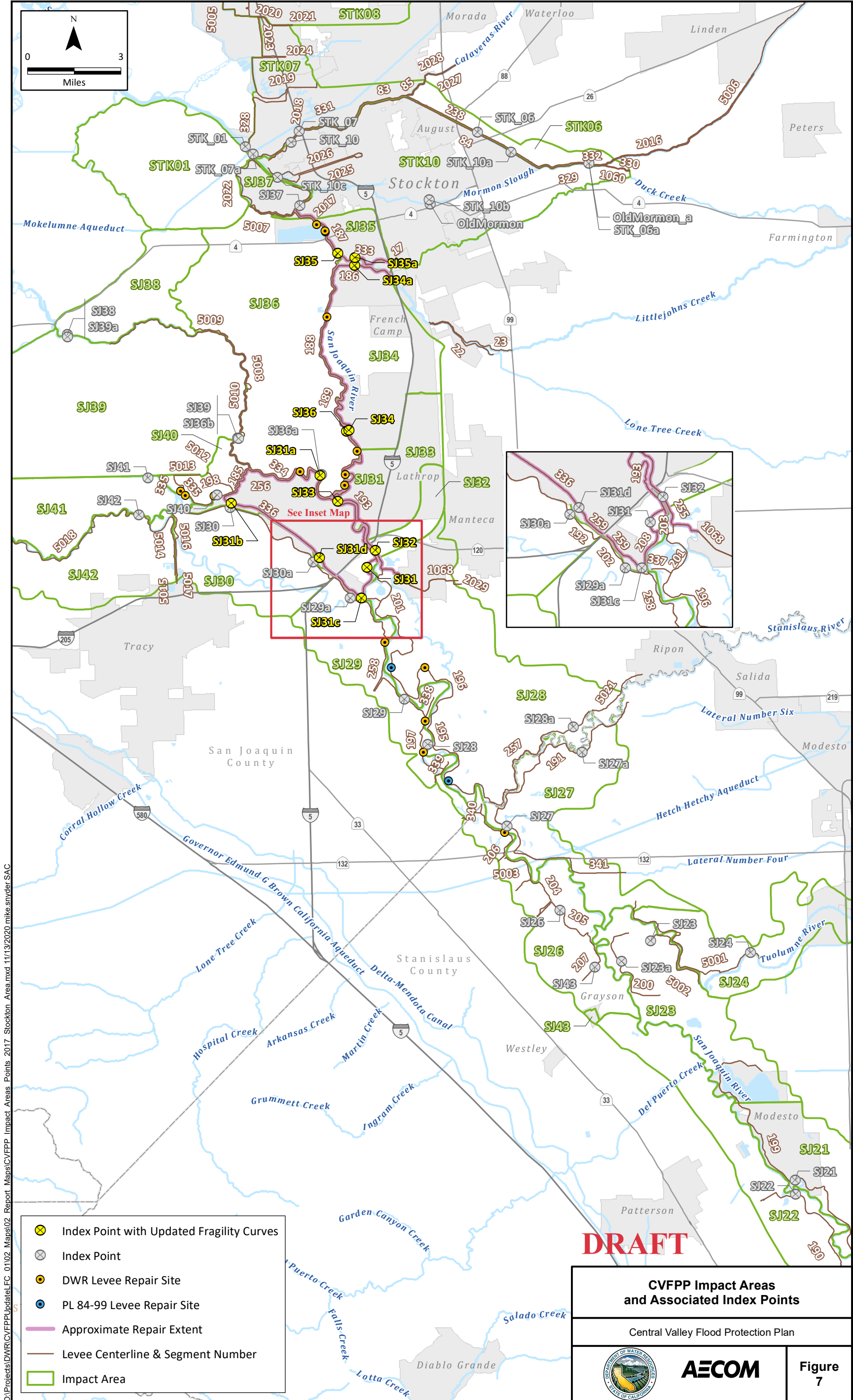


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CVFPP Impact Areas and Associated Index Points		
Central Valley Flood Protection Plan		
	AECOM	Figure 6 6



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- Index Point with Updated Fragility Curves
- Index Point
- DWR Levee Repair Site
- PL 84-99 Levee Repair Site
- Approximate Repair Extent
- Levee Centerline & Segment Number
- Impact Area

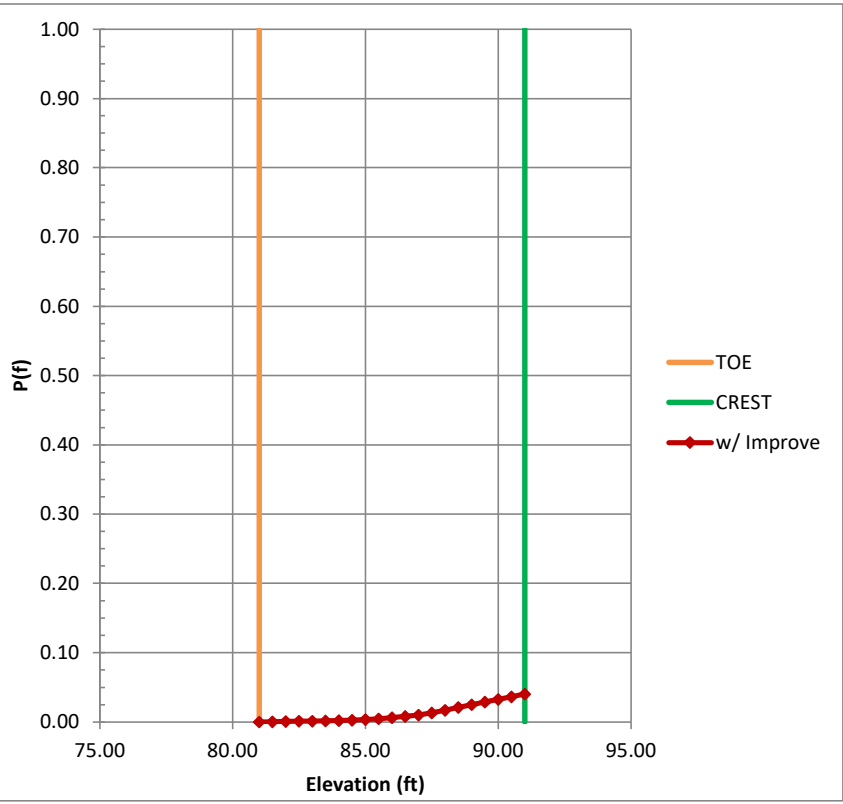
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CVFPP Impact Areas and Associated Index Points	
Central Valley Flood Protection Plan	
Figure 7	

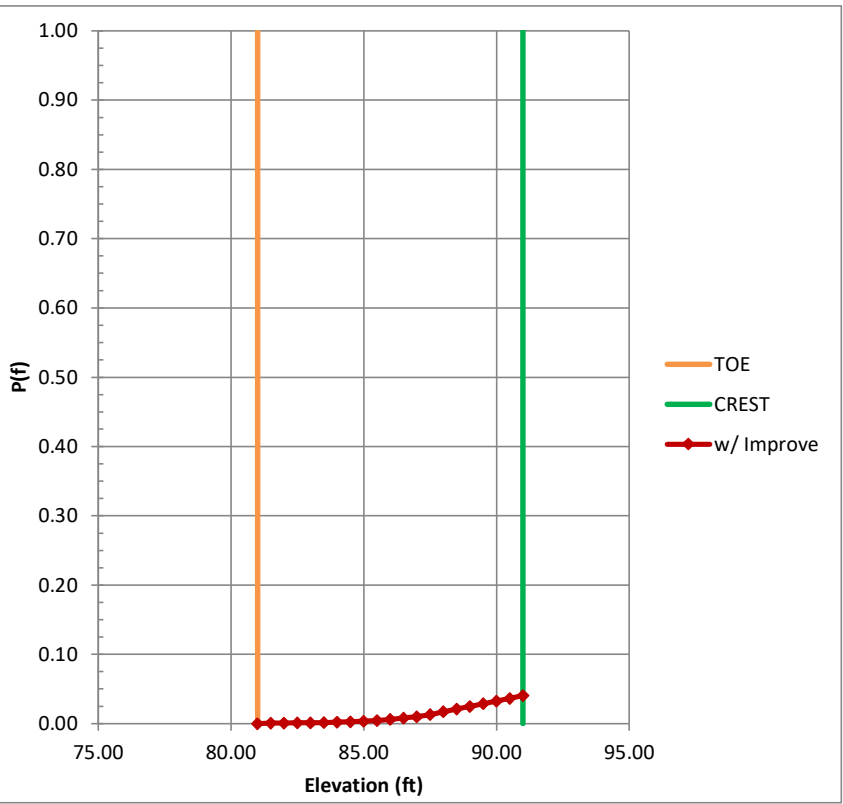
Summary Table of Urban Project Segments with completed/planned repairs

S.No	Index Point	Basin_ID	River/Flood Source	Bank	Crest EL	Landside Toe EL	200-yr WSE	Improvement (completed/To be completed by 2022)
1	SAC21	SAC21	Feather River	Right	91.0	81.0	85.70	Feather River West Levee
2	SAC22	SAC21	Feather River	Right	91.0	81.0	85.70	
3	SAC24a	SAC24	Feather River	Right	62.4	36.3	57.80	
4	SAC25	SAC25	Feather River	Right	82.8	61.3	78.80	
5	SAC25a	SAC25	Feather River	Right	81.8	52.6	74.60	
6	SAC26	SAC26	Yuba River	Right	87.8	63.3	80.20	Marysville Ring Levee
7	SAC26a	SAC26	Yuba River	Right	88.3	59.6	79.40	
8	SAC27	SAC27	Yuba River	Left	84.9	73.5	80.1	
9	SAC27a	SAC27	Yuba River	Left	82.1	64.8	77.00	RD 784
10	SAC28	SAC28	Feather River	Left	66	46.9	61.4	
11	SAC28a	SAC28	Best Slough	Right	65.1	51.5	61.2	
12	SAC28b	SAC28	Bear River	Right	64.7	41.4	59.5	
13	SAC36	SAC36	Sacramento River	Left	40.8	24.4	35.90	NMDEC
14	SAC36a	SAC35	Sacramento River	Right	47.7	30.9	44.7	
15	SAC37	SAC37	Natomas East Main Drainage Canal	Left	44.9	27.0	41.6	
16	SAC38	SAC38	Sacramento River	Left	41.4	21.8	36.4	
17	SAC39	SAC39	Sacramento River	Right	37.3	9.8	32.8	
18	SAC40a	SAC40	Natomas East Main Drainage Canal	Left	43.0	25.6	38.3	
19	Wheat_S		Wheatland	Right	94.8	86.9	91.8	Bear River Setback Levee
20	SAC63a	SAC63	Sacramento River	Left	38.1	23.5	35.7	ARFCD
21	SJ32	SJ32	San Joaquin River	Right	32.9	20.2	29.70	RD 17
22	SJ33	SJ33	San Joaquin River	Left	31.4	17.9	27.70	
23	SJ34	SJ34	San Joaquin River	Right	28.1	12.6	22.40	
24	SJ34a	SJ34	French Camp Slough	Left	20.8	10.5	15.90	RD 404
25	SJ35	SJ35	San Joaquin River	Right	21.8	8.6	15.70	
26	SJ35a	SJ35	San Joaquin River	Right	22.4	10.4	15.90	
26	SJ37	SJ37	San Joaquin River		44.9	27	41.6	

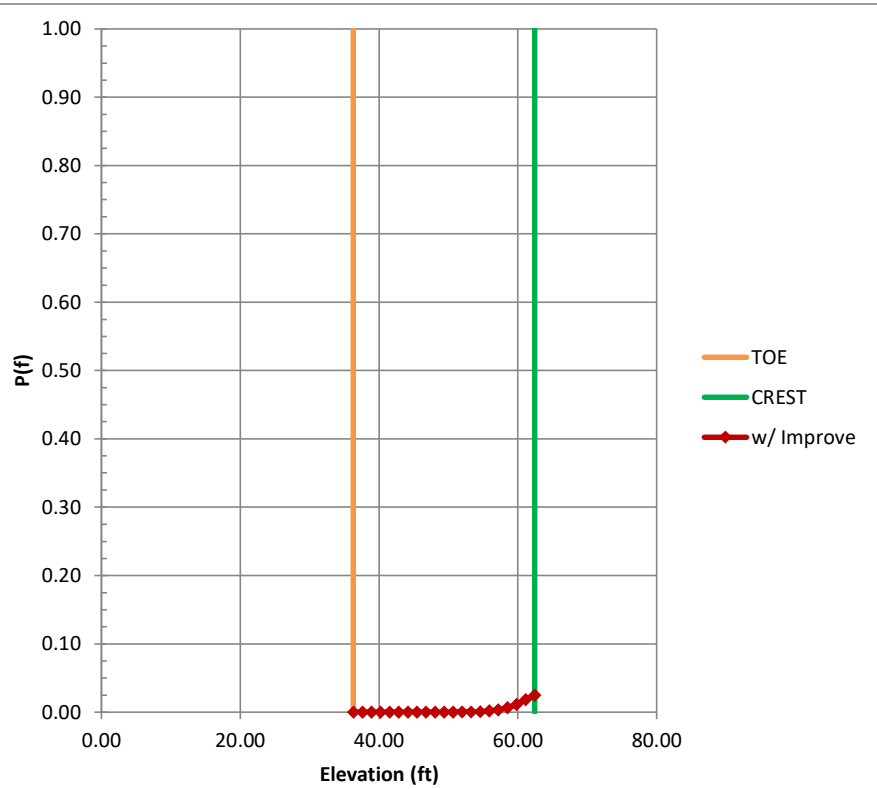
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82.5	0.1%	
83.0	0.1%	
83.5	0.2%	
84.0	0.2%	
84.5	0.3%	
85.0	0.4%	
85.5	0.5%	
86.0	0.6%	
86.5	0.8%	
87.0	1.0%	
87.5	1.3%	
88.0	1.7%	
88.5	2.1%	
89.0	2.5%	
89.5	2.9%	
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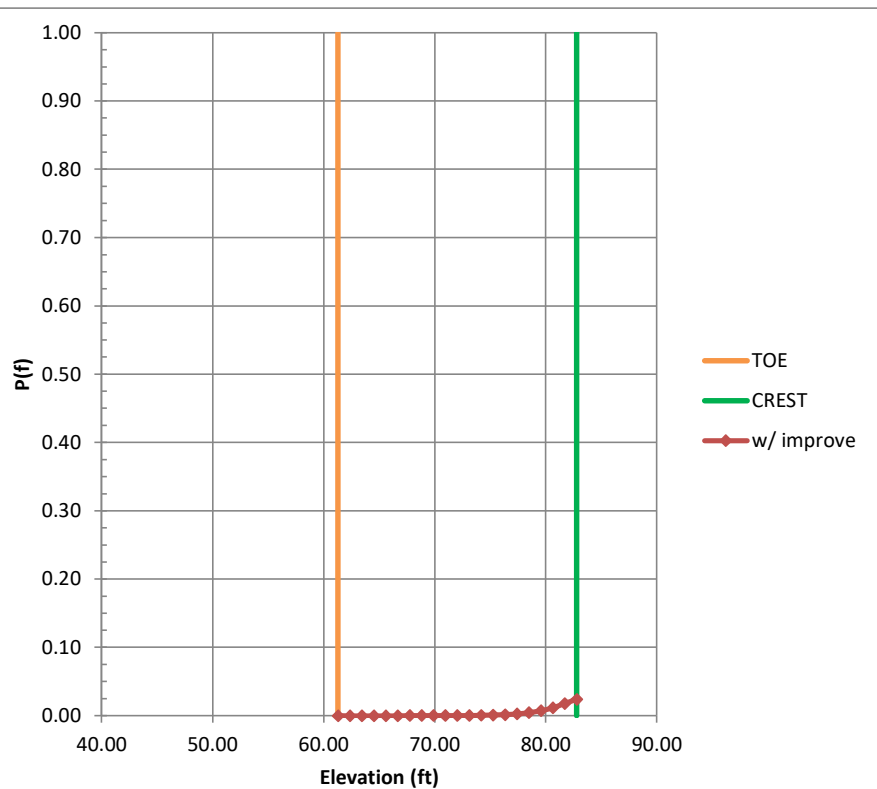
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82.5	0.1%	
83.0	0.1%	
83.5	0.2%	
84.0	0.2%	
84.5	0.3%	
85.0	0.4%	
85.5	0.5%	
86.0	0.6%	
86.5	0.8%	
87.0	1.0%	
87.5	1.3%	
88.0	1.7%	
88.5	2.1%	
89.0	2.5%	
89.5	2.9%	
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90.5	3.7%	
91.0	4.0%	
91.01		1



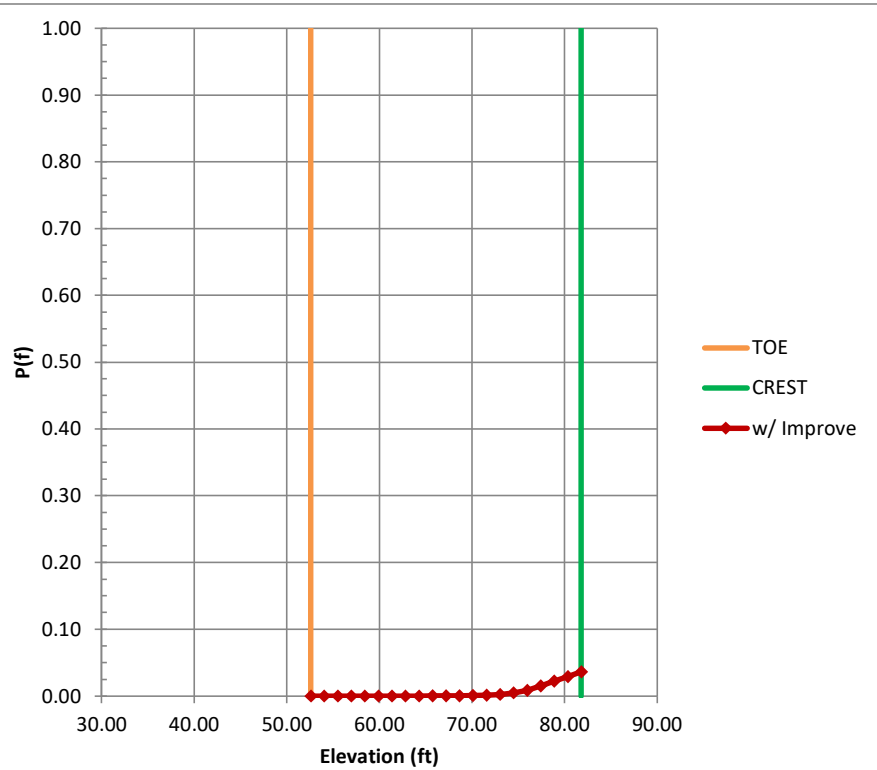
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Segment:	w/ Improve	
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37.61	0.0%	
38.91	0.0%	
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41.52	0.0%	
42.83	0.0%	
44.13	0.0%	
45.44	0.0%	
46.74	0.0%	
48.05	0.0%	
49.35	0.0%	
50.66	0.0%	
51.96	0.0%	
53.27	0.1%	
54.57	0.1%	
55.88	0.2%	
57.18	0.4%	
58.49	0.7%	
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62.40	2.5%	
62.41	1	



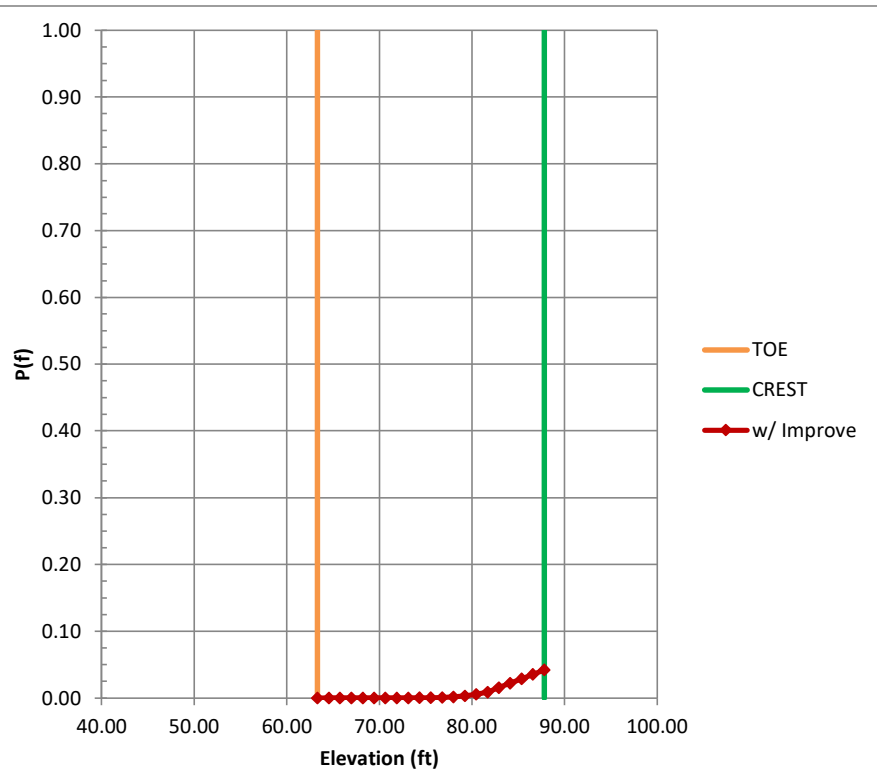
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63.45	0.0%	
64.53	0.0%	
65.60	0.0%	
66.68	0.0%	
67.75	0.0%	
68.83	0.0%	
69.90	0.0%	
70.98	0.0%	
72.05	0.0%	
73.13	0.0%	
74.20	0.1%	
75.28	0.1%	
76.35	0.1%	
77.43	0.3%	
78.50	0.4%	
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82.81	1	



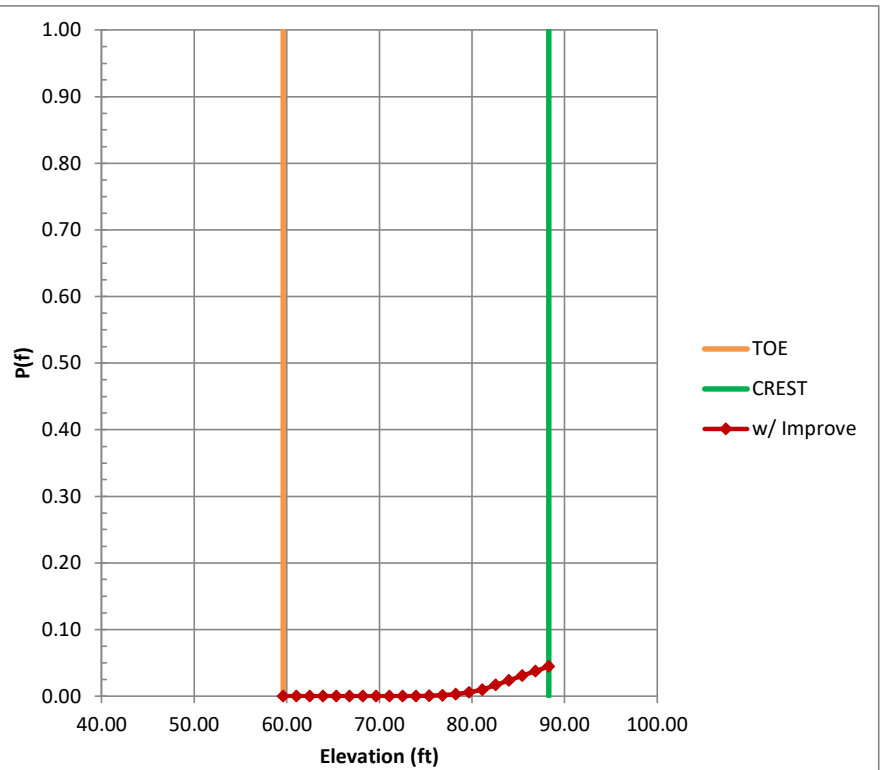
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Segment:	w/ Improve	
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54.06	0.0%	
55.52	0.0%	
56.98	0.0%	
58.44	0.0%	
59.90	0.0%	
61.36	0.0%	
62.82	0.0%	
64.28	0.0%	
65.74	0.0%	
67.20	0.0%	
68.66	0.0%	
70.12	0.1%	
71.58	0.1%	
73.04	0.2%	
74.50	0.5%	
75.96	0.8%	
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80.34	2.9%	
81.80	3.6%	
81.81		1



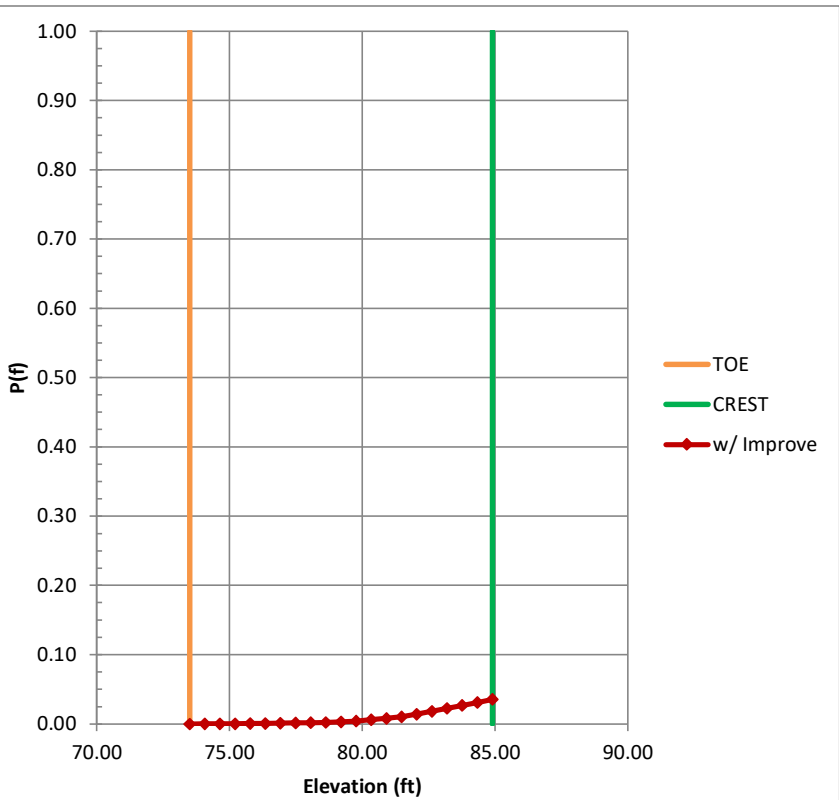
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65.75	0.0%	
66.98	0.0%	
68.20	0.0%	
69.43	0.0%	
70.65	0.0%	
71.88	0.0%	
73.10	0.0%	
74.33	0.0%	
75.55	0.0%	
76.78	0.1%	
78.00	0.2%	
79.23	0.3%	
80.45	0.6%	
81.68	0.9%	
82.90	1.6%	
84.13	2.2%	
85.35	2.9%	
86.58	3.5%	
87.80	4.2%	
87.81		1

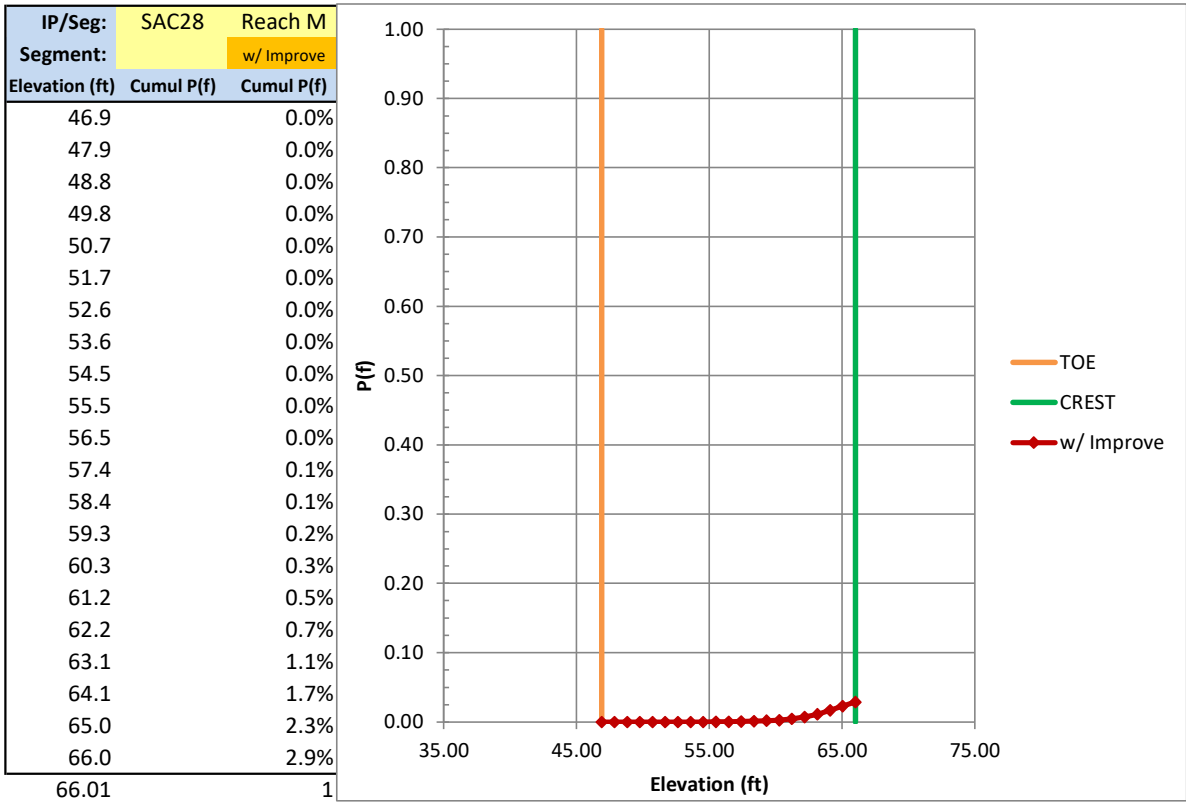
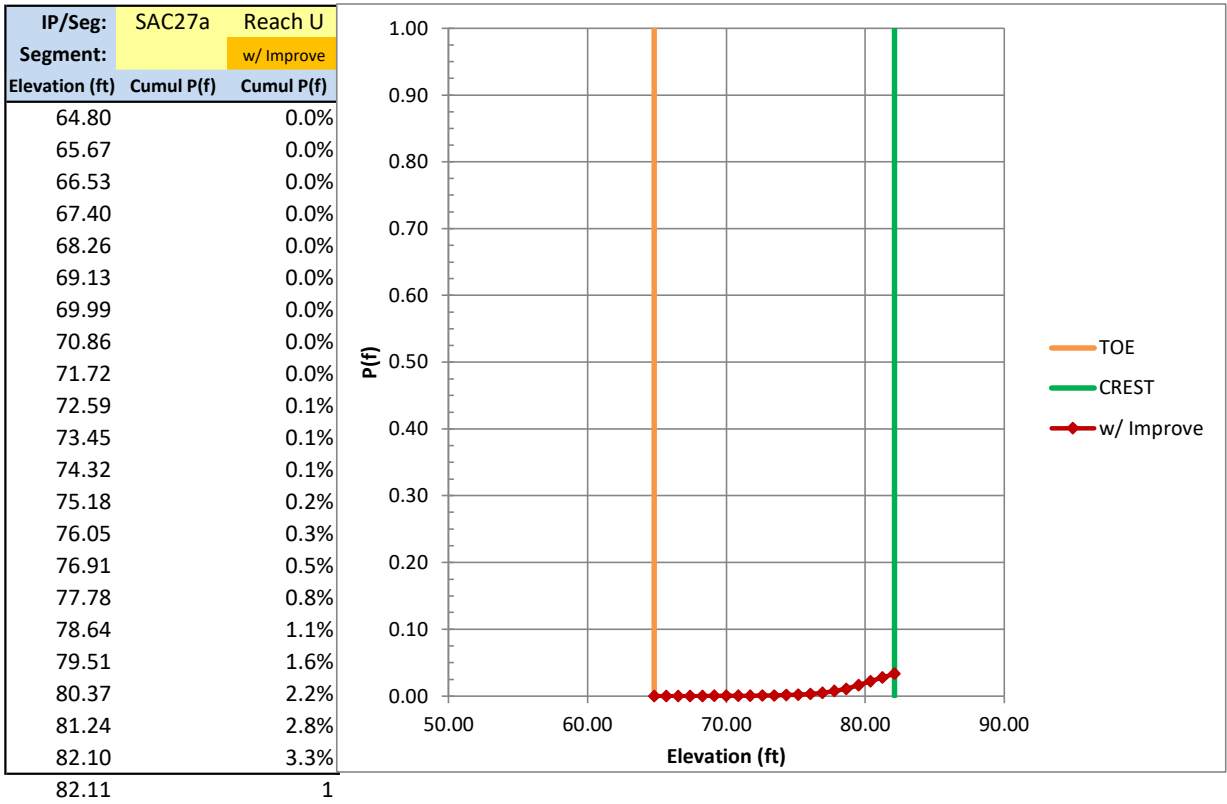


IP/Seg:	SAC26a	Reach H
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
59.60	0.0%	
61.04	0.0%	
62.47	0.0%	
63.91	0.0%	
65.34	0.0%	
66.78	0.0%	
68.21	0.0%	
69.65	0.0%	
71.08	0.0%	
72.52	0.0%	
73.95	0.0%	
75.39	0.1%	
76.82	0.1%	
78.26	0.3%	
79.69	0.6%	
81.13	1.0%	
82.56	1.7%	
84.00	2.4%	
85.43	3.1%	
86.87	3.8%	
88.30	4.5%	
88.31	1	

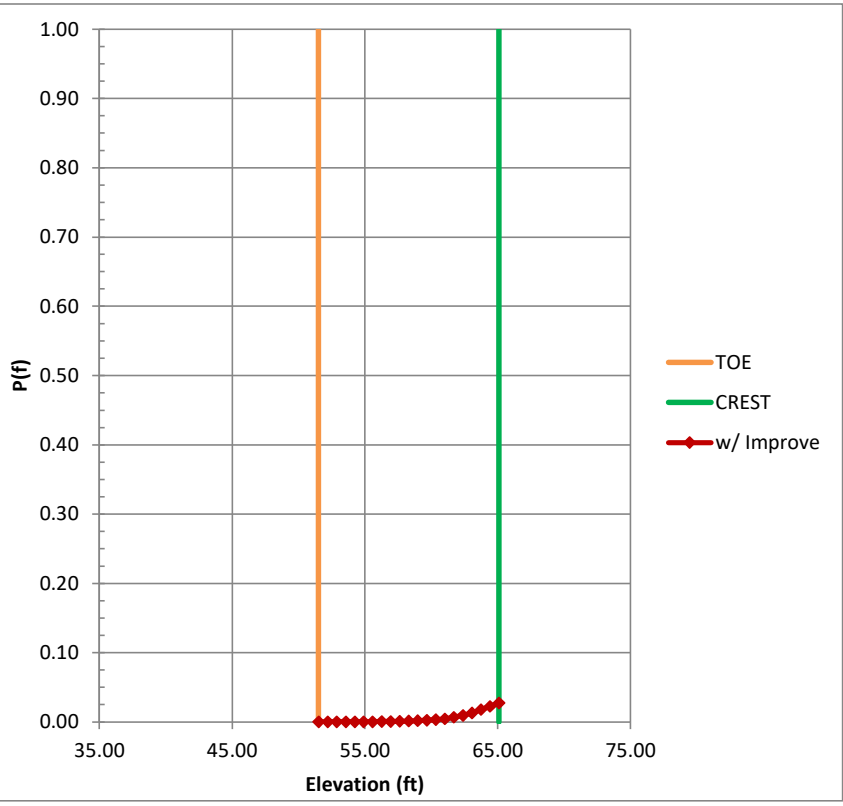


IP/Seg:	SAC27	Reach W
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
73.5	0.0%	
74.1	0.0%	
74.6	0.0%	
75.2	0.0%	
75.8	0.1%	
76.4	0.1%	
76.9	0.1%	
77.5	0.1%	
78.1	0.2%	
78.6	0.2%	
79.2	0.3%	
79.8	0.4%	
80.3	0.6%	
80.9	0.8%	
81.5	1.0%	
82.1	1.4%	
82.6	1.8%	
83.2	2.3%	
83.8	2.7%	
84.3	3.1%	
84.9	3.5%	
84.91	1	

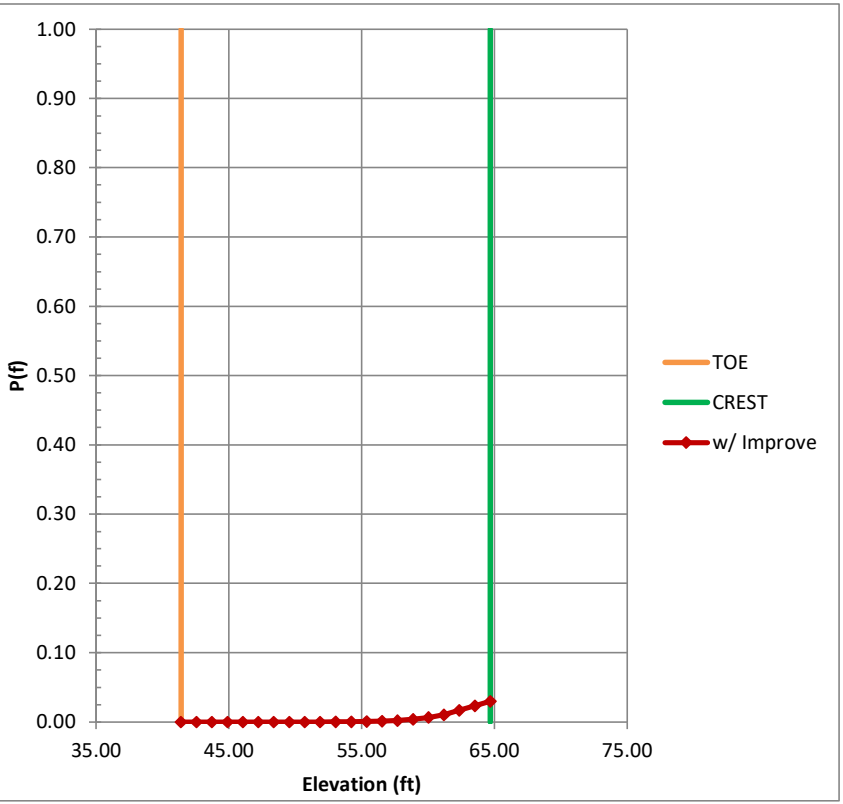




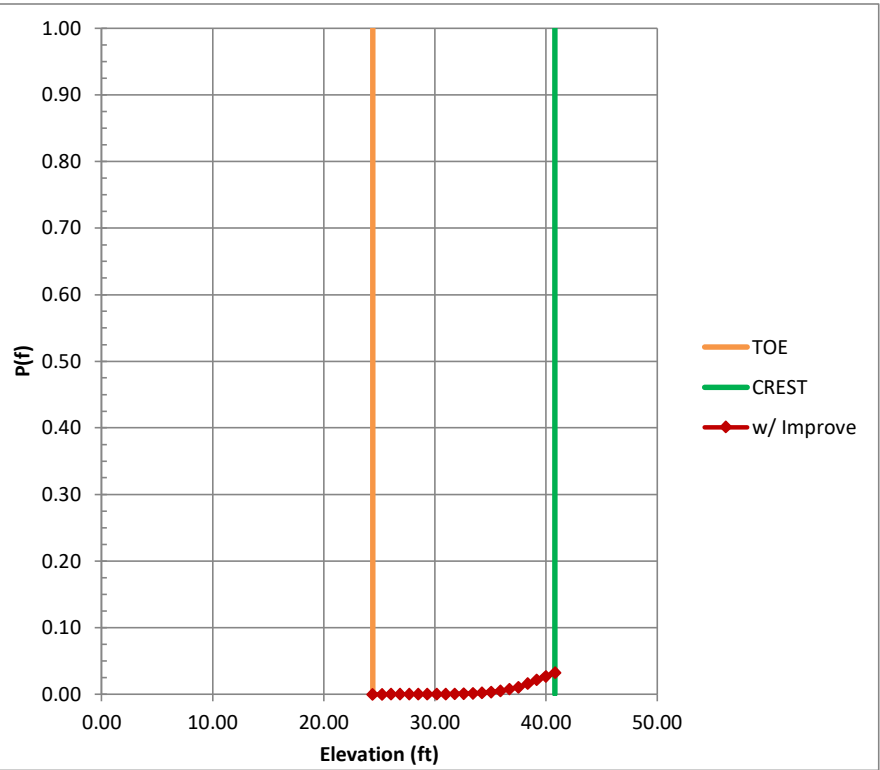
IP/Seg:	SAC28a	Reach E1
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
51.5	0.0%	
52.2	0.0%	
52.9	0.0%	
53.5	0.0%	
54.2	0.0%	
54.9	0.0%	
55.6	0.0%	
56.3	0.0%	
56.9	0.1%	
57.6	0.1%	
58.3	0.1%	
59.0	0.2%	
59.7	0.2%	
60.3	0.3%	
61.0	0.5%	
61.7	0.7%	
62.4	0.9%	
63.1	1.3%	
63.7	1.8%	
64.4	2.3%	
65.1	2.7%	
65.11	1	1



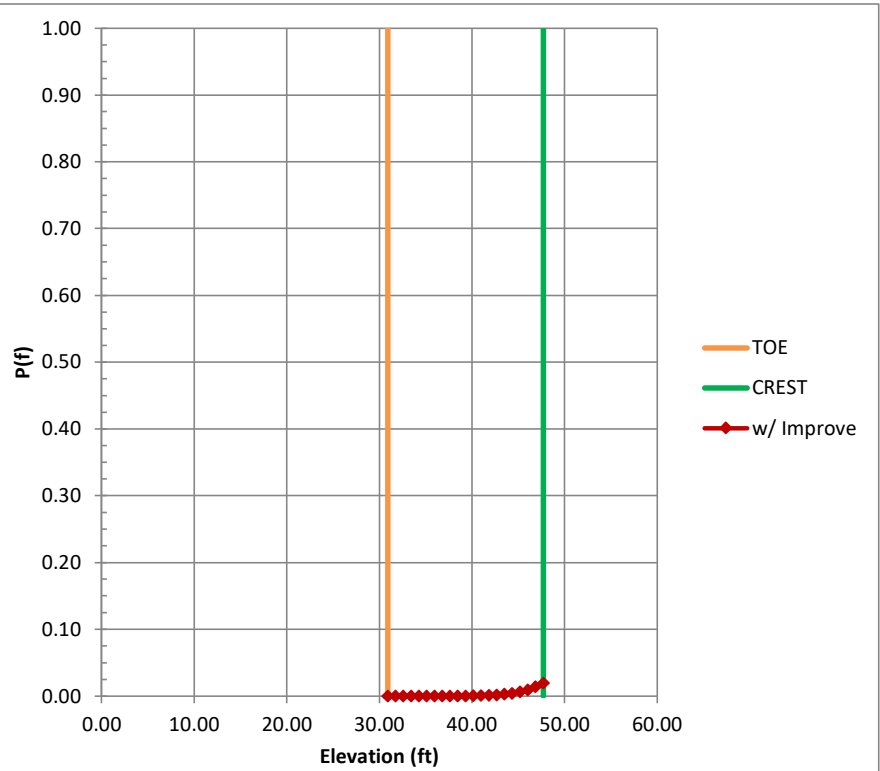
IP/Seg:	SAC28b	Reach J
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
41.4	0.0%	
42.6	0.0%	
43.7	0.0%	
44.9	0.0%	
46.1	0.0%	
47.2	0.0%	
48.4	0.0%	
49.6	0.0%	
50.7	0.0%	
51.9	0.0%	
53.1	0.0%	
54.2	0.0%	
55.4	0.1%	
56.5	0.1%	
57.7	0.2%	
58.9	0.4%	
60.0	0.7%	
61.2	1.0%	
62.4	1.7%	
63.5	2.3%	
64.7	3.0%	
64.71	1	1



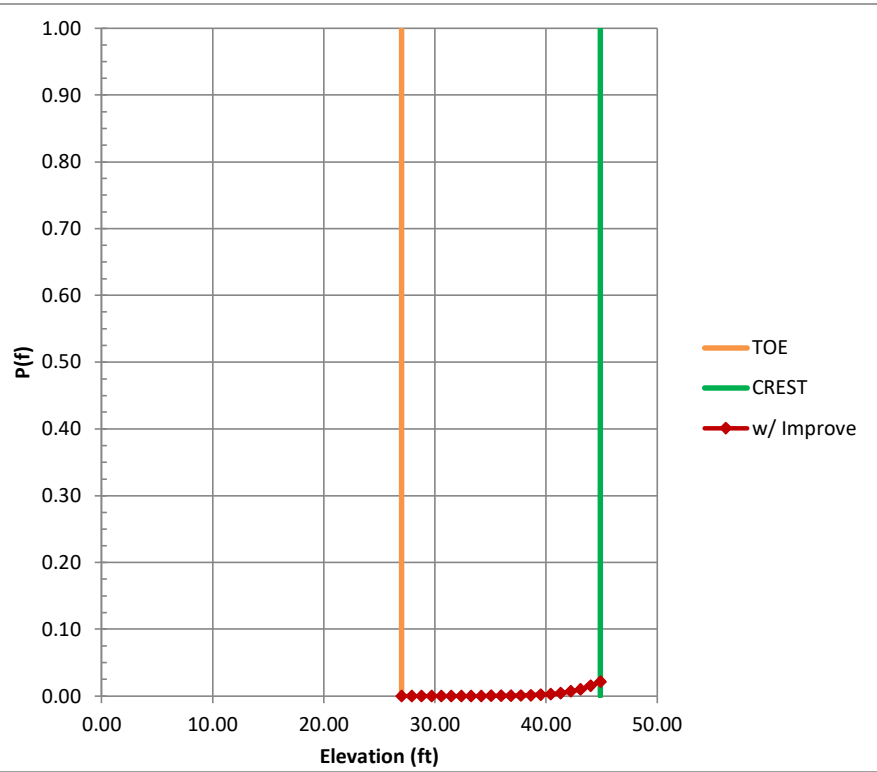
IP/Seg:	SAC36	Reach D
Segment:		w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
24.40	0.0%	
25.22	0.0%	
26.04	0.0%	
26.86	0.0%	
27.68	0.0%	
28.50	0.0%	
29.32	0.0%	
30.14	0.0%	
30.96	0.0%	
31.78	0.1%	
32.60	0.1%	
33.42	0.1%	
34.24	0.2%	
35.06	0.3%	
35.88	0.5%	
36.70	0.8%	
37.52	1.1%	
38.34	1.6%	
39.16	2.2%	
39.98	2.7%	
40.80	3.3%	
40.81		1



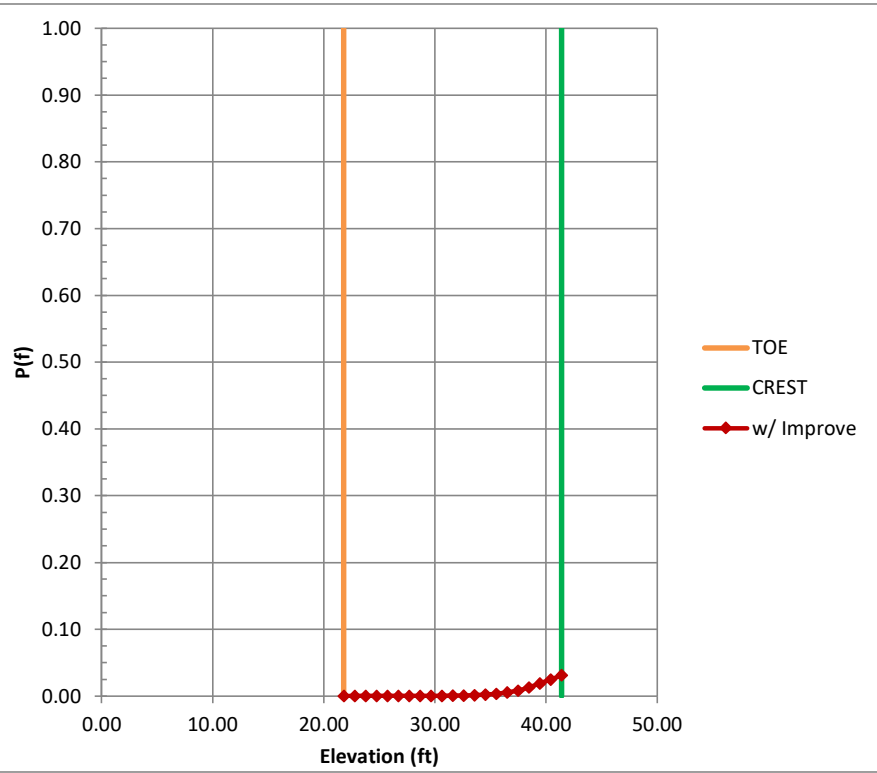
IP/Seg:	SAC36a	Reach B
Segment:		w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
30.90	0.0%	
31.74	0.0%	
32.58	0.0%	
33.42	0.0%	
34.26	0.0%	
35.10	0.0%	
35.94	0.0%	
36.78	0.0%	
37.62	0.0%	
38.46	0.0%	
39.30	0.0%	
40.14	0.1%	
40.98	0.1%	
41.82	0.1%	
42.66	0.2%	
43.50	0.3%	
44.34	0.4%	
45.18	0.7%	
46.02	0.9%	
46.86	1.4%	
47.70	2.0%	
47.71		1

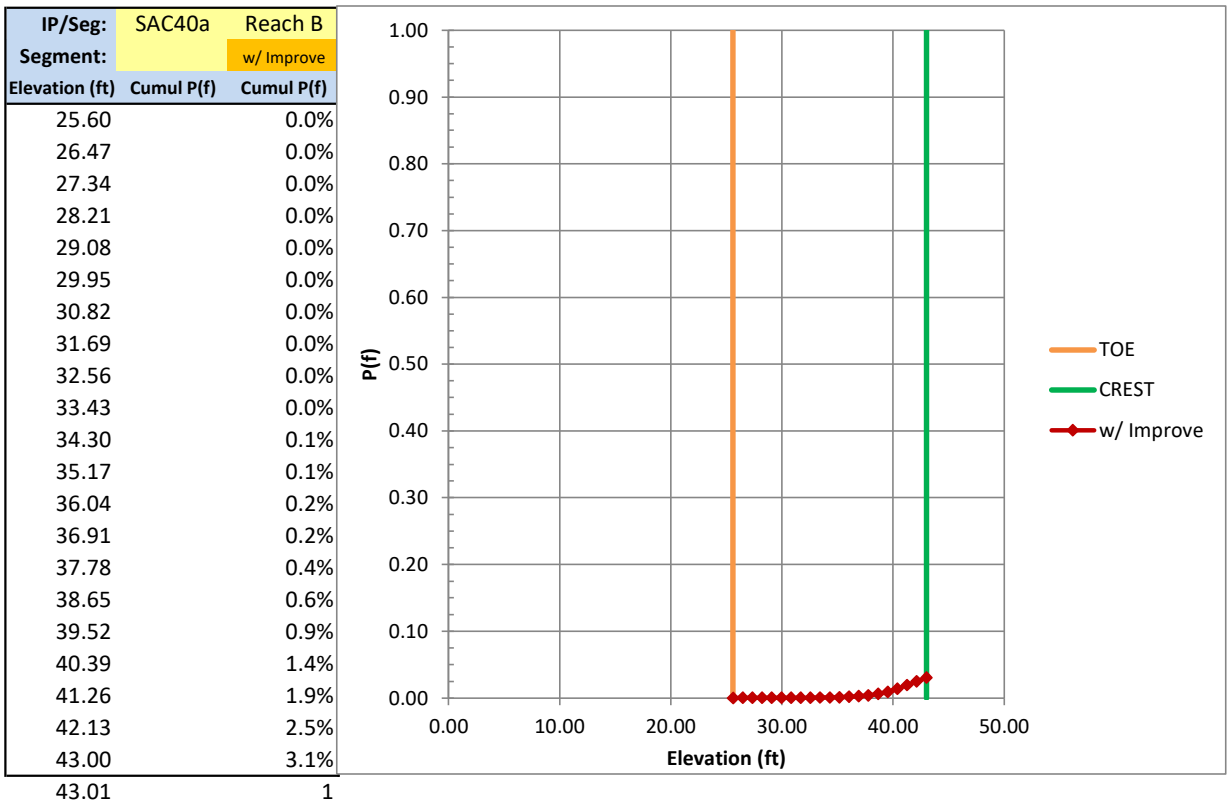
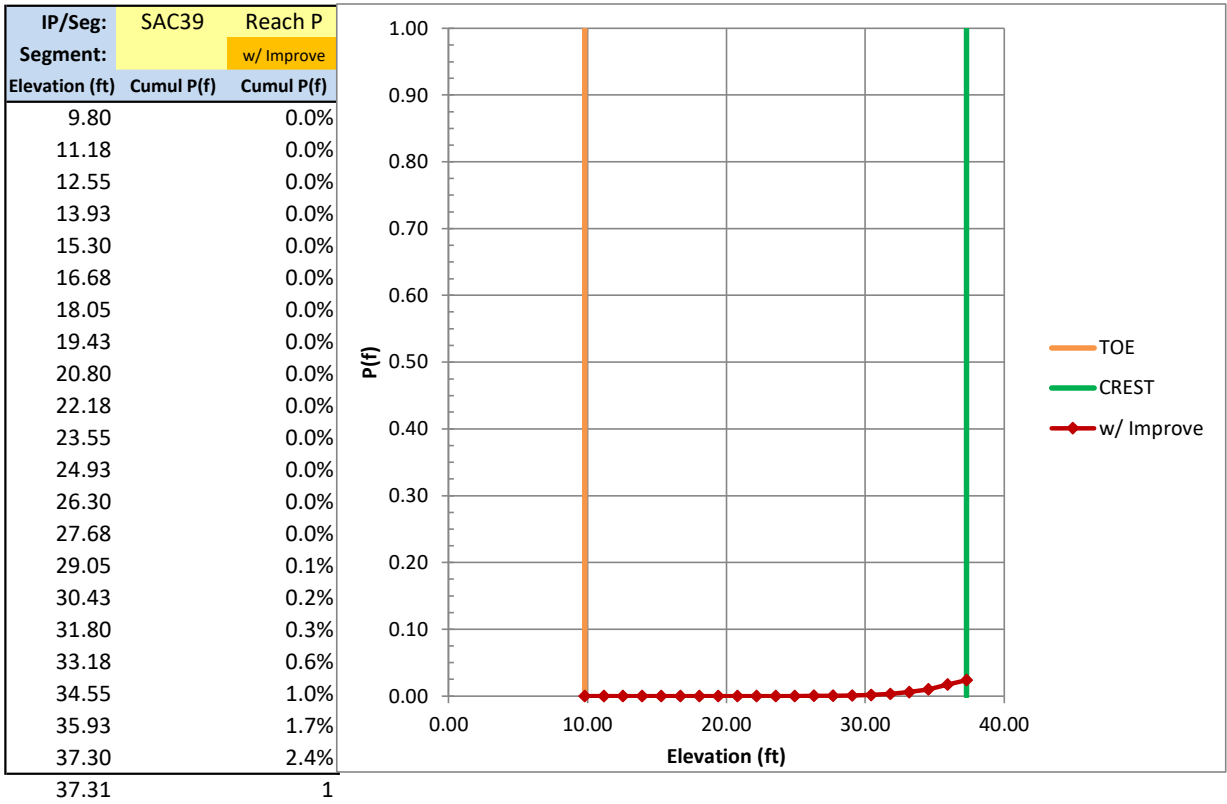


IP/Seg:	SAC37	Reach D2
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
27.00	0.0%	
27.90	0.0%	
28.79	0.0%	
29.69	0.0%	
30.58	0.0%	
31.48	0.0%	
32.37	0.0%	
33.27	0.0%	
34.16	0.0%	
35.06	0.0%	
35.95	0.0%	
36.85	0.0%	
37.74	0.1%	
38.64	0.1%	
39.53	0.2%	
40.43	0.3%	
41.32	0.4%	
42.22	0.7%	
43.11	1.0%	
44.01	1.6%	
44.90	2.1%	
44.91		1

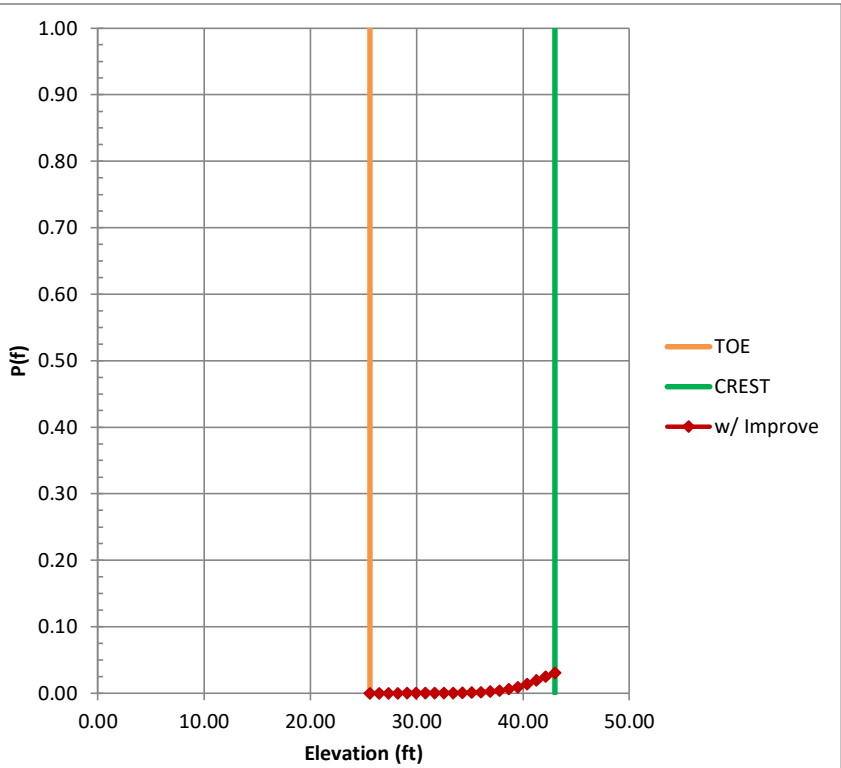


IP/Seg:	SAC38	Reach I
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
21.80	0.0%	
22.78	0.0%	
23.76	0.0%	
24.74	0.0%	
25.72	0.0%	
26.70	0.0%	
27.68	0.0%	
28.66	0.0%	
29.64	0.0%	
30.62	0.0%	
31.60	0.0%	
32.58	0.1%	
33.56	0.1%	
34.54	0.2%	
35.52	0.3%	
36.50	0.5%	
37.48	0.8%	
38.46	1.3%	
39.44	1.9%	
40.42	2.5%	
41.40	3.1%	
41.41		1

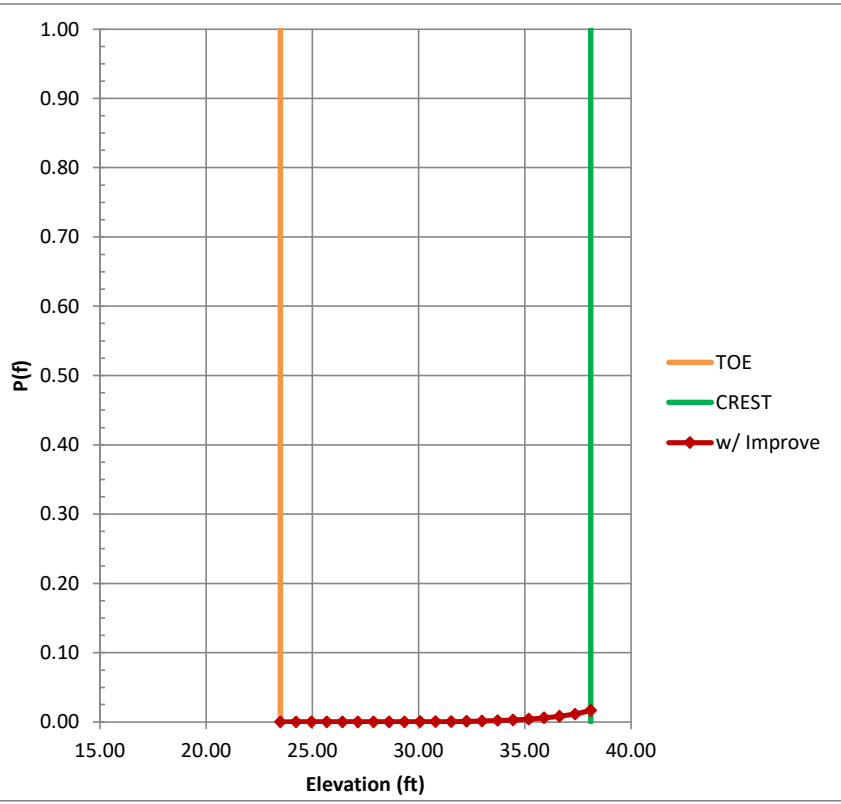




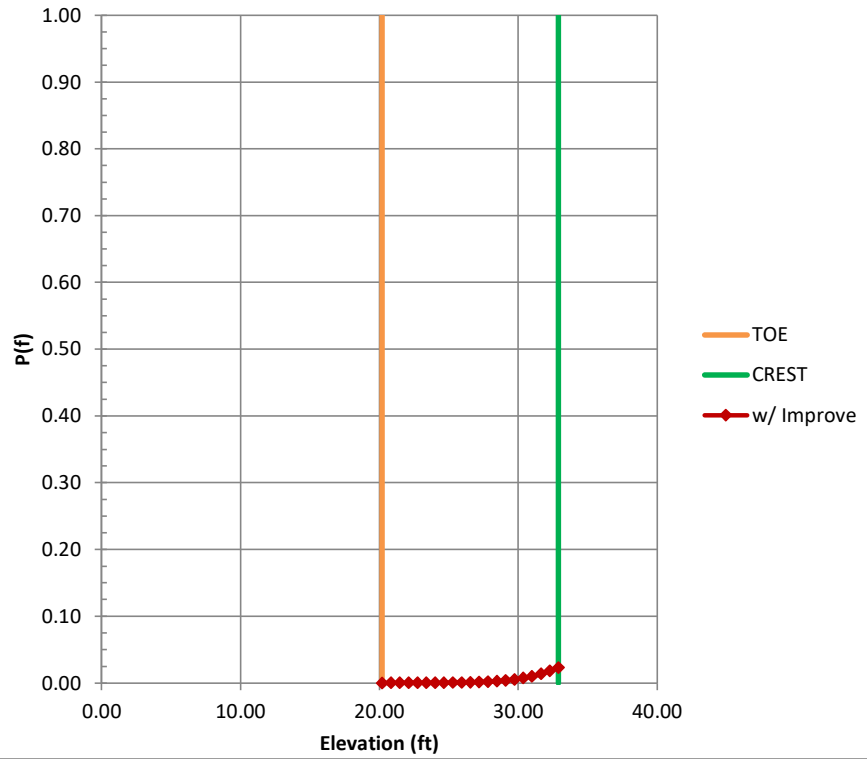
IP/Seg: Wheatland_S		
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
86.90	0.0%	
87.30	0.1%	
87.69	0.1%	
88.09	0.1%	
88.48	0.1%	
88.88	0.1%	
89.27	0.1%	
89.67	0.2%	
90.06	0.2%	
90.46	0.3%	
90.85	0.3%	
91.25	0.4%	
91.64	0.5%	
92.04	0.6%	
92.43	0.8%	
92.83	0.9%	
93.22	1.1%	
93.62	1.4%	
94.01	1.7%	
94.41	2.0%	
94.80	2.3%	
94.81		1



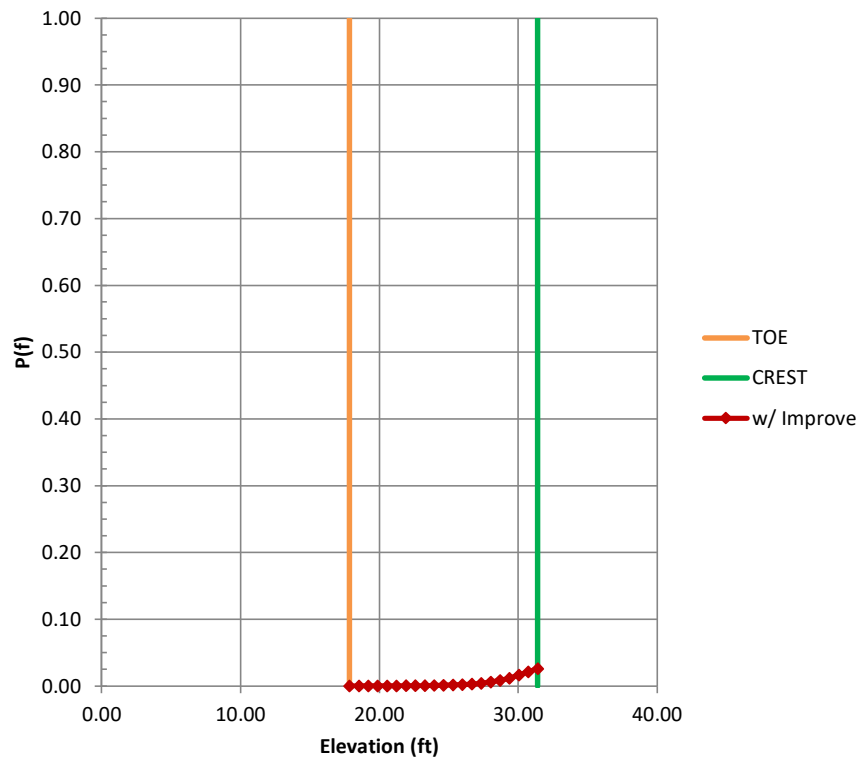
IP/Seg: SAC63a Reach D		
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
23.5	0.0%	
24.2	0.0%	
25.0	0.0%	
25.7	0.0%	
26.4	0.0%	
27.2	0.0%	
27.9	0.0%	
28.6	0.0%	
29.3	0.0%	
30.1	0.0%	
30.8	0.0%	
31.5	0.1%	
32.3	0.1%	
33.0	0.1%	
33.7	0.2%	
34.5	0.3%	
35.2	0.4%	
35.9	0.6%	
36.6	0.8%	
37.4	1.1%	
38.1	1.6%	
38.11		1



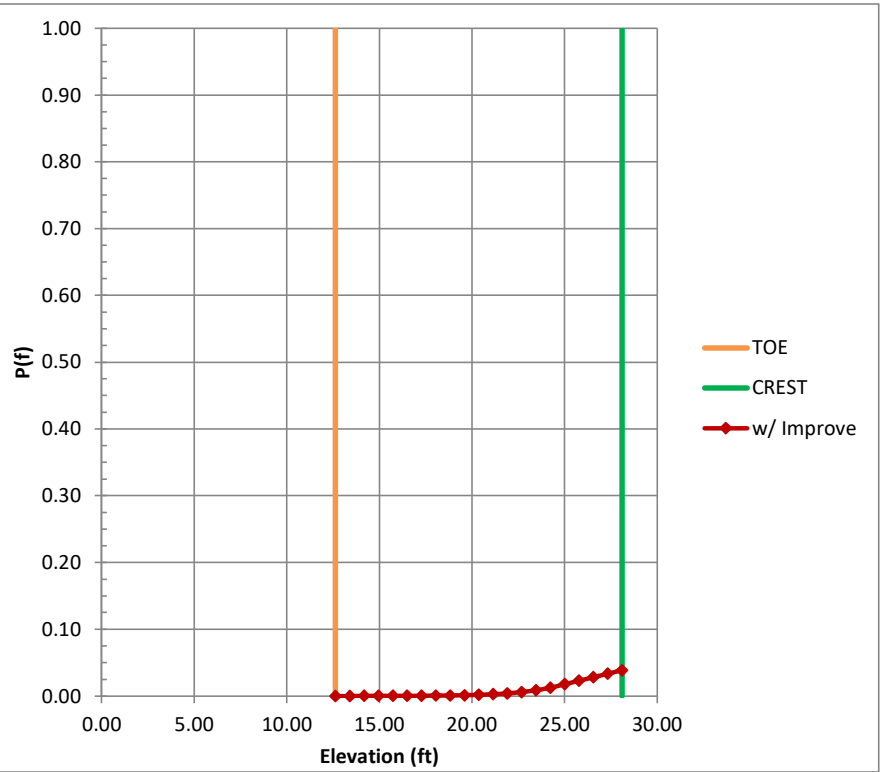
IP/Seg:	SJ32	Reach M3
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
20.20	0.0%	
20.84	0.0%	
21.47	0.0%	
22.11	0.0%	
22.74	0.0%	
23.38	0.0%	
24.01	0.0%	
24.65	0.0%	
25.28	0.1%	
25.92	0.1%	
26.55	0.1%	
27.19	0.1%	
27.82	0.2%	
28.46	0.3%	
29.09	0.4%	
29.73	0.5%	
30.36	0.7%	
31.00	1.0%	
31.63	1.4%	
32.27	1.8%	
32.90	2.3%	
32.91		1



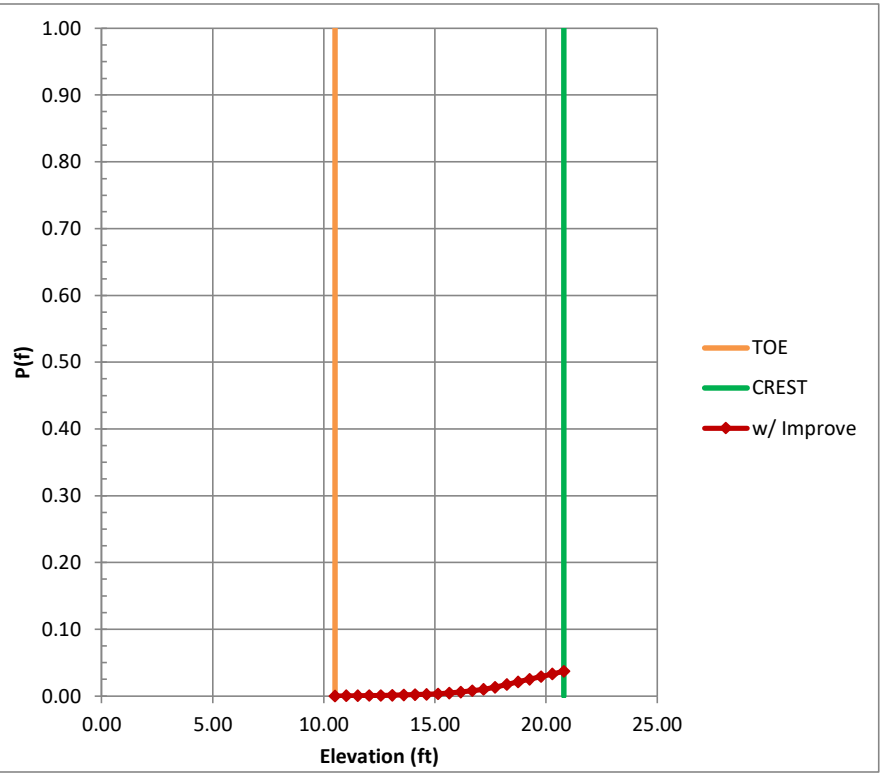
IP/Seg:	SJ33	Reach L2
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
17.85	0.0%	
18.53	0.0%	
19.21	0.0%	
19.88	0.0%	
20.56	0.0%	
21.24	0.0%	
21.92	0.0%	
22.59	0.0%	
23.27	0.1%	
23.95	0.1%	
24.63	0.1%	
25.30	0.2%	
25.98	0.2%	
26.66	0.3%	
27.34	0.4%	
28.01	0.6%	
28.69	0.9%	
29.37	1.2%	
30.05	1.6%	
30.72	2.1%	
31.40	2.6%	
31.41		1

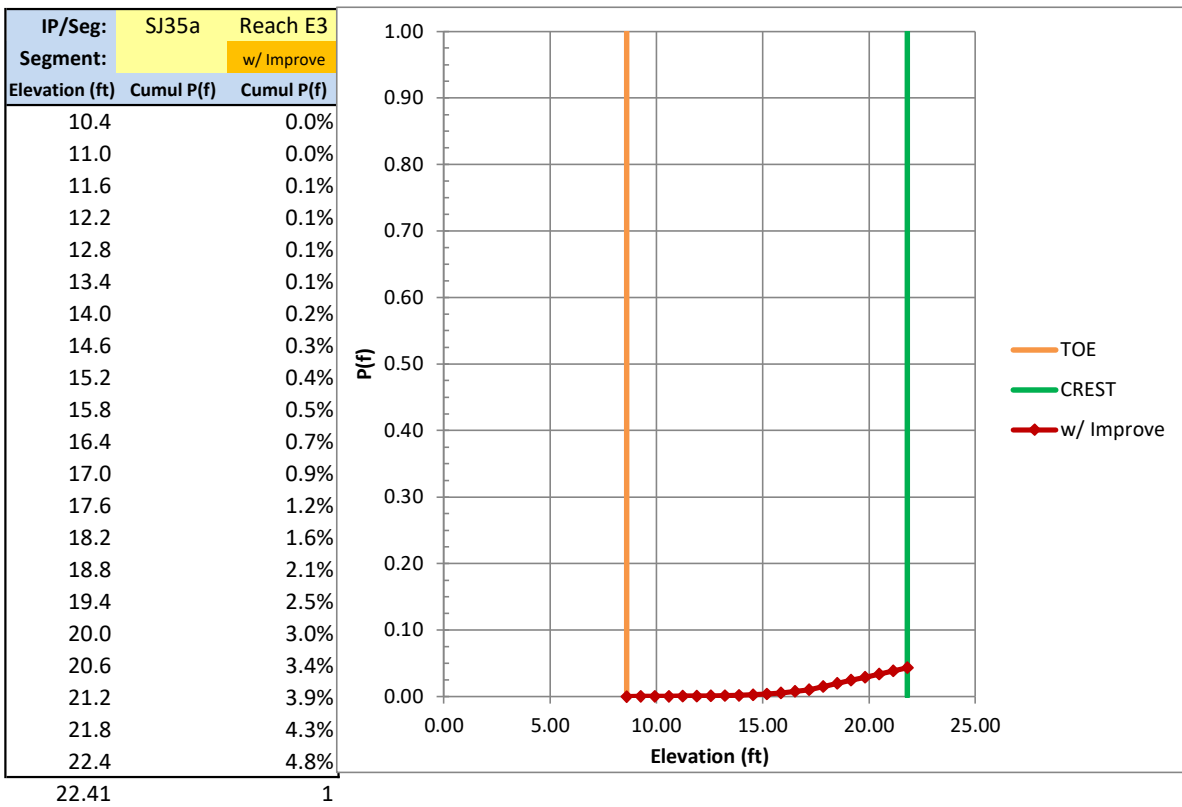
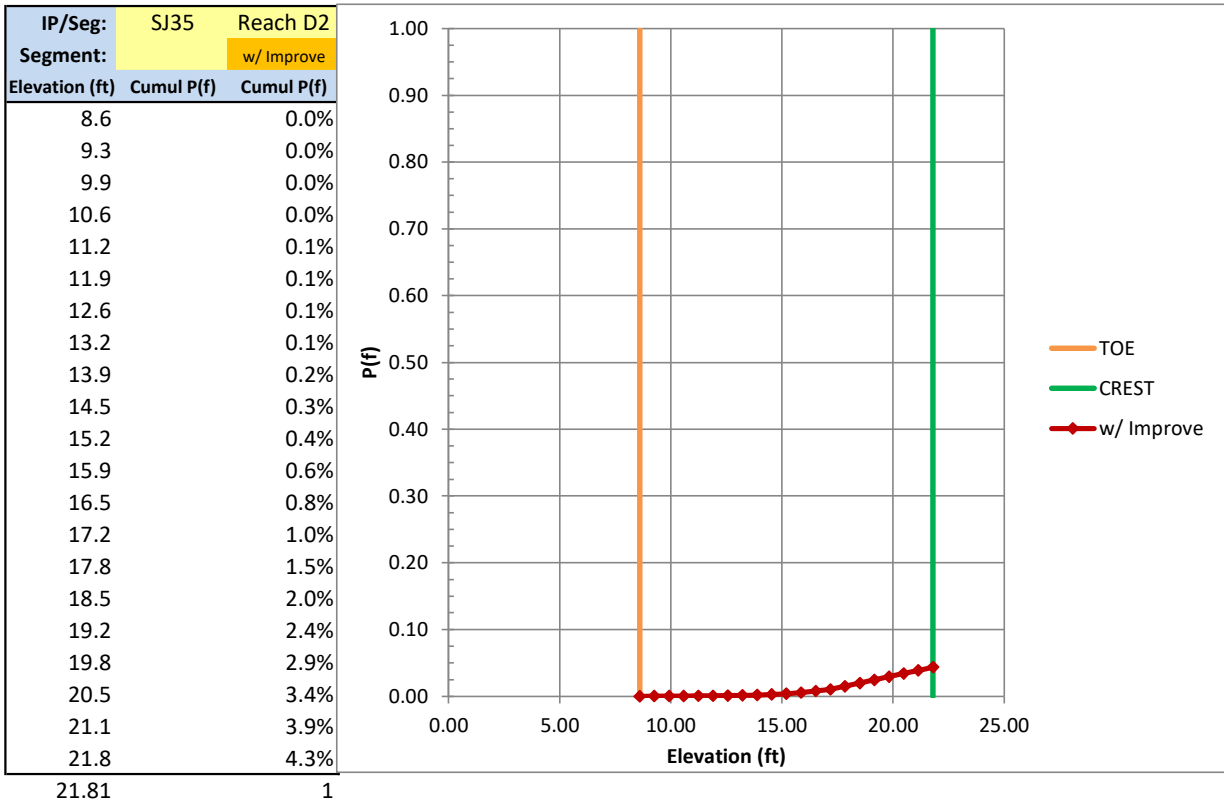


IP/Seg:	SJ34	Reach H2
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
12.63	0.0%	
13.40	0.0%	
14.18	0.0%	
14.95	0.0%	
15.72	0.0%	
16.50	0.0%	
17.27	0.0%	
18.04	0.1%	
18.82	0.1%	
19.59	0.1%	
20.37	0.2%	
21.14	0.3%	
21.91	0.4%	
22.69	0.6%	
23.46	0.9%	
24.23	1.2%	
25.01	1.8%	
25.78	2.3%	
26.55	2.8%	
27.33	3.3%	
28.10	3.9%	
28.11		1

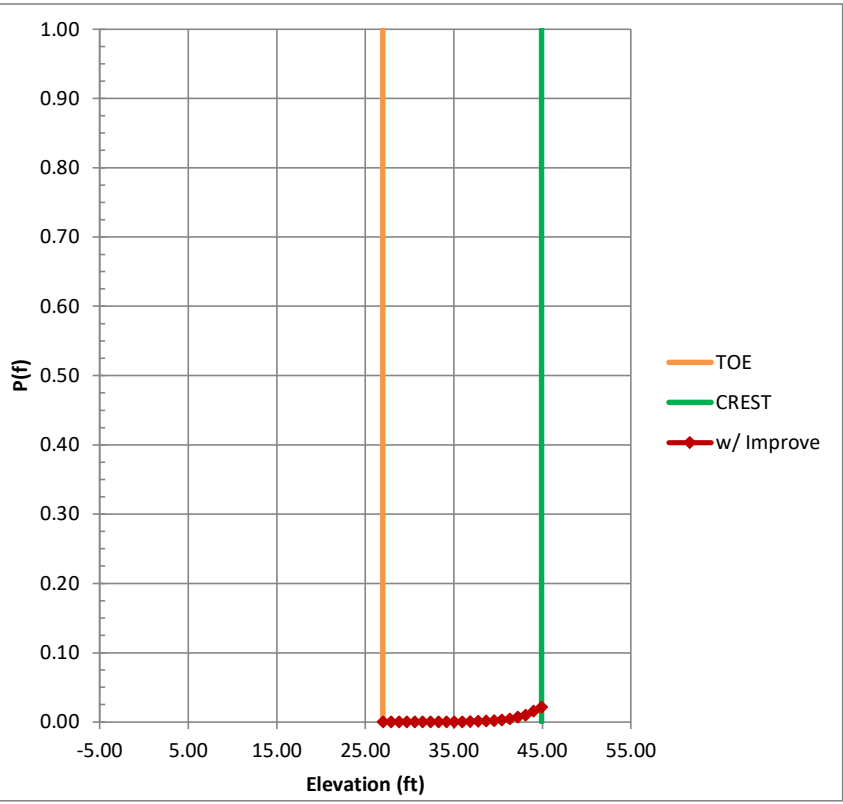


IP/Seg:	SJ34a	Reach B
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
10.50	0.0%	
11.02	0.0%	
11.53	0.1%	
12.05	0.1%	
12.56	0.1%	
13.08	0.1%	
13.59	0.2%	
14.11	0.2%	
14.62	0.3%	
15.14	0.3%	
15.65	0.4%	
16.17	0.6%	
16.68	0.8%	
17.20	1.0%	
17.71	1.3%	
18.23	1.7%	
18.74	2.1%	
19.26	2.5%	
19.77	2.9%	
20.29	3.3%	
20.80	3.7%	
20.81		1





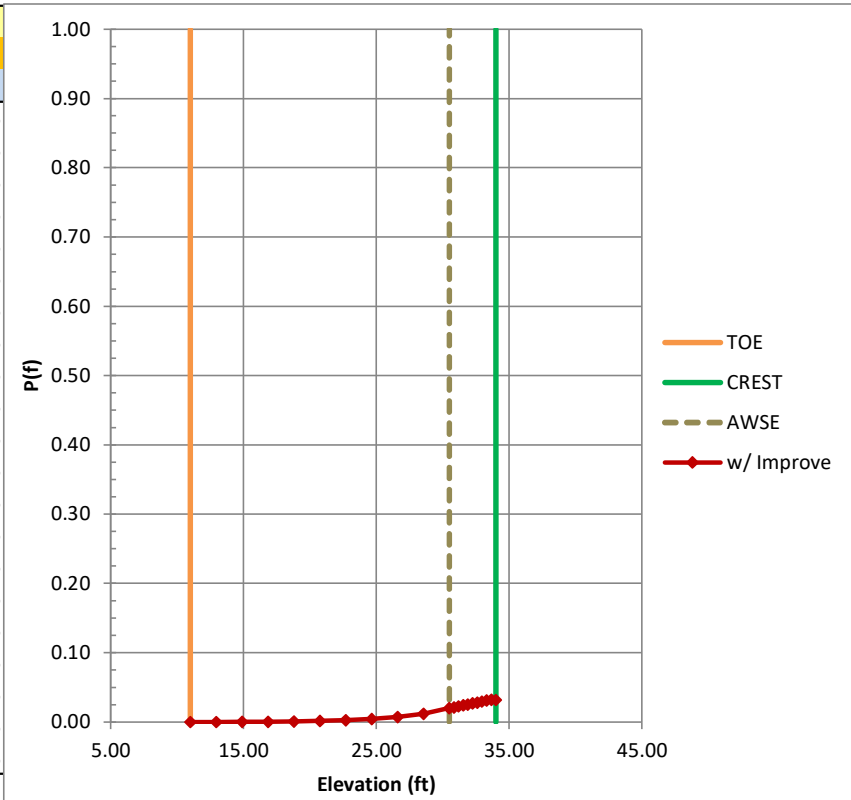
IP/Seg:	SJ37	Reach D2
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
27.0	0.0%	
27.9	0.0%	
28.8	0.0%	
29.7	0.0%	
30.6	0.0%	
31.5	0.0%	
32.4	0.0%	
33.3	0.0%	
34.2	0.0%	
35.1	0.0%	
36.0	0.0%	
36.8	0.0%	
37.7	0.1%	
38.6	0.1%	
39.5	0.2%	
40.4	0.3%	
41.3	0.4%	
42.2	0.7%	
43.1	1.0%	
44.0	1.6%	
44.9	2.1%	
44.91	1	



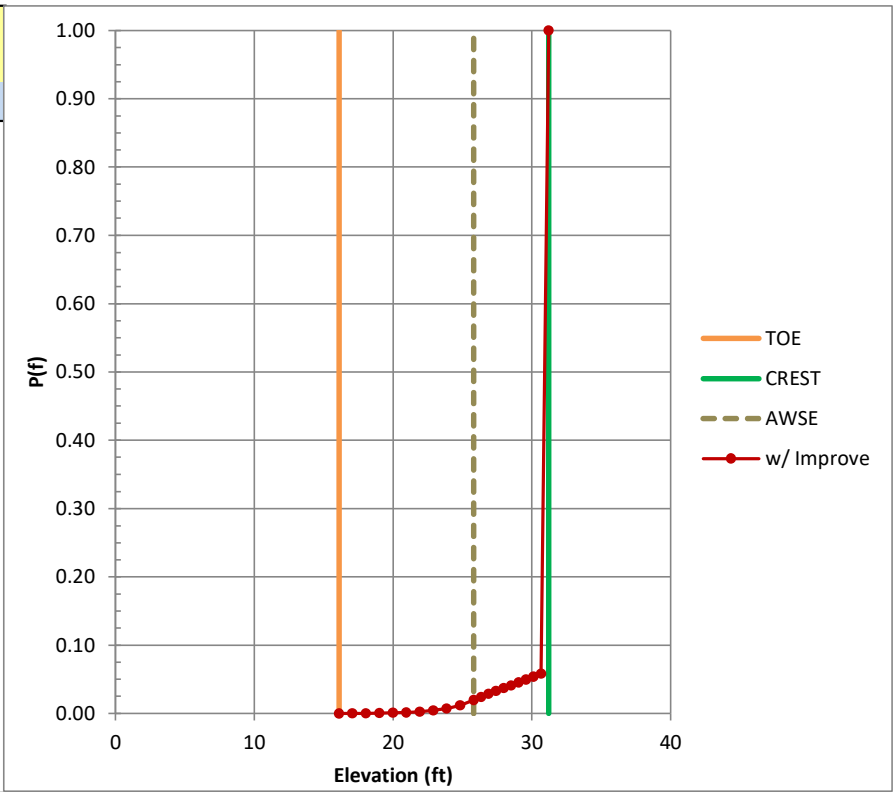
Summary Table of Non-Urban Project Segments with completed/planned repairs

S.No	Index Point	Levee Segment ID	Basin_ID	River/Flood Source	Bank	Crest EL	Landside Toe EL	AWSE	Improvement (completed/To be completed by 2022)
1	SAC35	393	SAC35	Yolo Bypass	Left	34.0	11.0	30.50	Elkhorn Project
2	SJ31	208	SJ31	San Joaquin River	Left	31.2	16.1	25.80	Stewart Tract Improvements
3	SJ31a	256	SJ31	Old River	Left	28.3	15.2	19.30	
4	SJ31b	192	SJ31	Paradise Cut	Right	24.7	2.9	17.00	
5	SJ31c	259	SJ31	Paradise Cut	Right	26.1	14.7	21.90	
6	SJ31d	336	SJ31	Paradise Cut	Right	22.4	11.2	17.20	
7	SJ36	189	SJ36	San Joaquin River	Left	28.4	6.9	19.30	RD 17

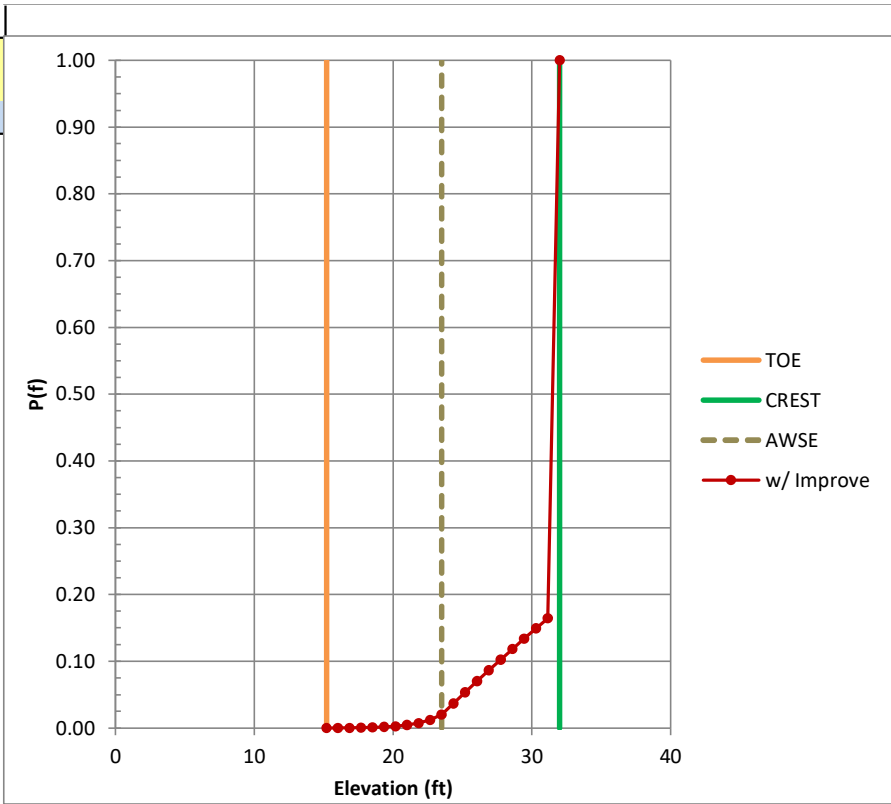
IP/Seg:	SAC35	Seg393
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
11.00		0.0%
12.95		0.0%
14.90		0.0%
16.85		0.1%
18.80		0.1%
20.75		0.2%
22.70		0.3%
24.65		0.4%
26.60		0.7%
28.55		1.2%
30.50		2.0%
30.85		2.1%
31.20		2.3%
31.55		2.4%
31.90		2.5%
32.25		2.7%
32.60		2.8%
32.95		3.0%
33.30		3.1%
33.65		3.2%
34.00		3.2%



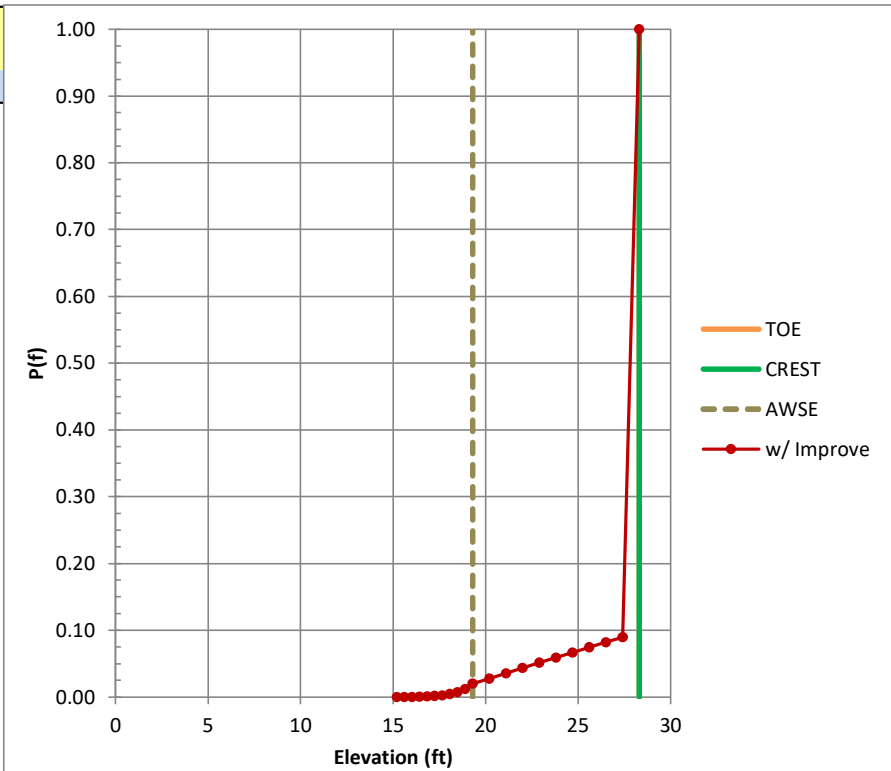
IP/Seg:	SJ 31	208
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
16.10	0.0%	
17.07	0.0%	
18.04	0.0%	
19.01	0.1%	
19.98	0.1%	
20.95	0.2%	
21.92	0.3%	
22.89	0.4%	
23.86	0.7%	
24.83	1.2%	
25.80	2.0%	
26.34	2.4%	
26.88	2.8%	
27.42	3.3%	
27.96	3.7%	
28.50	4.1%	
29.04	4.6%	
29.58	5.0%	
30.12	5.4%	
30.66	5.8%	
31.20	100.0%	



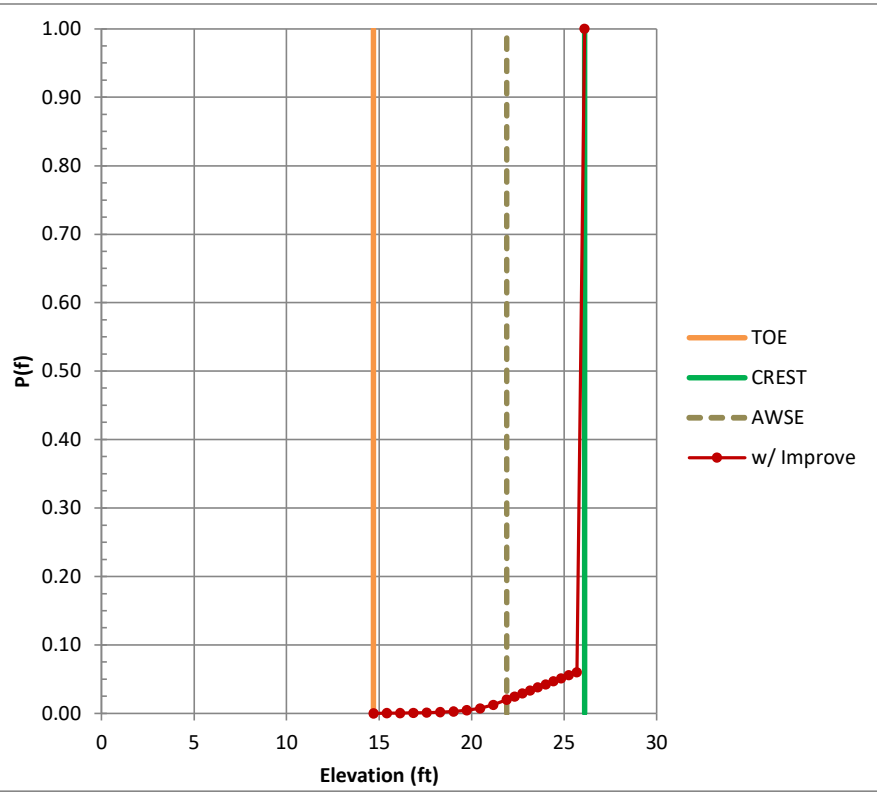
IP/Seg:	SJ 31a	193
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
15.20	0.0%	
16.03	0.0%	
16.86	0.0%	
17.69	0.1%	
18.52	0.1%	
19.35	0.2%	
20.18	0.3%	
21.01	0.4%	
21.84	0.7%	
22.67	1.2%	
23.50	2.0%	
24.35	3.7%	
25.20	5.3%	
26.05	7.0%	
26.90	8.6%	
27.75	10.2%	
28.60	11.8%	
29.45	13.4%	
30.30	14.9%	
31.15	16.4%	
32.00	100.0%	



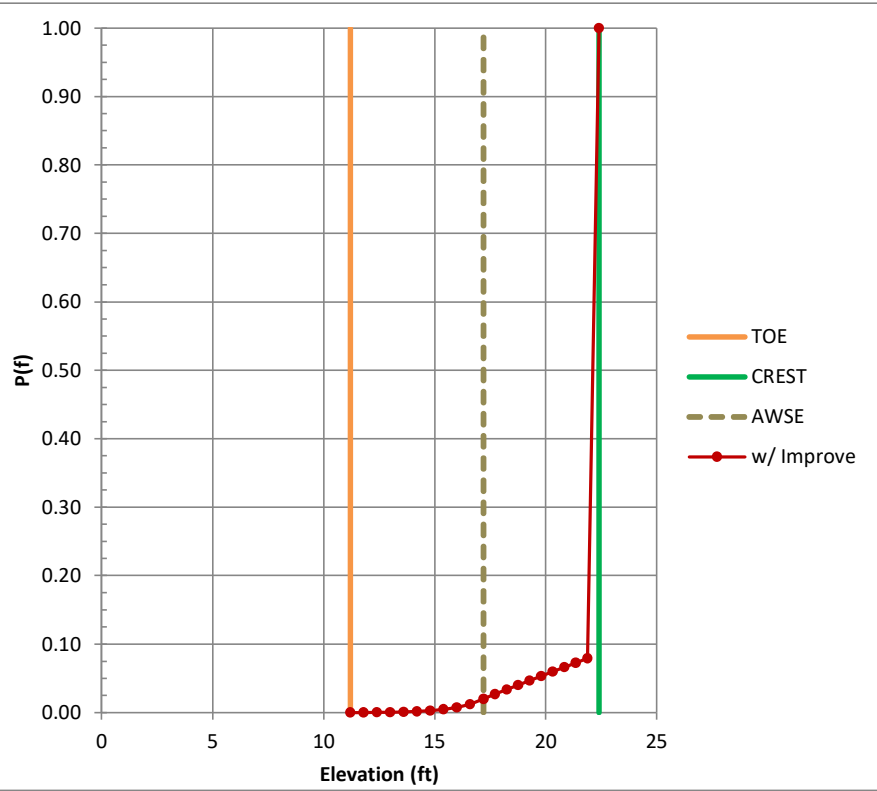
IP/Seg:	SJ 31b	256
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
15.20	0.0%	
15.61	0.0%	
16.02	0.0%	
16.43	0.1%	
16.84	0.1%	
17.25	0.2%	
17.66	0.3%	
18.07	0.4%	
18.48	0.7%	
18.89	1.2%	
19.30	2.0%	
20.20	2.8%	
21.10	3.6%	
22.00	4.3%	
22.90	5.1%	
23.80	5.9%	
24.70	6.7%	
25.60	7.4%	
26.50	8.2%	
27.40	8.9%	
28.30	100.0%	



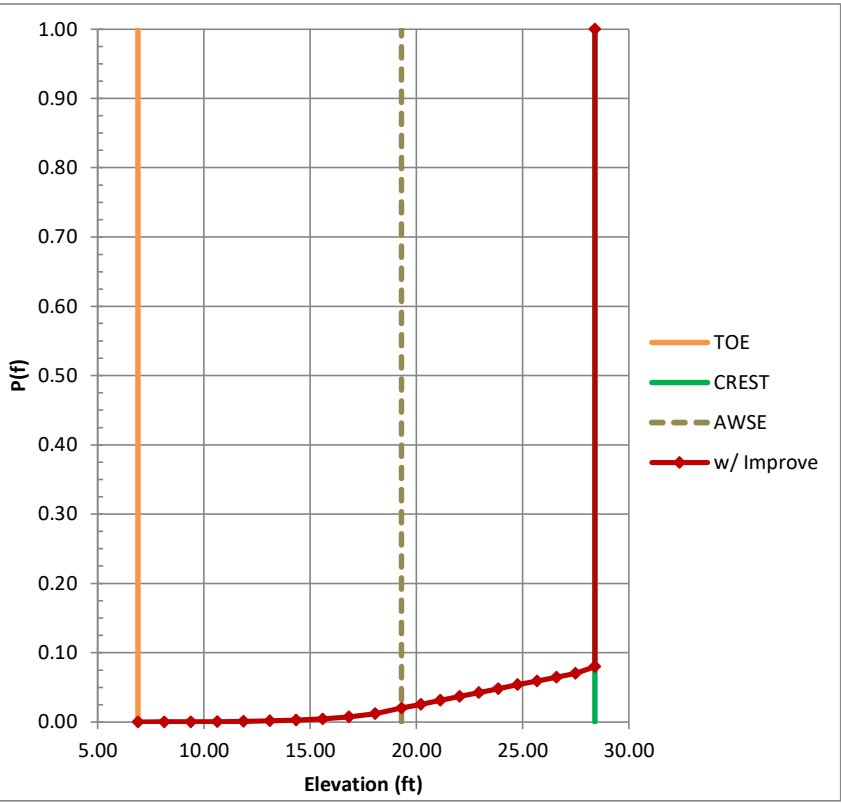
IP/Seg:	SJ 31c	259
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
14.70	0.0%	
15.42	0.0%	
16.14	0.0%	
16.86	0.1%	
17.58	0.1%	
18.30	0.2%	
19.02	0.3%	
19.74	0.4%	
20.46	0.7%	
21.18	1.2%	
21.90	2.0%	
22.32	2.4%	
22.74	2.9%	
23.16	3.3%	
23.58	3.8%	
24.00	4.2%	
24.42	4.7%	
24.84	5.1%	
25.26	5.6%	
25.68	6.0%	
26.10	100.0%	



IP/Seg:	SJ 31d	336
Segment:	w/ Improve	
Elevation (ft)	Cumul P(f)	Cumul P(f)
11.20	0.0%	
11.80	0.0%	
12.40	0.0%	
13.00	0.1%	
13.60	0.1%	
14.20	0.2%	
14.80	0.3%	
15.40	0.4%	
16.00	0.7%	
16.60	1.2%	
17.20	2.0%	
17.72	2.7%	
18.24	3.3%	
18.76	4.0%	
19.28	4.6%	
19.80	5.3%	
20.32	6.0%	
20.84	6.6%	
21.36	7.3%	
21.88	7.9%	
22.40	100.0%	



IP/Seg:	SJ36	Seg189
Segment:		w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
6.9	0.0%	
8.1	0.0%	
9.4	0.0%	
10.6	0.1%	
11.9	0.1%	
13.1	0.2%	
14.3	0.3%	
15.6	0.4%	
16.8	0.7%	
18.1	1.2%	
19.3	2.0%	
20.2	2.6%	
21.1	3.1%	
22.0	3.7%	
22.9	4.2%	
23.9	4.8%	
24.8	5.4%	
25.7	5.9%	
26.6	6.5%	
27.5	7.0%	
28.4	8.0%	
28.4		1



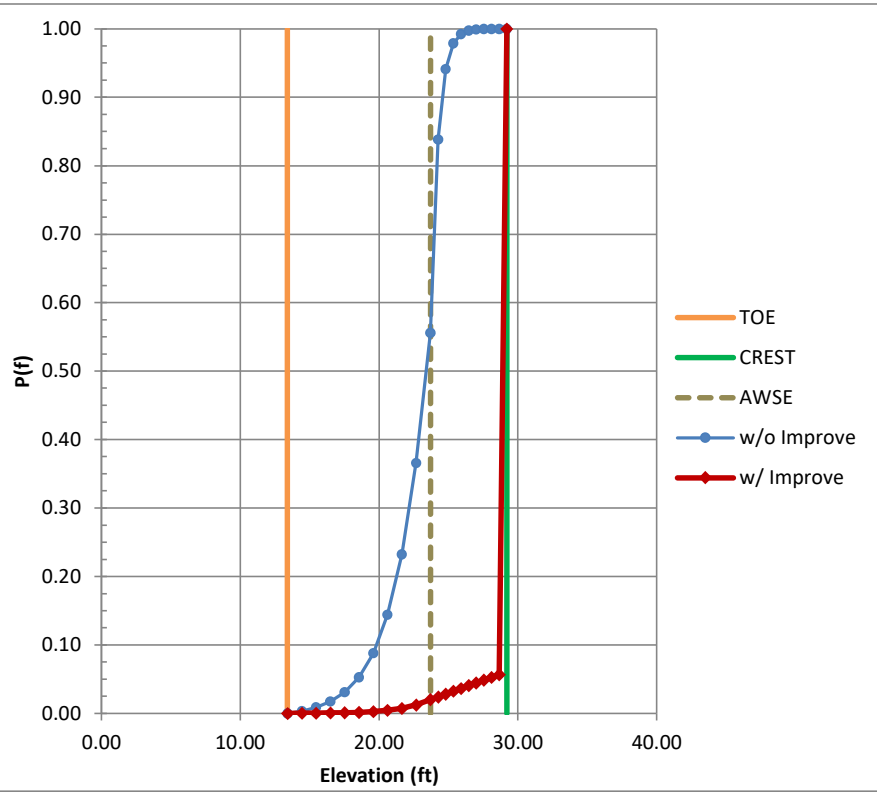
Appendix B

1. Summary Table of Hazard Level Categorizations - **Non-Urban** Project Segments in Sacramento County
2. “Without Project” and “With Project” Fragility Curves for **Non-Urban** Project Segments in Sacramento County

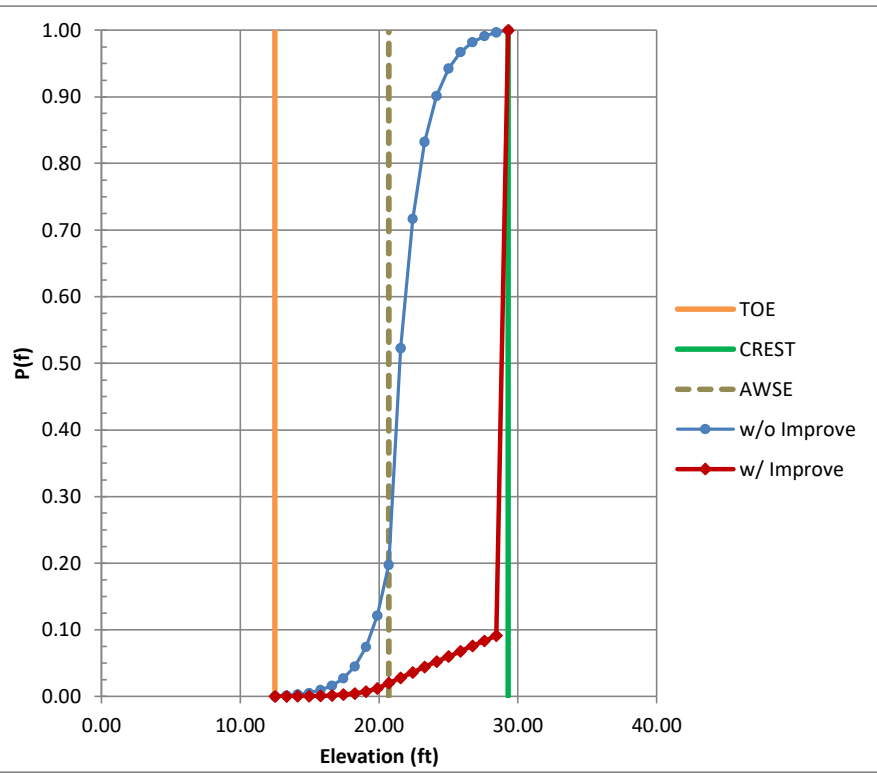
**Sacramento County Hazard Level Categorizations
Non-Urban Project Segments**

S.No	Basin ID	Segment #	"Without Project" Categorizations				"With Project" Categorizations				Comments
			US	ST	TS	E	US	ST	TS	E	
1	SAC44/45 Hood	106	C-	B	C-	B	A	A	A	A	US - Underseepage ST - Stability TS - Throughseepage E - Erosion
2	SAC47/48 Courtland	126-1	C	A	B	B	A	A	A	A	
3		126-2	C-	A	B	B	A	A	A	A	
4		131	C-	A	C	B	A	A	A	A	
5	SAC50 W. Walnut Grove	113-1	B	B	B	B	A	A	A	A	
6		113-2	C-	B	C	B	A	A	A	A	
7		113-3	C-	B	C	C	A	A	A	A	
8		113-4	C	B	C	B	A	A	A	A	
9		384-1	C-	B	C	B	A	A	A	A	
10		384-2	C	B	C	B	A	A	A	A	
11		384-3	C	B	C	B	A	A	A	A	
12	SAC51 Locke	121	C	A	B	A	A	A	A	A	
13		127	C	A	B	A	A	A	A	A	
14	SAC52/53 E. Walnut Grove	128	B	A	C	C-	A	A	A	A	
15		130	C-	B	B	C-	A	A	A	A	
16	SAC54 Isleton	40	B	C	B	C	A	A	A	A	
17		129	B	C-	B	B	A	A	A	A	
18		378	A	B	B	A	A	A	A	A	
19		390-1	B	A	B	C	A	A	A	A	
20		390-2	C-	A	B	C	A	A	A	A	

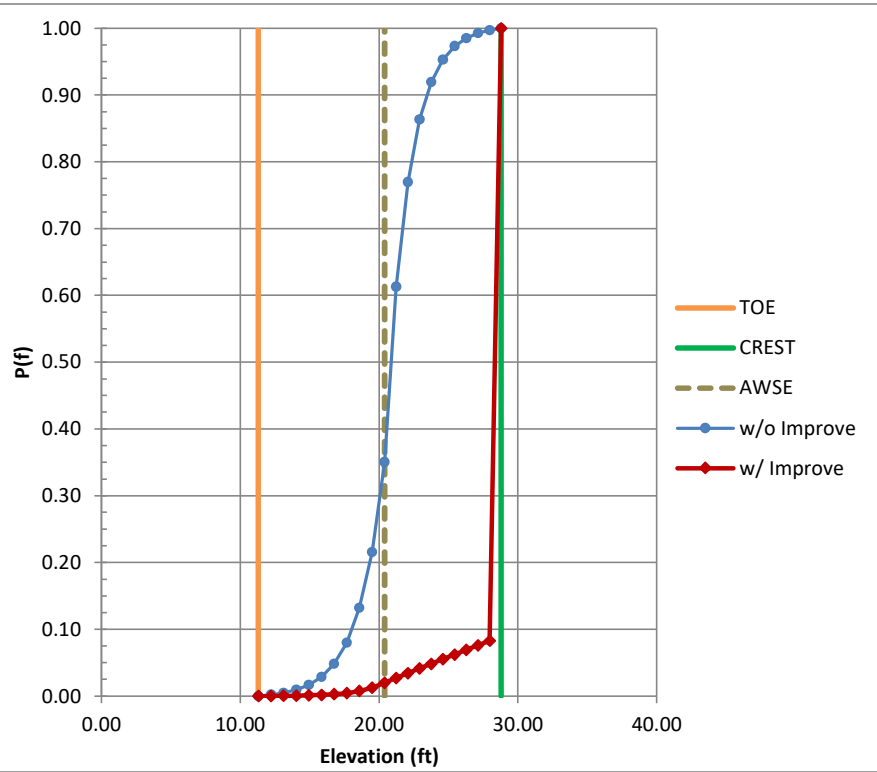
IP/Seg:	SAC44/45	106
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
13.40	0.0%	0.0%
14.43	0.3%	0.0%
15.46	0.9%	0.0%
16.49	1.7%	0.1%
17.52	3.1%	0.1%
18.55	5.3%	0.2%
19.58	8.8%	0.3%
20.61	14.4%	0.4%
21.64	23.2%	0.7%
22.67	36.6%	1.2%
23.70	55.6%	2.0%
24.25	83.8%	2.4%
24.80	94.1%	2.8%
25.35	97.9%	3.2%
25.90	99.2%	3.6%
26.45	99.7%	4.0%
27.00	99.9%	4.4%
27.55	100.0%	4.9%
28.10	100.0%	5.3%
28.65	100.0%	5.7%
29.20	100.0%	100.0%



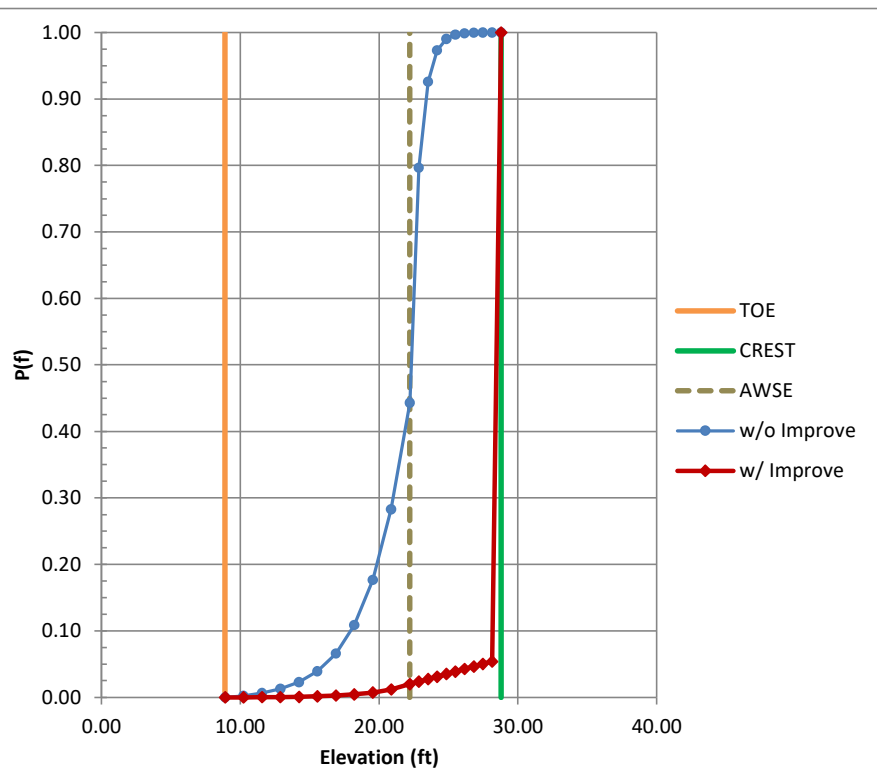
IP/Seg:	SAC47/48	126-1
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
12.50	0.0%	0.0%
13.32	0.1%	0.0%
14.14	0.3%	0.0%
14.96	0.5%	0.1%
15.78	0.9%	0.1%
16.60	1.6%	0.2%
17.42	2.7%	0.3%
18.24	4.5%	0.4%
19.06	7.4%	0.7%
19.88	12.1%	1.2%
20.70	19.7%	2.0%
21.56	52.3%	2.8%
22.42	71.7%	3.6%
23.28	83.2%	4.4%
24.14	90.1%	5.2%
25.00	94.3%	6.0%
25.86	96.7%	6.8%
26.72	98.2%	7.6%
27.58	99.1%	8.3%
28.44	99.7%	9.1%
29.30	100.0%	100.0%



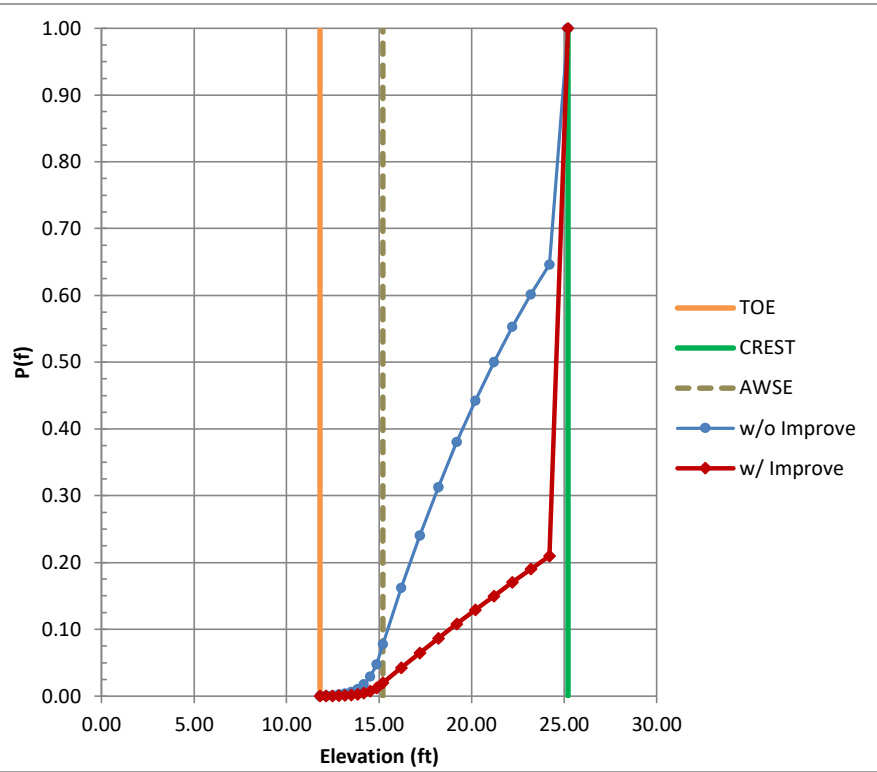
IP/Seg:	SAC47/48	126-2
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
11.30	0.0%	0.0%
12.21	0.2%	0.0%
13.12	0.5%	0.0%
14.03	0.9%	0.1%
14.94	1.7%	0.1%
15.85	2.9%	0.2%
16.76	4.8%	0.3%
17.67	8.0%	0.4%
18.58	13.2%	0.7%
19.49	21.6%	1.2%
20.40	35.0%	2.0%
21.24	61.3%	2.7%
22.08	77.0%	3.4%
22.92	86.3%	4.1%
23.76	91.9%	4.8%
24.60	95.3%	5.5%
25.44	97.3%	6.2%
26.28	98.5%	6.9%
27.12	99.3%	7.6%
27.96	99.7%	8.3%
28.80	100.0%	100.0%



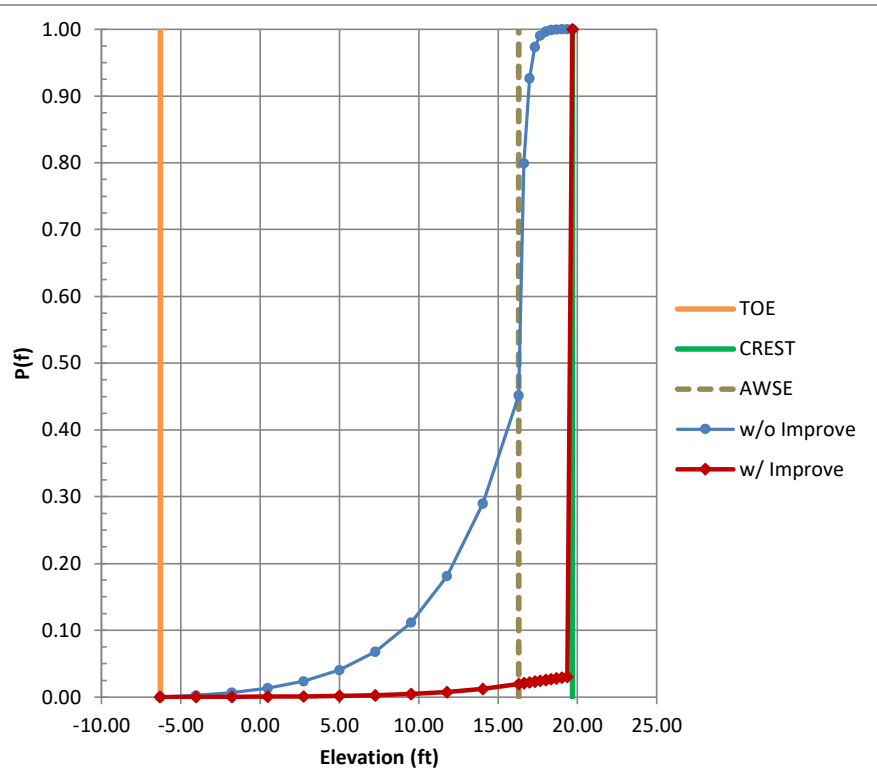
IP/Seg:	SAC47/48	131
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
8.90	0.0%	0.0%
10.23	0.3%	0.0%
11.56	0.7%	0.0%
12.89	1.3%	0.1%
14.22	2.3%	0.1%
15.55	3.9%	0.2%
16.88	6.6%	0.3%
18.21	10.9%	0.4%
19.54	17.7%	0.7%
20.87	28.3%	1.2%
22.20	44.3%	2.0%
22.86	79.7%	2.4%
23.52	92.6%	2.8%
24.18	97.3%	3.1%
24.84	99.0%	3.5%
25.50	99.7%	3.9%
26.16	99.9%	4.3%
26.82	100.0%	4.7%
27.48	100.0%	5.0%
28.14	100.0%	5.4%
28.80	100.0%	100.0%



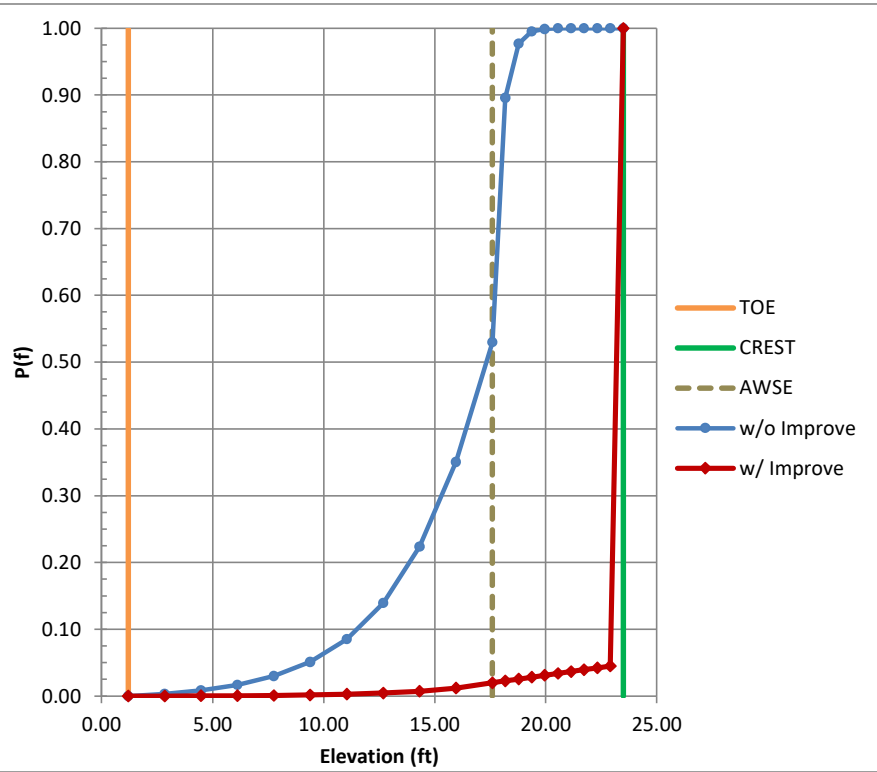
IP/Seg:	SAC50	113-1
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
11.80	0.0%	0.0%
12.14	0.0%	0.0%
12.48	0.1%	0.0%
12.82	0.2%	0.1%
13.16	0.4%	0.1%
13.50	0.6%	0.2%
13.84	1.1%	0.3%
14.18	1.8%	0.4%
14.52	2.9%	0.7%
14.86	4.8%	1.2%
15.20	7.8%	2.0%
16.20	16.2%	4.2%
17.20	24.0%	6.5%
18.20	31.3%	8.7%
19.20	38.0%	10.8%
20.20	44.3%	12.9%
21.20	50.0%	15.0%
22.20	55.3%	17.0%
23.20	60.2%	19.0%
24.20	64.6%	21.0%
25.20	100.0%	100.0%



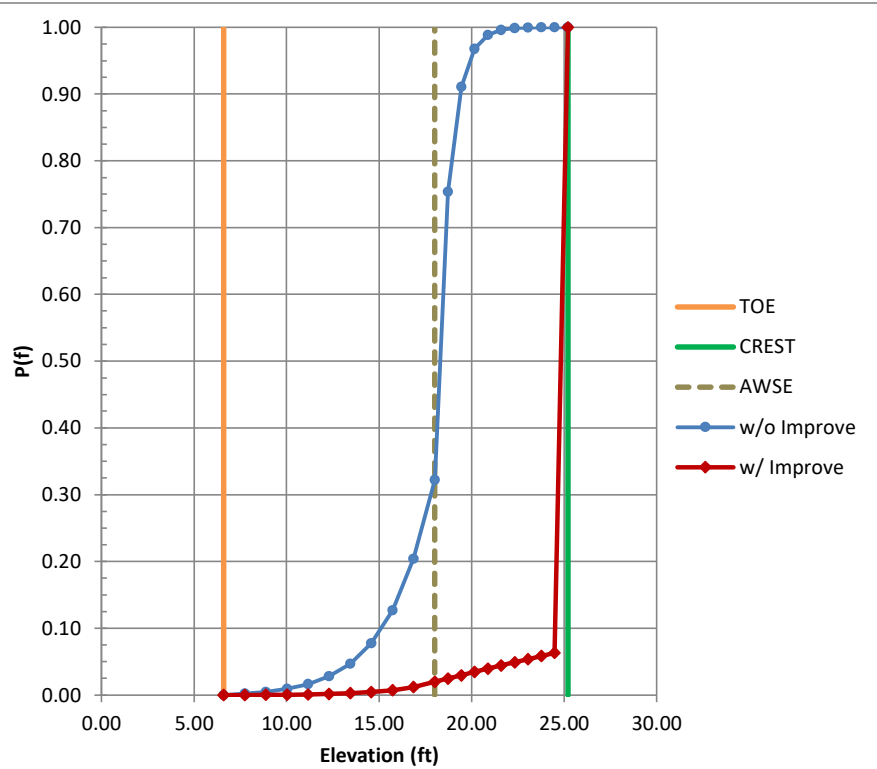
IP/Seg:	SAC50	113-2
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
-6.30	0.0%	0.0%
-4.04	0.3%	0.0%
-1.78	0.7%	0.0%
0.48	1.3%	0.1%
2.74	2.4%	0.1%
5.00	4.0%	0.2%
7.26	6.8%	0.3%
9.52	11.2%	0.4%
11.78	18.1%	0.7%
14.04	29.0%	1.2%
16.30	45.1%	2.0%
16.64	79.9%	2.1%
16.98	92.7%	2.2%
17.32	97.3%	2.3%
17.66	99.0%	2.5%
18.00	99.7%	2.6%
18.34	99.9%	2.7%
18.68	100.0%	2.8%
19.02	100.0%	2.9%
19.36	100.0%	3.0%
19.70	100.0%	100.0%



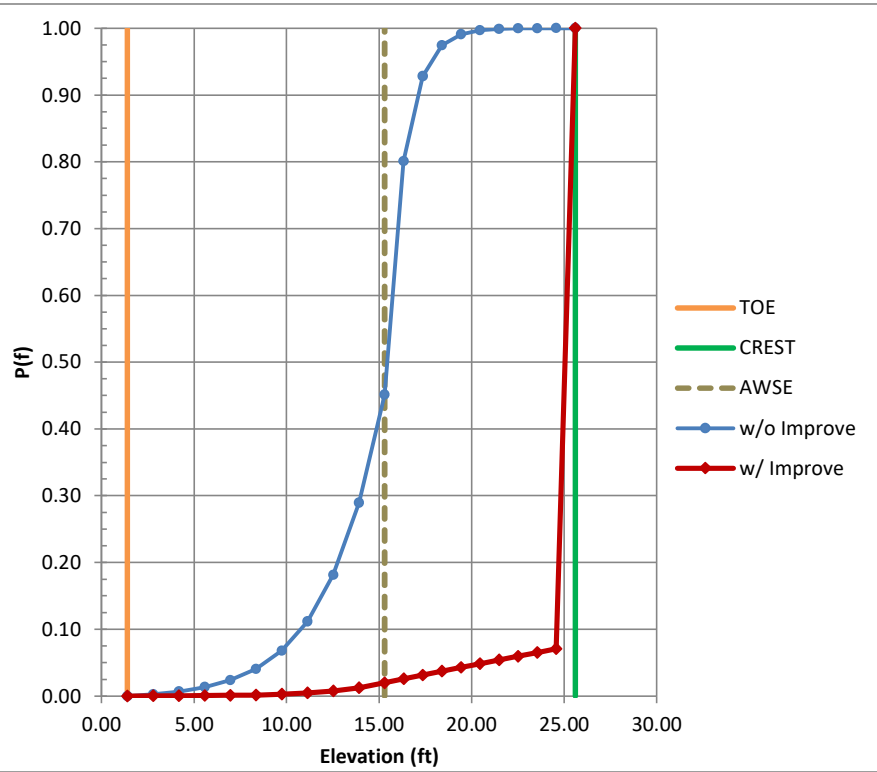
IP/Seg:	SAC50	113-3
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
1.20	0.0%	0.0%
2.84	0.3%	0.0%
4.48	0.9%	0.0%
6.12	1.7%	0.1%
7.76	3.0%	0.1%
9.40	5.1%	0.2%
11.04	8.5%	0.3%
12.68	13.9%	0.4%
14.32	22.4%	0.7%
15.96	35.1%	1.2%
17.60	53.0%	2.0%
18.19	89.6%	2.3%
18.78	97.7%	2.5%
19.37	99.5%	2.8%
19.96	99.9%	3.1%
20.55	100.0%	3.4%
21.14	100.0%	3.7%
21.73	100.0%	3.9%
22.32	100.0%	4.2%
22.91	100.0%	4.5%
23.50	100.0%	100.0%



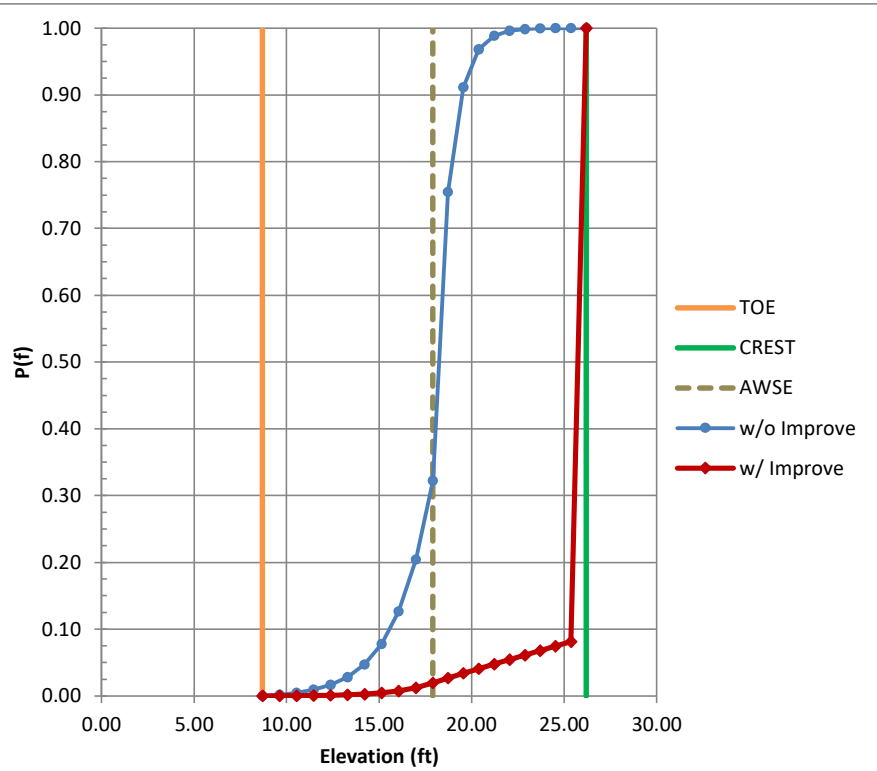
IP/Seg:	SAC50	113-4
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
6.60	0.0%	0.0%
7.74	0.2%	0.0%
8.88	0.5%	0.0%
10.02	0.9%	0.1%
11.16	1.6%	0.1%
12.30	2.8%	0.2%
13.44	4.7%	0.3%
14.58	7.8%	0.4%
15.72	12.7%	0.7%
16.86	20.4%	1.2%
18.00	32.2%	2.0%
18.72	75.4%	2.5%
19.44	91.1%	3.0%
20.16	96.8%	3.4%
20.88	98.9%	3.9%
21.60	99.6%	4.4%
22.32	99.9%	4.9%
23.04	100.0%	5.4%
23.76	100.0%	5.9%
24.48	100.0%	6.3%
25.20	100.0%	100.0%



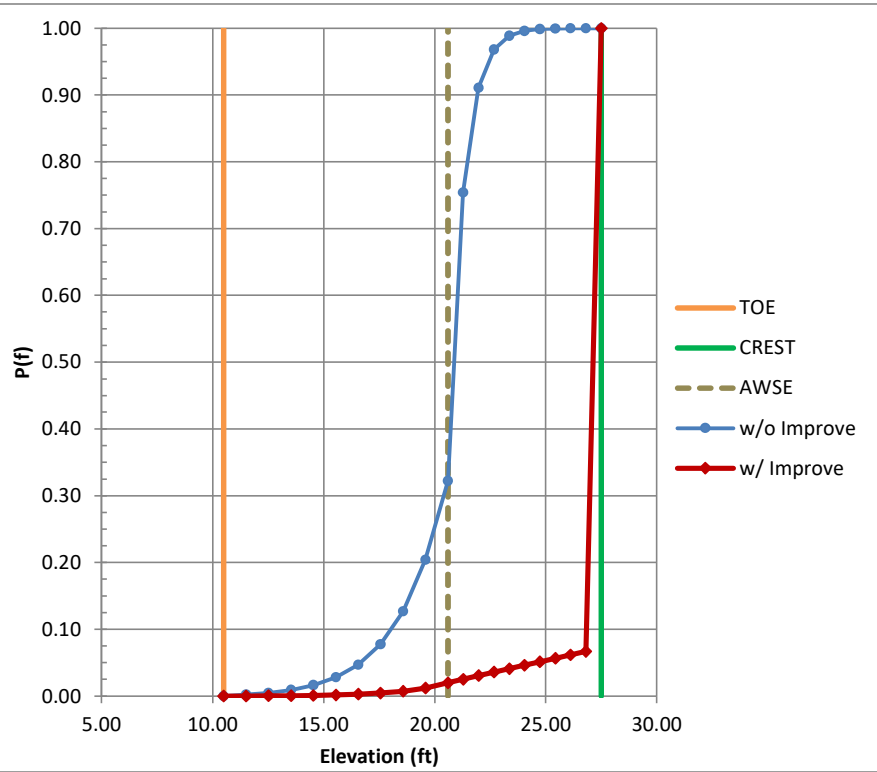
IP/Seg:	SAC50	384-1
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
1.40	0.0%	0.0%
2.79	0.3%	0.0%
4.18	0.7%	0.0%
5.57	1.3%	0.1%
6.96	2.4%	0.1%
8.35	4.0%	0.2%
9.74	6.8%	0.3%
11.13	11.2%	0.4%
12.52	18.1%	0.7%
13.91	29.0%	1.2%
15.30	45.1%	2.0%
16.33	80.1%	2.6%
17.36	92.8%	3.1%
18.39	97.4%	3.7%
19.42	99.1%	4.3%
20.45	99.7%	4.8%
21.48	99.9%	5.4%
22.51	100.0%	6.0%
23.54	100.0%	6.5%
24.57	100.0%	7.1%
25.60	100.0%	100.0%



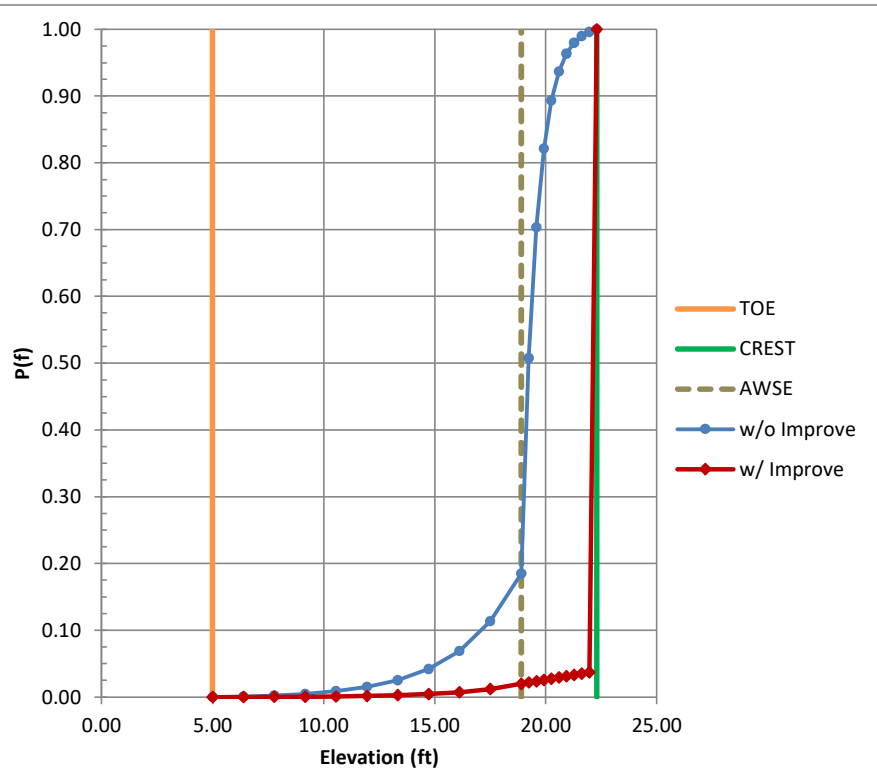
IP/Seg:	SAC50	384-2
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
8.7	0.0%	0.0%
9.6	0.2%	0.0%
10.5	0.5%	0.0%
11.5	0.9%	0.1%
12.4	1.6%	0.1%
13.3	2.8%	0.2%
14.2	4.7%	0.3%
15.1	7.8%	0.4%
16.1	12.7%	0.7%
17.0	20.4%	1.2%
17.9	32.2%	2.0%
18.7	75.5%	2.7%
19.6	91.2%	3.4%
20.4	96.8%	4.1%
21.2	98.9%	4.8%
22.1	99.6%	5.4%
22.9	99.9%	6.1%
23.7	100.0%	6.8%
24.5	100.0%	7.5%
25.4	100.0%	8.1%
26.2	100.0%	100.0%



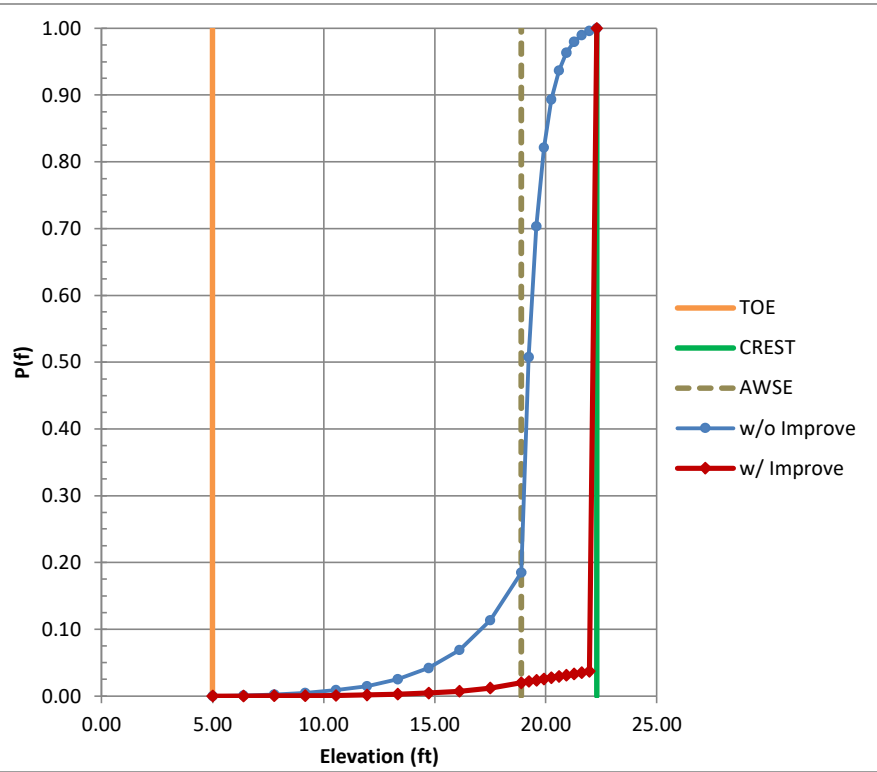
IP/Seg:	SAC50	384-3
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
10.5	0.0%	0.0%
11.5	0.2%	0.0%
12.5	0.5%	0.0%
13.5	0.9%	0.1%
14.5	1.6%	0.1%
15.6	2.8%	0.2%
16.6	4.7%	0.3%
17.6	7.8%	0.4%
18.6	12.7%	0.7%
19.6	20.4%	1.2%
20.6	32.2%	2.0%
21.3	75.4%	2.5%
22.0	91.1%	3.0%
22.7	96.8%	3.6%
23.4	98.9%	4.1%
24.1	99.6%	4.6%
24.7	99.9%	5.1%
25.4	100.0%	5.6%
26.1	100.0%	6.2%
26.8	100.0%	6.7%
27.5	100.0%	100.0%



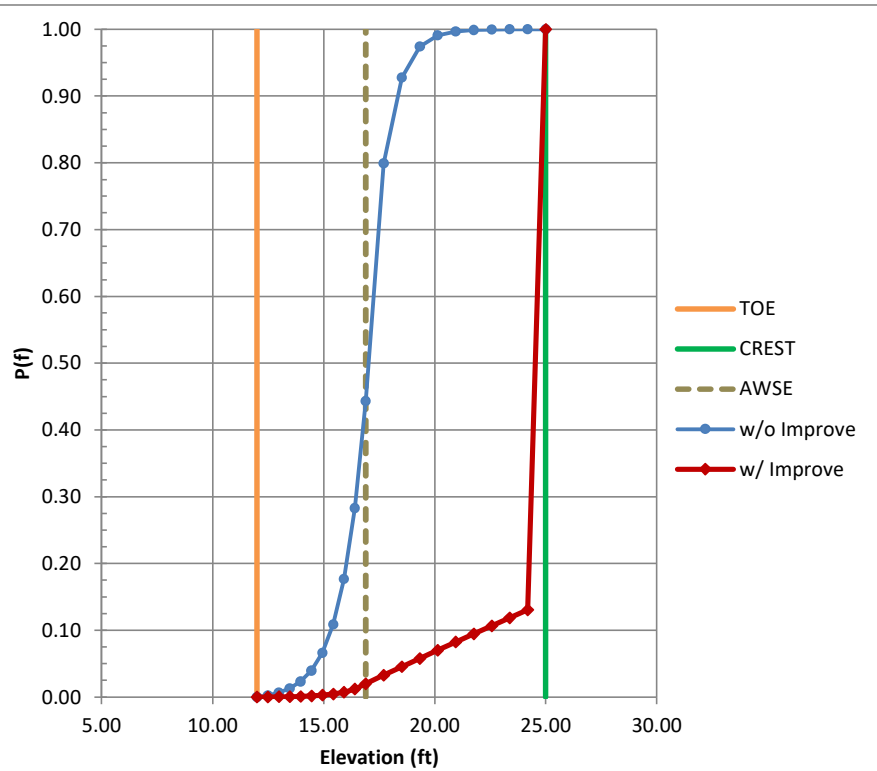
IP/Seg:	SAC51	121
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
5.0	0.0%	0.0%
6.4	0.1%	0.0%
7.8	0.2%	0.0%
9.2	0.5%	0.1%
10.6	0.9%	0.1%
12.0	1.5%	0.2%
13.3	2.5%	0.3%
14.7	4.2%	0.4%
16.1	6.9%	0.7%
17.5	11.3%	1.2%
18.9	18.5%	2.0%
19.2	50.8%	2.2%
19.6	70.3%	2.4%
19.9	82.1%	2.6%
20.3	89.3%	2.7%
20.6	93.7%	2.9%
20.9	96.3%	3.1%
21.3	98.0%	3.3%
21.6	99.0%	3.5%
22.0	99.6%	3.7%
22.3	100.0%	100.0%



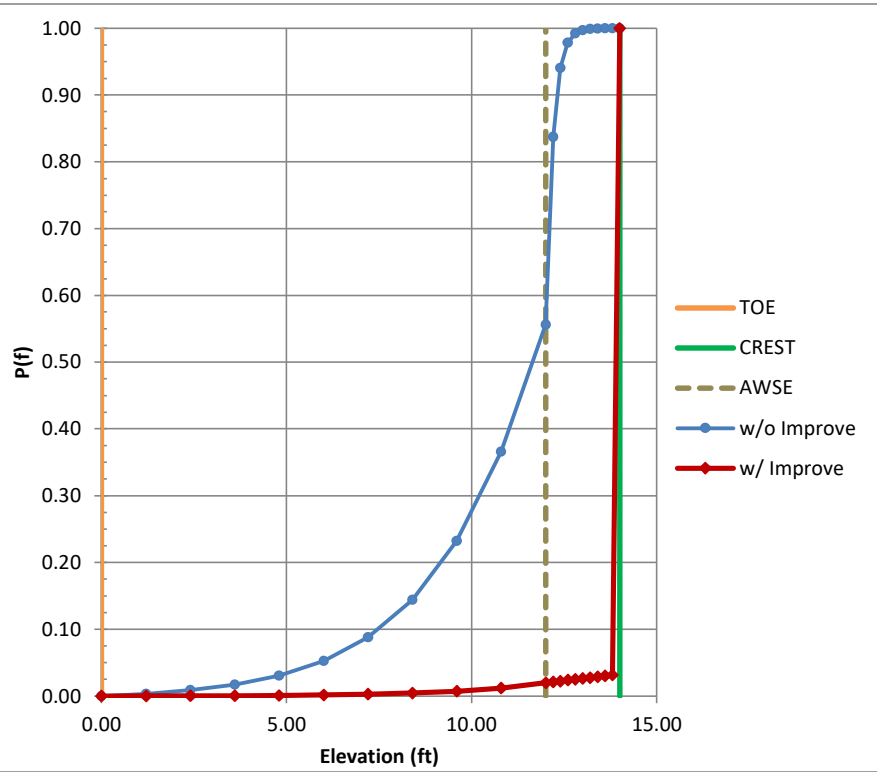
IP/Seg:	SAC51	127
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
5.0	0.0%	0.0%
6.4	0.1%	0.0%
7.8	0.2%	0.0%
9.2	0.5%	0.1%
10.6	0.9%	0.1%
12.0	1.5%	0.2%
13.3	2.5%	0.3%
14.7	4.2%	0.4%
16.1	6.9%	0.7%
17.5	11.3%	1.2%
18.9	18.5%	2.0%
19.2	50.8%	2.2%
19.6	70.3%	2.4%
19.9	82.1%	2.6%
20.3	89.3%	2.7%
20.6	93.7%	2.9%
20.9	96.3%	3.1%
21.3	98.0%	3.3%
21.6	99.0%	3.5%
22.0	99.6%	3.7%
22.3	100.0%	100.0%



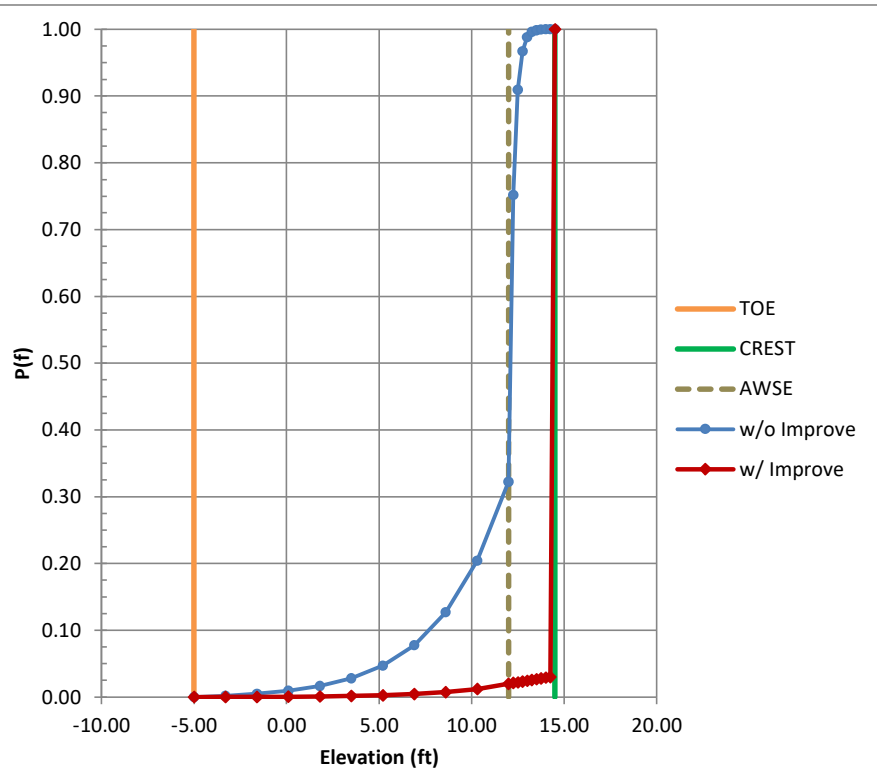
IP/Seg:	SAC52/53	128
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
12.0	0.0%	0.0%
12.5	0.3%	0.0%
13.0	0.7%	0.0%
13.5	1.3%	0.1%
14.0	2.3%	0.1%
14.5	3.9%	0.2%
14.9	6.6%	0.3%
15.4	10.9%	0.4%
15.9	17.7%	0.7%
16.4	28.3%	1.2%
16.9	44.3%	2.0%
17.7	79.9%	3.3%
18.5	92.8%	4.5%
19.3	97.4%	5.8%
20.1	99.1%	7.0%
21.0	99.7%	8.2%
21.8	99.9%	9.5%
22.6	100.0%	10.7%
23.4	100.0%	11.9%
24.2	100.0%	13.0%
25.0	100.0%	100.0%



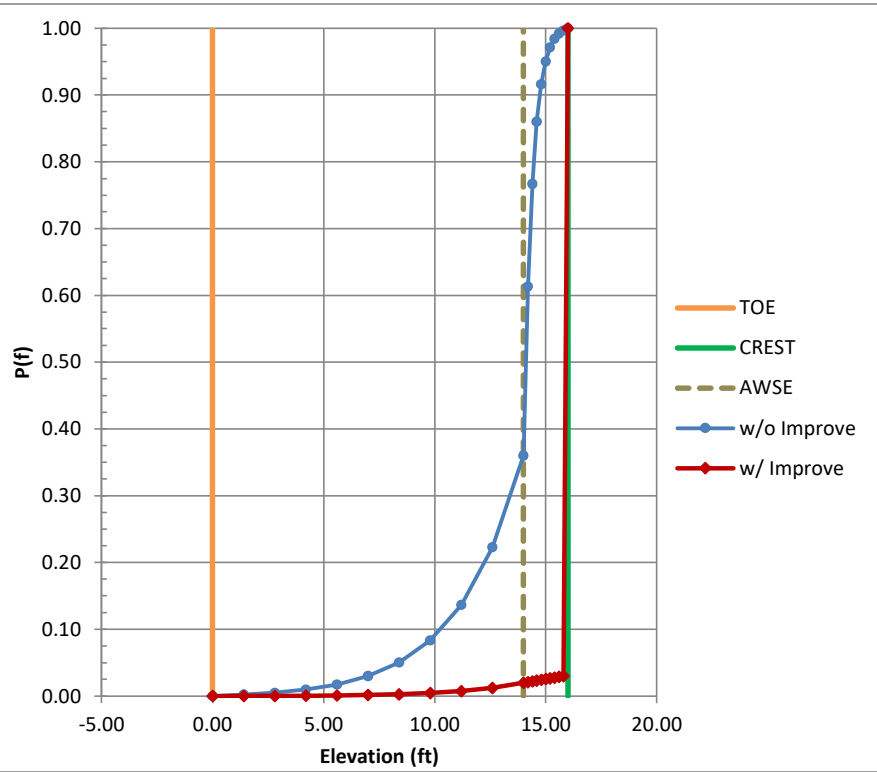
IP/Seg:	SAC52/53	130
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
0.0	0.0%	0.0%
1.2	0.3%	0.0%
2.4	0.9%	0.0%
3.6	1.7%	0.1%
4.8	3.1%	0.1%
6.0	5.3%	0.2%
7.2	8.8%	0.3%
8.4	14.4%	0.4%
9.6	23.2%	0.7%
10.8	36.6%	1.2%
12.0	55.6%	2.0%
12.2	83.7%	2.1%
12.4	94.1%	2.2%
12.6	97.8%	2.4%
12.8	99.2%	2.5%
13.0	99.7%	2.6%
13.2	99.9%	2.8%
13.4	100.0%	2.9%
13.6	100.0%	3.0%
13.8	100.0%	3.1%
14.0	100.0%	100.0%



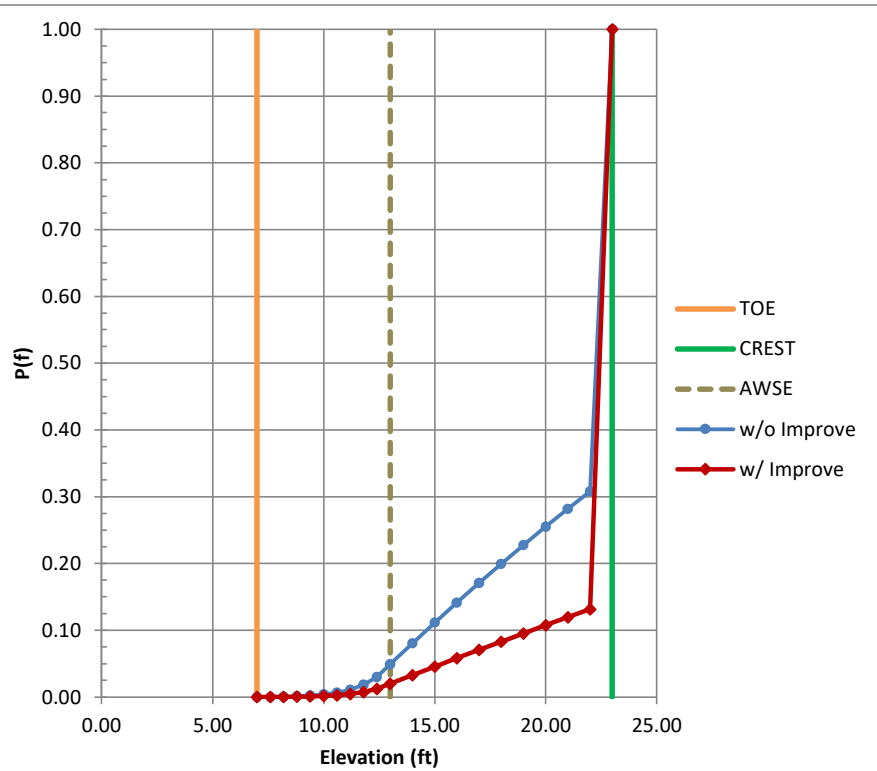
IP/Seg:	SAC54	40
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
-5.0	0.0%	0.0%
-3.3	0.2%	0.0%
-1.6	0.5%	0.0%
0.1	0.9%	0.1%
1.8	1.6%	0.1%
3.5	2.8%	0.2%
5.2	4.7%	0.3%
6.9	7.8%	0.4%
8.6	12.7%	0.7%
10.3	20.4%	1.2%
12.0	32.2%	2.0%
12.3	75.2%	2.1%
12.5	90.9%	2.2%
12.8	96.7%	2.3%
13.0	98.8%	2.4%
13.3	99.6%	2.6%
13.5	99.9%	2.7%
13.8	100.0%	2.8%
14.0	100.0%	2.9%
14.3	100.0%	3.0%
14.5	100.0%	100.0%



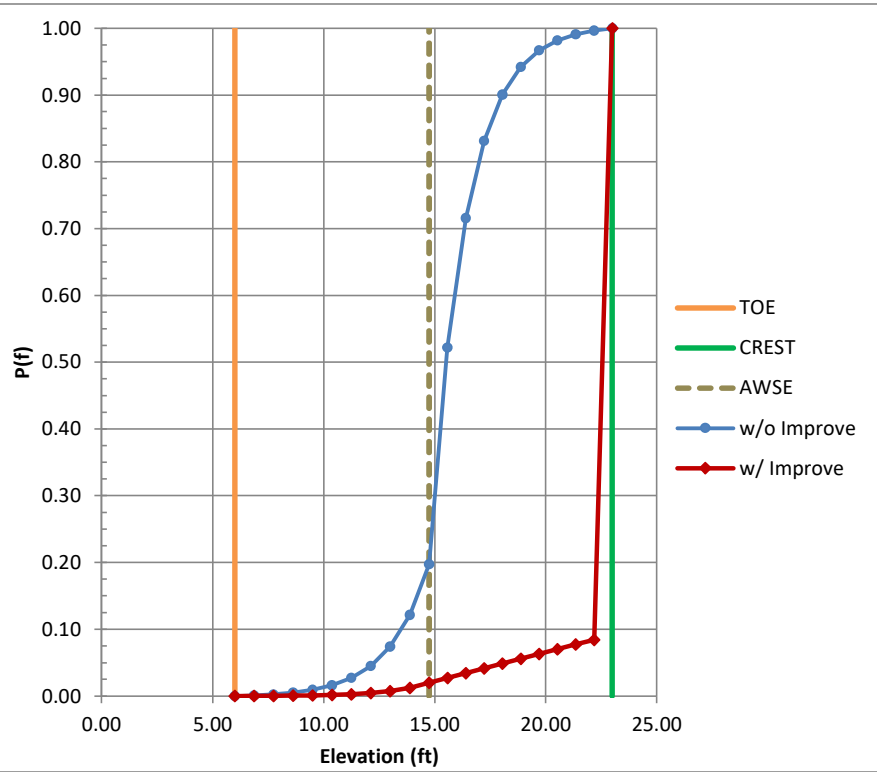
IP/Seg:	SAC54	129
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
0.0	0.0%	0.0%
1.4	0.2%	0.0%
2.8	0.5%	0.0%
4.2	1.0%	0.1%
5.6	1.7%	0.1%
7.0	3.0%	0.2%
8.4	5.0%	0.3%
9.8	8.3%	0.4%
11.2	13.7%	0.7%
12.6	22.3%	1.2%
14.0	36.0%	2.0%
14.2	61.4%	2.1%
14.4	76.7%	2.2%
14.6	86.0%	2.3%
14.8	91.6%	2.4%
15.0	95.0%	2.5%
15.2	97.1%	2.6%
15.4	98.4%	2.8%
15.6	99.2%	2.9%
15.8	99.7%	3.0%
16.0	100.0%	100.0%



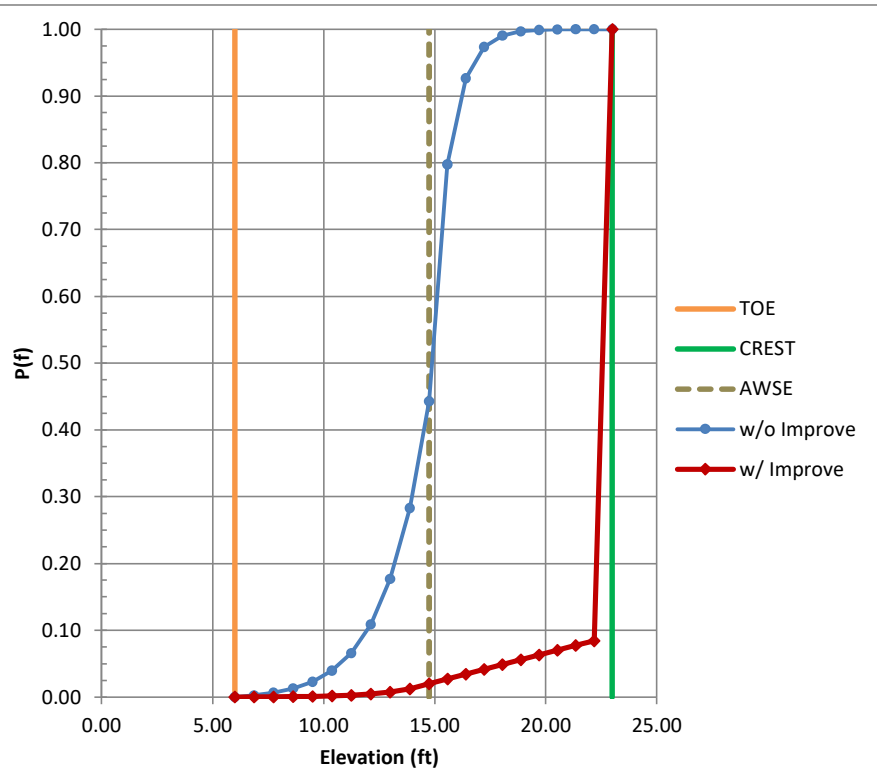
IP/Seg:	SAC54	378
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
7.0	0.0%	0.0%
7.6	0.0%	0.0%
8.2	0.1%	0.0%
8.8	0.1%	0.1%
9.4	0.2%	0.1%
10.0	0.4%	0.2%
10.6	0.7%	0.3%
11.2	1.1%	0.4%
11.8	1.8%	0.7%
12.4	3.0%	1.2%
13.0	4.9%	2.0%
14.0	8.1%	3.3%
15.0	11.1%	4.5%
16.0	14.1%	5.8%
17.0	17.1%	7.1%
18.0	19.9%	8.3%
19.0	22.8%	9.5%
20.0	25.5%	10.7%
21.0	28.2%	11.9%
22.0	30.8%	13.1%
23.0	100.0%	100.0%



IP/Seg:	SAC54	390-1
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
6.0	0.0%	0.0%
6.9	0.1%	0.0%
7.8	0.3%	0.0%
8.6	0.5%	0.1%
9.5	0.9%	0.1%
10.4	1.6%	0.2%
11.3	2.7%	0.3%
12.1	4.5%	0.4%
13.0	7.4%	0.7%
13.9	12.1%	1.2%
14.8	19.7%	2.0%
15.6	52.2%	2.7%
16.4	71.6%	3.4%
17.2	83.1%	4.2%
18.1	90.1%	4.9%
18.9	94.2%	5.6%
19.7	96.7%	6.3%
20.5	98.2%	7.0%
21.4	99.1%	7.7%
22.2	99.7%	8.4%
23.0	100.0%	100.0%



IP/Seg:	SAC54	390-2
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
6.0	0.0%	0.0%
6.9	0.3%	0.0%
7.8	0.7%	0.0%
8.6	1.3%	0.1%
9.5	2.3%	0.1%
10.4	3.9%	0.2%
11.3	6.6%	0.3%
12.1	10.9%	0.4%
13.0	17.7%	0.7%
13.9	28.3%	1.2%
14.8	44.3%	2.0%
15.6	79.7%	2.7%
16.4	92.7%	3.4%
17.2	97.4%	4.2%
18.1	99.1%	4.9%
18.9	99.7%	5.6%
19.7	99.9%	6.3%
20.5	100.0%	7.0%
21.4	100.0%	7.7%
22.2	100.0%	8.4%
23.0	100.0%	100.0%



Appendix C

1. Summary Table of Hazard Level Categorization for **Non-Urban** Non-Project Segments in Sacramento County

Sacramento County Hazard Level Categorization Non-Urban Non-Project Segments

S.No	Basin ID	Segment #	"Without Project" Categorizations				Comments
			US	ST	TS	E	
1	Sac 44/45 Hood	HNCL	C	A	C	B	US - Underseepage ST - Stability TS - Throughseepage E - Erosion
2		HDERR-1	B	A	B	B	
3		HDERR-2	C	B	B	A	
4		HDSRR	B	B	B	B	
5	SAC47/48 Courtland	1040-1	B	A	B	B	
6		1040-2	B	A	B	A	
7		1041-1	A	A	B	A	
8		1041-2	B	B	B	A	
9		1041-3	B	B	A	A	
10	SAC51 Locke	1053	B	A	A	A	
11		1054-1	C	A	C	A	
12		1054-2	C	B	B	A	
13		1054-3	B	B	B	A	
14	SAC52/53 E. Walnut Grove	1043	C	B	C	B	
15		Dry Levee	A	A	A	A	
16		1051	B	B	B	A	
17		1052	B	A	A	A	
18	SAC54 Isleton	1048	B	B	B	A	
19		1049	C	C-	B	B	
20		1050	C	C-	B	B	

Project name:
CVFPP Update – Levee Fragility Curves

Project ref:
Contract Number 4600013352

From:
Rich Millet
Nagesh Malyala

Date:
December 23, 2020

To:
Stephen Cowdin, California Department of Water Resources (DWR)
Jesus Esparza (DWR)
Darren Bonfantine (DWR)

Technical Memorandum Addendum

1. Introduction

This addendum supplements the Technical Memorandum (AECOM, November 12, 2020) submitted to Department of Water Resources (DWR). This addendum addresses DWR's query and clarifies the representative fragility curves at the pre-established 2017 CVFPP Index Point locations for levees within the Sacramento County. The 2017 CVFPP Index Points were established for each Leveed Area Network (LAN) or Impact Area on Project levees. Each LAN or Impact area forms a closed basin with a network of both Project and non-Project levees.

The Technical Memorandum (AECOM, November 12, 2020) included discussion of Sacramento County levees in Tasks 2 and 3. The discussion covered development of Hazard Level Classifications and updated "Without Project" and "With Project" fragility curves for Project levees and Hazard Level Classifications for non-Project levees. Since the 2017 CVFPP Index Points were located only on Project levees, but the Hazard Level Classification and fragility curve was developed for each sub-reach, DWR sought clarification on the representative fragility curve to be used at each Index Point. This addendum summarizes the approach and assumptions considered in identifying the representative fragility curve at each 2017 CVFPP Index Point within Sacramento County LANs.

2. Approach & Assumptions

Project levees within Sacramento County were evaluated based on supplemental investigation completed in 2019-2020, which provided a better understanding of the current levee conditions. Using the updated investigation data, some of the Sacramento County Project and non-Project levees were divided into multiple sub-reaches. Hazard Level Classifications were developed for each sub-reach, at an assessment cross section location, and submitted as part of the Technical Memorandum (November 12, 2020). The steps and assumptions to identify the representative fragility curve at the pre-established 2017 CVFPP Index Point for each LAN within Sacramento County are outlined below:

1. The preliminary list of Project and non-Project levee segments, and sub-reaches considered for the evaluation within Sacramento County, were listed in the Table 1 and Table 2 of the Technical Memorandum (AECOM, November 12, 2020).
2. Hazard Level Classifications and updated fragility curves developed for each of the Project levee and corresponding sub-reaches were presented in Appendix B, and Hazard Level Classifications for each non-Project levees and sub-reaches were presented in Appendix C (AECOM, November 12, 2020).
3. Index point locations, from the 2017 CVFPP effort, at pre-established locations on Project levees are to be used for the 2022 CVFPP update effort too. Due to the division of Project levees into multiple sub-reaches, the representative fragility curve at the Index Point needed to be established for each LAN or Impact Area.

4. To establish the representative “Without Project” fragility curve at the 2017 CVFPP Index Point, the representative Hazard Level Classification for the LAN needed to be established. The Hazard Level Classification of the “Critical” (highest hazard level) sub-reach, within the LAN, was considered representative for the LAN.
5. This “Critical” Hazard Level Classifications was used to develop the “Without Project” fragility curve at the established Index Point location. If the “Critical” Hazard Level Classification for a LAN was assessed at a cross section away from the Index Point, then the cross section details at the Index Point were used to develop the representative fragility curve.
6. A summary table of Index points, associated levee segment, and the representative Hazard Level Classifications for “Without Project” (current conditions) and “With Project” (future remediated condition) fragility curves considered within Sacramento County, are presented in Table A. “Without Project” (current conditions) and “With Project” (future remediated condition) fragility curves at the 9 Index points were included in the Attachment A of this document.

Table A. Representative Hazard Level Classifications at Index Points in Sacramento County

Sacramento County Representative Hazard Level Classifications Non-Urban Project Segments											
S.No	Index Point	Segment #	"Without Project" Categorizations				"With Project" Categorizations				Legend
			US	ST	TS	E	US	ST	TS	E	
1	SAC44/45 Hood	106	C-	B	C-	B	A	A	A	A	US - Underseepage ST - Stability TS - Throughseepage E - Erosion
2	SAC47/48 Courtland	131	C-	A	C	B	A	A	A	A	
3	SAC50 W. Walnut Grove	113	C-	B	C	C	A	A	A	A	
4	SAC50a W. Walnut Grove	384	C-	B	C	B	A	A	A	A	
5	SAC51 Locke	121	C	A	B	A	A	A	A	A	
6	SAC52 E. Walnut Grove	128	B	A	C	C-	A	A	A	A	
7	SAC53 E. Walnut Grove	130	C-	B	B	C-	A	A	A	A	
8	SAC54 Isleton	129	B	C-	B	B	A	A	A	A	
9	SAC54a Isleton	390	C-	A	B	C	A	A	A	A	

References

AECOM, Technical Memorandum, CVFPP Update – Levee Fragility Curves, November 12, 2020.

URS, Technical Memorandum - Levee Assessment Tool, Non-Urban Levee Evaluations Project Task Order No. U100, July 16, 2009.

URS, Technical Memorandum - Levee Assessment Procedures Update, Non-Urban Levee Evaluations Project Task Order No. U100, January 26, 2010.

URS, Geotechnical Assessment Report, Non-Urban Levee Evaluations Project Task Order No. U104, April, 2011a.

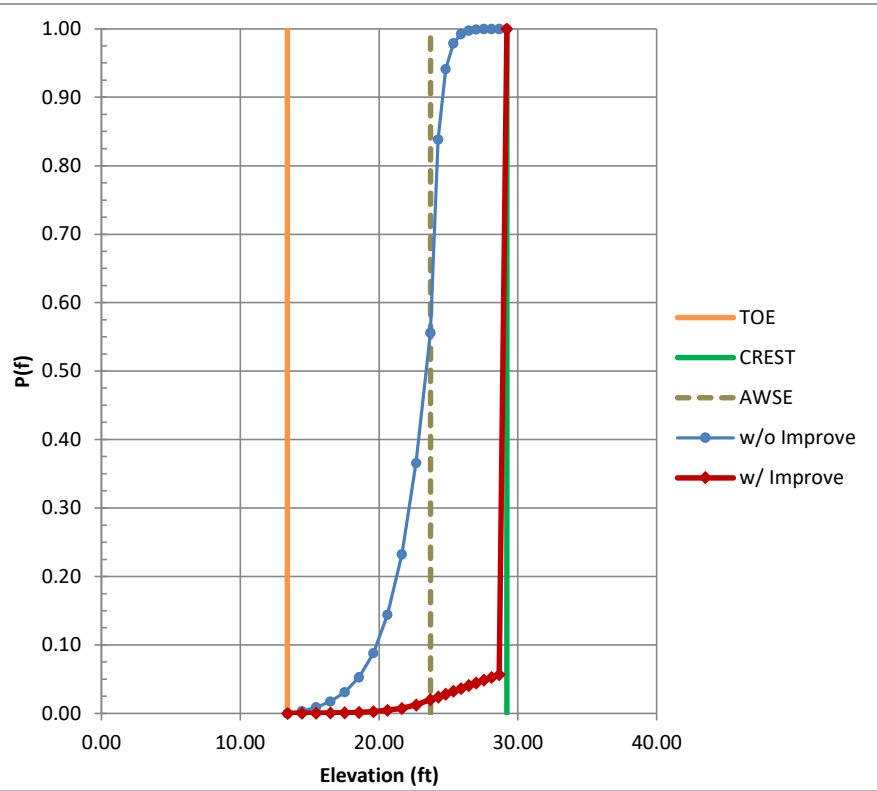
URS, Technical Memorandum – Fragility Curve Development, Non-Urban Levee Evaluations Project Task Order No. U108, November 28, 2011b.

URS, Technical Memorandum – 2014 Performance Curve Development, Non-Urban Levee Evaluations Project Task Order No. U119, January 28, 2015.

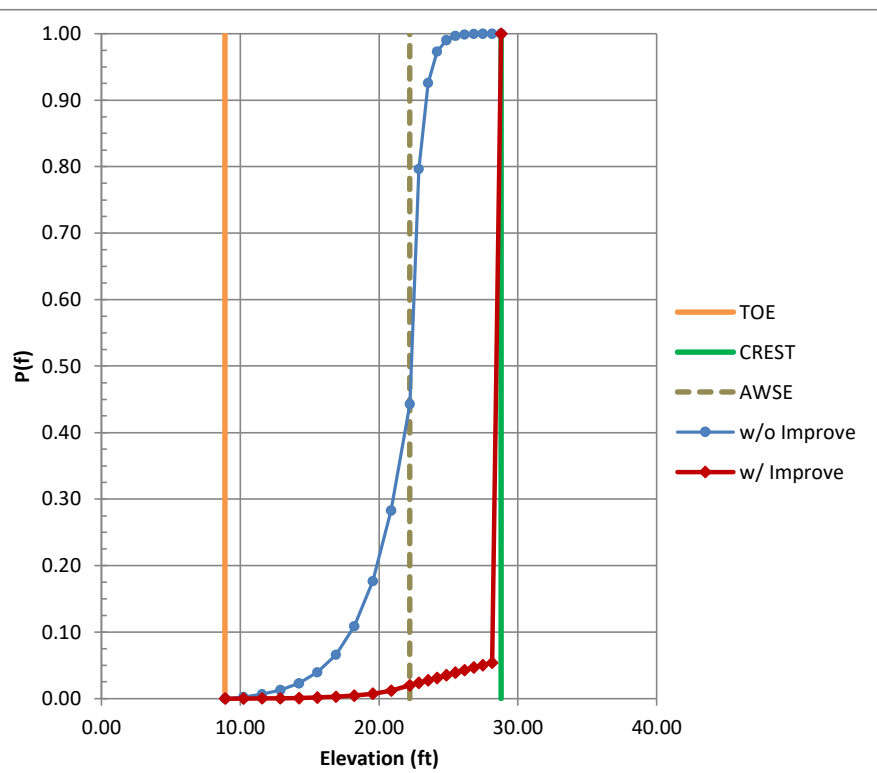
Attachment A

“Without Project” and “With Project” Representative Fragility Curves at Index Points in Sacramento County

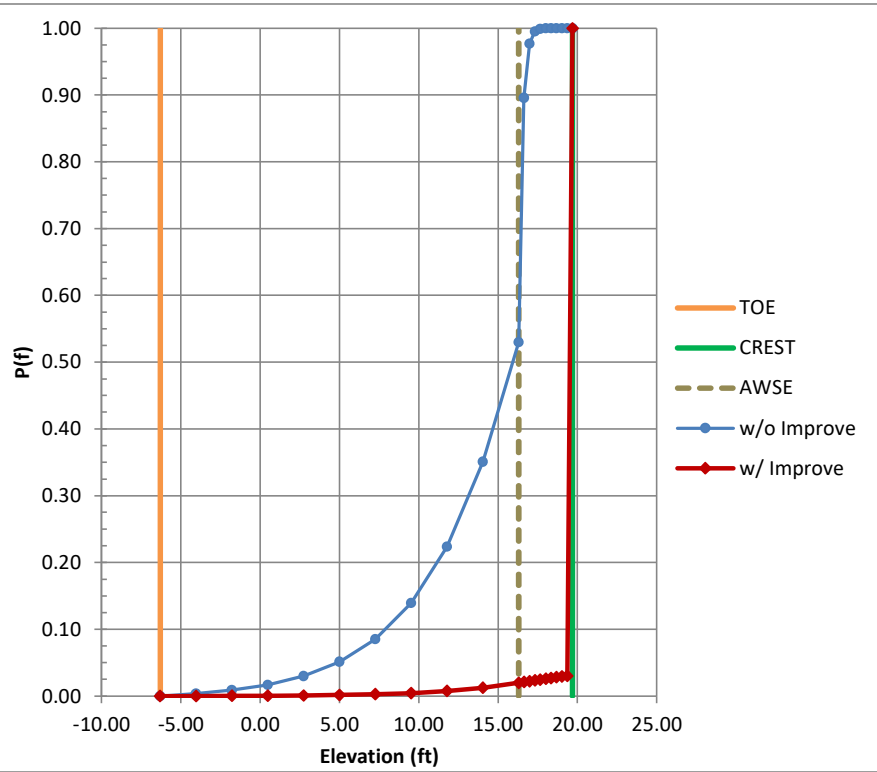
IP/Seg:	SAC44/45	106
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
13.40	0.0%	0.0%
14.43	0.3%	0.0%
15.46	0.9%	0.0%
16.49	1.7%	0.1%
17.52	3.1%	0.1%
18.55	5.3%	0.2%
19.58	8.8%	0.3%
20.61	14.4%	0.4%
21.64	23.2%	0.7%
22.67	36.6%	1.2%
23.70	55.6%	2.0%
24.25	83.8%	2.4%
24.80	94.1%	2.8%
25.35	97.9%	3.2%
25.90	99.2%	3.6%
26.45	99.7%	4.0%
27.00	99.9%	4.4%
27.55	100.0%	4.9%
28.10	100.0%	5.3%
28.65	100.0%	5.7%
29.20	100.0%	100.0%



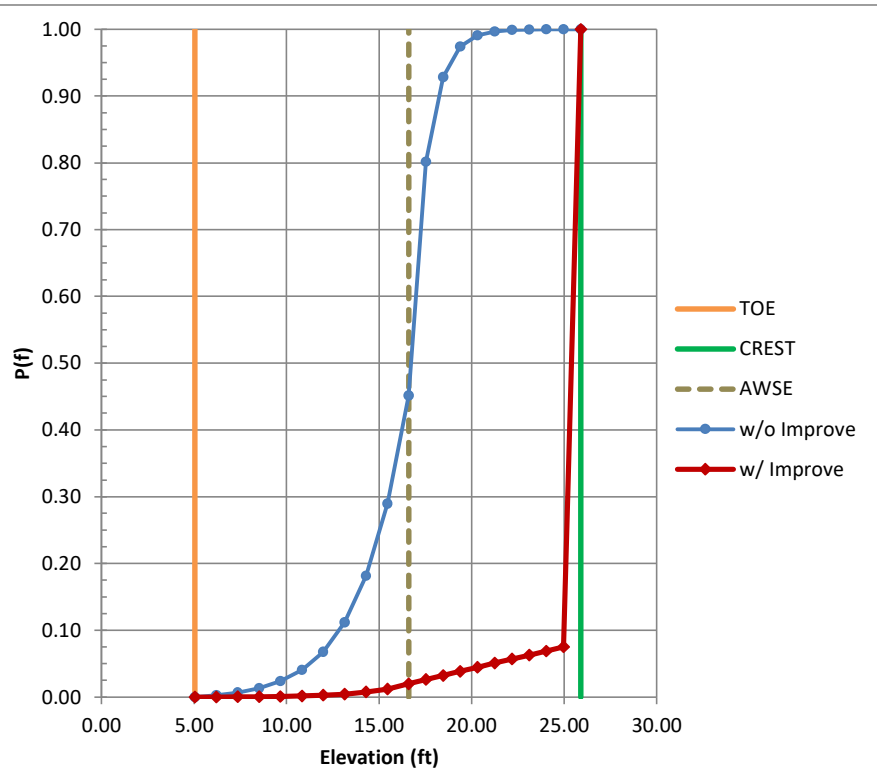
IP/Seg:	SAC47/48	131
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
8.90	0.0%	0.0%
10.23	0.3%	0.0%
11.56	0.7%	0.0%
12.89	1.3%	0.1%
14.22	2.3%	0.1%
15.55	3.9%	0.2%
16.88	6.6%	0.3%
18.21	10.9%	0.4%
19.54	17.7%	0.7%
20.87	28.3%	1.2%
22.20	44.3%	2.0%
22.86	79.7%	2.4%
23.52	92.6%	2.8%
24.18	97.3%	3.1%
24.84	99.0%	3.5%
25.50	99.7%	3.9%
26.16	99.9%	4.3%
26.82	100.0%	4.7%
27.48	100.0%	5.0%
28.14	100.0%	5.4%
28.80	100.0%	100.0%



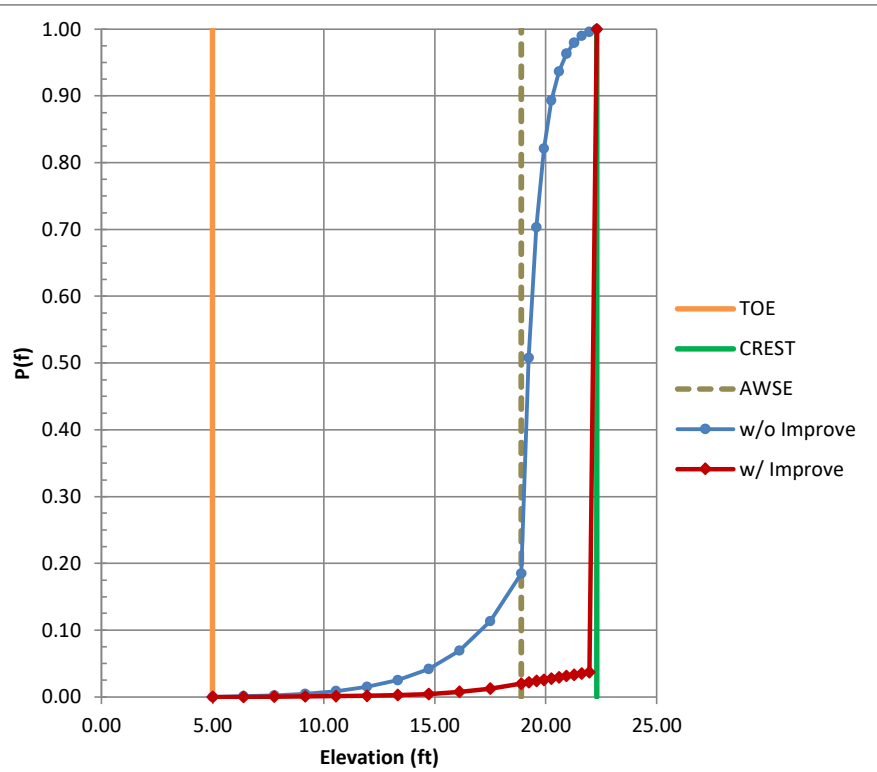
IP/Seg:	SAC50	113
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
-6.30	0.0%	0.0%
-4.04	0.3%	0.0%
-1.78	0.9%	0.0%
0.48	1.7%	0.1%
2.74	3.0%	0.1%
5.00	5.1%	0.2%
7.26	8.5%	0.3%
9.52	13.9%	0.4%
11.78	22.4%	0.7%
14.04	35.1%	1.2%
16.30	53.0%	2.0%
16.64	89.6%	2.1%
16.98	97.7%	2.2%
17.32	99.5%	2.3%
17.66	99.9%	2.5%
18.00	100.0%	2.6%
18.34	100.0%	2.7%
18.68	100.0%	2.8%
19.02	100.0%	2.9%
19.36	100.0%	3.0%
19.70	100.0%	100.0%



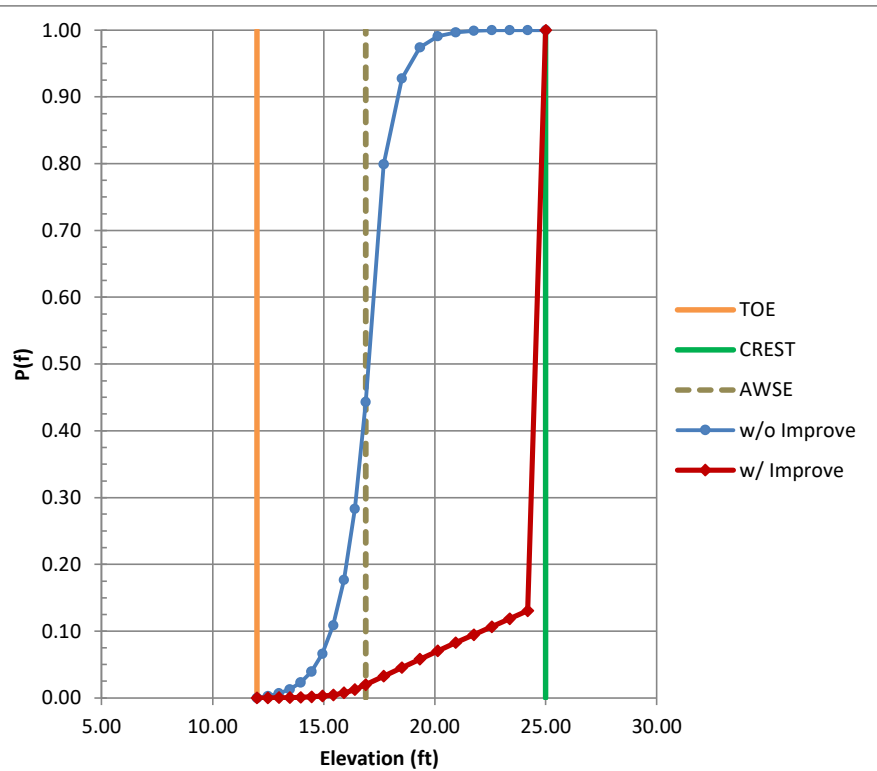
IP/Seg:	SAC50a	384
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
5.05	0.0%	0.0%
6.21	0.3%	0.0%
7.36	0.7%	0.0%
8.52	1.3%	0.1%
9.67	2.4%	0.1%
10.83	4.0%	0.2%
11.98	6.8%	0.3%
13.14	11.2%	0.4%
14.29	18.1%	0.7%
15.45	29.0%	1.2%
16.60	45.1%	2.0%
17.53	80.1%	2.6%
18.46	92.8%	3.2%
19.39	97.4%	3.8%
20.32	99.1%	4.5%
21.25	99.7%	5.1%
22.18	99.9%	5.7%
23.11	100.0%	6.3%
24.04	100.0%	6.9%
24.97	100.0%	7.5%
25.90	100.0%	100.0%



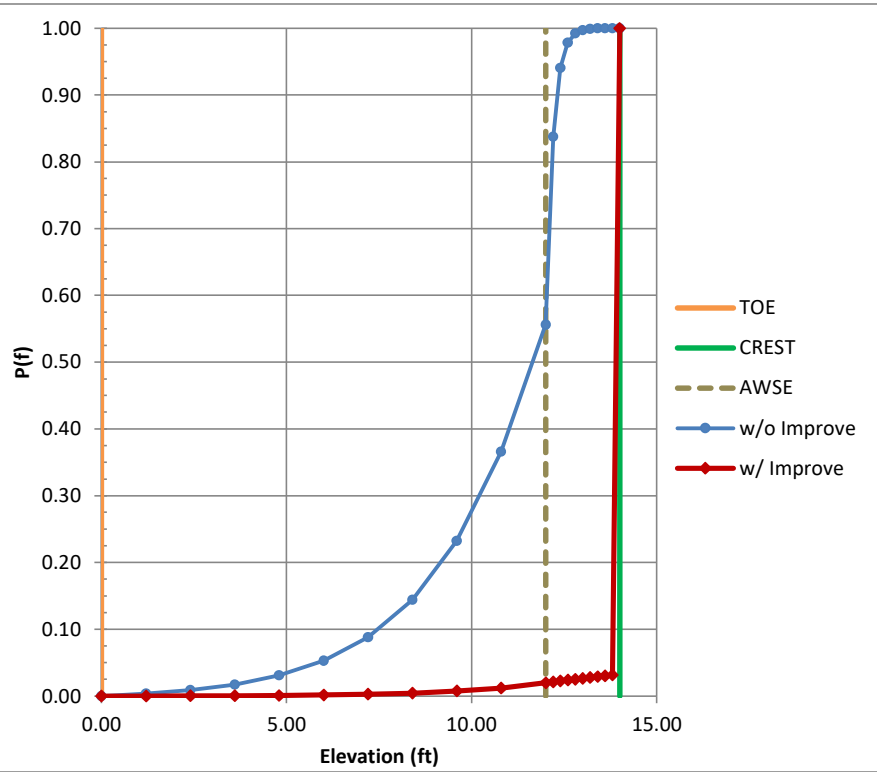
IP/Seg:	SAC51	121
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
5.0	0.0%	0.0%
6.4	0.1%	0.0%
7.8	0.2%	0.0%
9.2	0.5%	0.1%
10.6	0.9%	0.1%
12.0	1.5%	0.2%
13.3	2.5%	0.3%
14.7	4.2%	0.4%
16.1	6.9%	0.7%
17.5	11.3%	1.2%
18.9	18.5%	2.0%
19.2	50.8%	2.2%
19.6	70.3%	2.4%
19.9	82.1%	2.6%
20.3	89.3%	2.7%
20.6	93.7%	2.9%
20.9	96.3%	3.1%
21.3	98.0%	3.3%
21.6	99.0%	3.5%
22.0	99.6%	3.7%
22.3	100.0%	100.0%



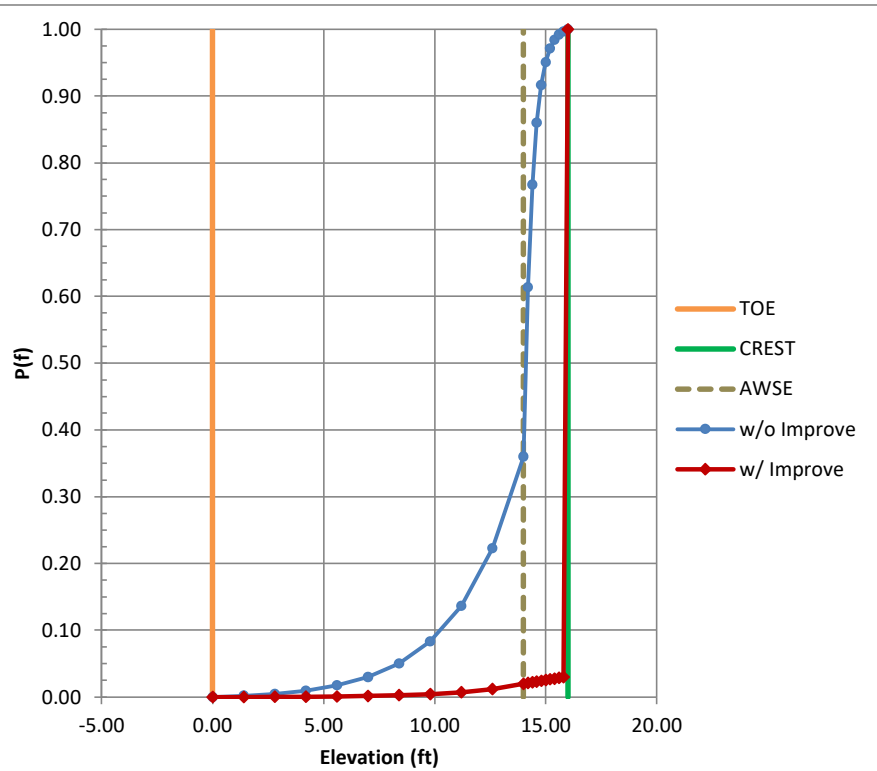
IP/Seg:	SAC52	128
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
12.0	0.0%	0.0%
12.5	0.3%	0.0%
13.0	0.7%	0.0%
13.5	1.3%	0.1%
14.0	2.3%	0.1%
14.5	3.9%	0.2%
14.9	6.6%	0.3%
15.4	10.9%	0.4%
15.9	17.7%	0.7%
16.4	28.3%	1.2%
16.9	44.3%	2.0%
17.7	79.9%	3.3%
18.5	92.8%	4.5%
19.3	97.4%	5.8%
20.1	99.1%	7.0%
21.0	99.7%	8.2%
21.8	99.9%	9.5%
22.6	100.0%	10.7%
23.4	100.0%	11.9%
24.2	100.0%	13.0%
25.0	100.0%	100.0%



IP/Seg:	SAC53	130
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
0.0	0.0%	0.0%
1.2	0.3%	0.0%
2.4	0.9%	0.0%
3.6	1.7%	0.1%
4.8	3.1%	0.1%
6.0	5.3%	0.2%
7.2	8.8%	0.3%
8.4	14.4%	0.4%
9.6	23.2%	0.7%
10.8	36.6%	1.2%
12.0	55.6%	2.0%
12.2	83.7%	2.1%
12.4	94.1%	2.2%
12.6	97.8%	2.4%
12.8	99.2%	2.5%
13.0	99.7%	2.6%
13.2	99.9%	2.8%
13.4	100.0%	2.9%
13.6	100.0%	3.0%
13.8	100.0%	3.1%
14.0	100.0%	100.0%



IP/Seg:	SAC54	129
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
0.0	0.0%	0.0%
1.4	0.2%	0.0%
2.8	0.5%	0.0%
4.2	1.0%	0.1%
5.6	1.7%	0.1%
7.0	3.0%	0.2%
8.4	5.0%	0.3%
9.8	8.3%	0.4%
11.2	13.7%	0.7%
12.6	22.3%	1.2%
14.0	36.0%	2.0%
14.2	61.4%	2.1%
14.4	76.7%	2.2%
14.6	86.0%	2.3%
14.8	91.6%	2.4%
15.0	95.0%	2.5%
15.2	97.1%	2.6%
15.4	98.4%	2.8%
15.6	99.2%	2.9%
15.8	99.7%	3.0%
16.0	100.0%	100.0%



IP/Seg:	SAC54a	390
Segment:	w/o Improve	w/ Improve
Elevation (ft)	Cumul P(f)	Cumul P(f)
6.0	0.0%	0.0%
6.9	0.3%	0.0%
7.8	0.7%	0.0%
8.6	1.3%	0.1%
9.5	2.3%	0.1%
10.4	3.9%	0.2%
11.3	6.6%	0.3%
12.1	10.9%	0.4%
13.0	17.7%	0.7%
13.9	28.3%	1.2%
14.8	44.3%	2.0%
15.6	79.7%	2.7%
16.4	92.7%	3.4%
17.2	97.4%	4.2%
18.1	99.1%	4.9%
18.9	99.7%	5.6%
19.7	99.9%	6.3%
20.5	100.0%	7.0%
21.4	100.0%	7.7%
22.2	100.0%	8.4%
23.0	100.0%	100.0%

