2021

West Bank & Vicinity GRR

Appendix B – Geotechnical Engineering

US Army Corps of Engineers®
New Orleans District

U.S. Army Corps of Engineers, New Orleans District

Non-Federal Sponsor: Coastal Protection and Restoration Authority Board of Louisiana

March 2021

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WEST BANK & VICINITY GRR
APPENDIX B – GEOTECHNICAL ENGINEERING

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WEST BANK & VICINITY GRR
APPENDIX B - GEOTECHNICAL

1 INTRODUCTION

1.1 OVERVIEW

The appendix documents geotechnical analyses for levee lifts for future conditions of 2073 intermediate project grades.

1.2 SCOPE

The scope of this appendix is to project lift schedules to the year 2073, based on the previously developed lift schedules to the year 2057, and to perform stability analysis for Mississippi River Levee (MRL)-WBV-9, 10 and 11. Settlement-induced bending moment (SIBM) caused by levee lifts on adjacent T-wall transition, and additional stability measures from the lifts were not included in the analyses. 100-year analysis only looked at RSLR, not settlement.

1.2.1 STUDY AREA

The study area is West Bank and Vicinity, which borders the Mississippi River to the west, north and east, and Lake Salvador to the south.

1.3 GEOTECHNICAL TERMINOLOGY

Consolidation: settlement of soil as a result of dissipation of pore water pressure over time.

Shear strength: the internal resistance per unit area that the soil mass can offer to resist failure and sliding along any plane inside it.

Stability berm: an earthen structure built laterally and adjacent to a levee slope to help keep it stable from sliding.

2 FUTURE WITH PROJECT/ACTION CONDITION

2.1 PRIOR ANALYSIS

“Previously developed lift schedules” or “prior lift schedules” were last prepared in 2014 to estimate levee lifts needed to ensure that previously established design grades were maintained from settlement over time. Consolidation settlement of the foundation was caused by the volume change in saturated cohesive soils due to expulsion of the water

that occupies the void spaces. The volume change was induced by the levee load that compresses the soil layers.

The process of developing prior lift schedules involved creating consolidation parameters from subsurface exploration and testing, estimating stress increase from levee load, and using Settle3D computer program.

Shrinkage and consolidation of levee fill were also considered in the development of lift schedules.

Due to the non-uniform nature of soil's physical structure and substance, settlement was estimated and lift schedules were developed for planning purposes only.

2.2 1% AEP LIFT SCHEDULE ANALYSIS

Survey of levee elevations was performed in November and December 2018. Survey was performed in fourteen survey reaches which consist of different levees. Settlement was estimated and lift schedules developed for the levees with prior analyses.

First, lift schedules previously developed to 2057 for levees of each survey reach were compared to each other and the levee with representative settlement curves was selected. It should be noted that in some cases lift schedules for all levees of a certain survey reach were not previously developed.

Secondly, previously constructed lift was drawn with year and elevation, on the prior lift schedule. Thirdly, the November or December 2018 average survey values of the control levee were plotted. Since survey elevation included the 6-inch thick articulated concrete block if the levee was armored, the survey was lowered 6 inches for the actual levee crown. A settlement curve was then drawn from the actual lift elevation to the survey elevation.

If this settlement curve intersected the new design grade, another levee lift was drawn. The thickness of the lift was similar to the thickness of the prior schedule, or was modified to reduce the number of lifts to save costs. Subsequent lifts were developed as similar shaped curves.

Survey reach 1 consisted of WBV-17b.2, WBV-18.2, WBV-71 and WBV-72. Levee WBV-71 was selected as the representative levee. Prior lift schedules consisting of the design grade from 2007 to 2057 and five lifts were shown as dashed lines. The five lifts were in 2011, 2013, 2017, 2023 and 2045. Design grade from 2007 to intermediate project grade or 100-year new in 2073 was drawn in red. Previously constructed lift (+11.5 in 2013) and 2018 high, average and low surveys were also drawn. Settlement curve in red was then drawn from lift elevation to survey elevation. A lift also in red was developed when the settlement curve intersected the design grade. The maximum lift

thickness followed those of the prior lifts. One lift was required in 2039 to elevation +12, and another in 2052 to +12.5.

Due to the pandemic telework condition, it was not possible to remove the bold grey solid lines from prior work.

Survey reach 2 consisting of the levee WBV-15a.2 was analyzed similarly to survey reach 1.

For levee WBV-14c.2 in survey reach 3, settlement curve from 2011 lift to 2018 average survey was determined and it was close to prior lift schedule. There was no armoring so the average survey was used. Prior schedules showed the design grades in green, survey elevations in blue, and projected crown elevations in light red. Since prior lift schedules existed in pdf format only, it was not possible to edit information on plate for clarity. New design grades, actual settlement and future lifts were shown in red. The actual lift in 2019 was plotted and settlement curve estimated, following the shape of the curve from 2011 lift to 2018 survey. Due to the pandemic work condition, old work in solid grey line (100-year old) could not be removed for clarity.

WBV-14b.2 in survey reach 4 was analyzed similarly to survey reach 3.

WBV-14a.2 in survey reach 5 is an interior levee with no direct storm surge effect from the Gulf of Mexico. Prior lift schedules showed the design grade in green at +8.5, survey elevations in blue, and projected crown elevations in light red. Actual settlement in gray was drawn from 2012 lift to 2018 average survey and it was close the prior curve. A lift was required in 2019 and the settlement curve in gray was estimated similar to that of the prior schedule.

WBV-06a.2 in survey reach 6 is an interior levee with a design grade at +8.5. Prior analysis was in bold blue. Since prior lift schedules existed in pdf format only, it was not possible to edit information on plate for clarity. Since the settlement curve from construction grade to 2018 average survey stayed above the design grade, no future lifts were required.

WBV-47.1 in survey reach 7 is an interior levee with a design grade at +8.2. Prior analysis was in dotted gray and settlement curve in solid gray. Since the settlement curve from previously constructed lift to 2018 average survey stayed above the design grade, no future lifts were required.

WBV-48.2 in survey reaches 8 and 9 is an interior levee with a design grade at +8.5. Prior lifts were in bold blue and settlement curve in light gray. Since the settlement curve from previous lift to 2018 average survey stayed above the design grade, no future lifts were required.

Prior schedule of WBV-12 in survey reach 10 consisted of four lifts in dashed gray lines. Since latest lift was constructed in 2018, same as survey, settlement curve in solid yellow was assumed to follow curve in prior schedule. It was not possible to remove the solid red and grey line and curves from old work (100-year old) for clarity.

Prior schedules of WBV-MRL-1.2b in survey reach 11 consisted of theoretical settlement and lifts in dashed blue, and actual settlement and projected lifts in yellow. There seemed to be a good correlation between the two. It was not possible to remove the red project grade and grey settlement curve from old work (100-year old).

Projected settlement of WBV-MRL-6.1 in survey reach 12 showed a lift of approximately 1.5 foot in 2040. There seemed to be a good correlation between settlement in prior analysis and actual settlement from the latest lift. It was not possible to remove the red project grade and solid grey settlement curve from old work (100-year old).

Projected settlement of WBV-MRL-7.1 in survey reach 13 showed no required lift. There seemed to be a good correlation between settlement in prior analysis and actual settlement from the latest lift. It was not possible to remove the red project grade and solid grey settlement curve from old work (100-year old).

Projected settlement of WBV-MRL-9 and WBV-MRL-11 in survey reach 13 showed a lift in 2040 and 2060, respectively.

Summary of lift schedules is shown in Appendix A Civil.

2.3 0.5% AEP LIFT SCHEDULE ANALYSIS

0.5% AEP settlement was interpolated between 0.2% AEP and 1% AEP settlement and presented in Appendix A. Considering the level of effort of the study, general reevaluation, interpolation was appropriate.

2.4 LEVEE STABILITY ANALYSIS

Stability was analyzed for raising the WPV-MRL-9, 10 and 11 to the 2073 design grades while shifting the centerline to the flood side to avoid additional right-of-way need on the protected side.

Boring data was collected and strengthlines created. Surveys were conducted in 2020 and representative cross sections selected. GeoStudio Slope/W version 2019 with Spencer's method of analysis was used, and HSDRRS criteria for minimum factors of safety apply. Since Still Water Level (SWL) and Low Water Level (LWL) were not available, Water at Project Grade (WPG) or High Water Level (HWL) was used.

HSDRRS Slope Stability Design Factors of Safety

Analysis Condition	Required Minimum Factor of Safety	
	Spencer Method[1]	Method of Planes[2]
End of Construction[3]	1.3	1.3
Design Hurricane[4] (SWL)	1.5	1.3
Design Hurricane (SWL) w/ dry PS borrow pit[10]	1.3	1.3
Water at Project Grade (levees)[5]	1.4 (1.5)[6]	1.2
Water at Construction Grade (levees)[5]	1.2	N/A
Extreme Hurricane (water @ top of I-walls)[5]	1.4 (1.5)[6]	1.3
Extreme Hurricane (water @ top of T-walls)[5a]	1.4 (1.5)[6]	1.2
Low Water (hurricane condition)[7]	1.4	1.3
Low Water (non-hurricane condition)[8] S-case	1.4	1.3
Water at Project Grade Utility Crossing[9]	1.5 (1.4)	1.3 (1.2)

Centerline borings for WBV-MRL-9 consisted of WB-85.3-U, WB-84.5CU, R-85.75-RUC, R-84.5-RUC and W-87.4-U drilled in 1971 to 2010 with depths of 130 feet to 150 feet. Toe borings consisted of WB-84.75UPT, WB-84.2UPT, R-85.75-RUT, R-84.5-RUT and R-86.8-UR drilled in 1968 to 2010 with depths of 130 feet to 150 feet.

Centerline borings for WBV-MRL-10 consisted of R-88.2-AU drilled in 1973 with depth of 130 feet. Toe borings consisted of ACT-2UT, R-88.2-AUT, 5-UL, 4-UL, 1-U and U-1 drilled in 1947 to 2002 with depths of 60 feet to 100 feet.

Centerline borings for WBV-MRL-11 consisted of ASA-5UCL, ASA-2UCL, W-92.2-UC, W-94.8-U, W-94.5-U, W-93.9-U, R-90.25-RU, W-94.4-U, W-90.8-U, R-89.1-RUC, R-88.49-UR, and R-89.7-UR drilled in 1969 to 2007 with depth of 60 feet to 220 feet. Toe borings consisted of M-94.4-UR, M-94.2-UR, M-94.0-UR, W-95.1-UT, W-94.5-UT, W-93.9-UT, W-94.9-UT, W-94.7-UT, M-94.6-UL, R-89.7-URT and R-89.1-RUT drilled in 1969 to 2007 with depths of 90 feet to 230 feet.

Since the minimum factors of safety were met, WBV-MRL-9 and WBV-11 were able to be raised and the alignment shifted to the flood side. WBV-MRL-10 raise did not meet the required factor of safety and a floodwall was recommended.

2.5 ASSUMPTIONS AND RISK

The assumption was that settlement curves follow the same trends as those of the curves developed to 2057. In lieu of sufficient data (latest lift occurred after survey), settlement curve was assumed to follow prior lift schedule. To be conservative, the same assumption also applies to subsequent lift schedules following a first lift with a small amount of settlement. Risk should be reasonable. Stability aspect was performed for a few selected WBV-MRL levees and considered a reasonable risk. SIBM was not considered at this stage and risk should be reasonable.

3 LEVEE COMPOSITION

A typical levee is constructed of high plasticity clay or low plasticity clay with less than 35% sand and 9% organic material. The clay is compacted to at least 90% maximum dry density at a moisture content of within +5% to -3% optimum moisture content.

4 SETTLEMENT MONITORING / CONSTRUCTION IMPLEMENTATION

An initial construction grade is typically approximately 2-3 feet higher than the design grade at the start of the design life. The purpose for that is: to account for a settlement balance, allow for strength gain in the foundation due to consolidation, minimize the increase in required levee footprint, and maintain the constructed crown at or above the design life for approximately 5-7 years. When the time-rate settlement curve (i.e. placed at the construction grade elevation) is scheduled to cross the assumed linearly-varying design elevation line on the lift schedule/plot, another lift is required. If authority/funding is in place, MVN or the NFS will start looking into this approximately a year or so before the time-rate settlement curve theoretically crosses the design line so that surveys can be taken to verify the theoretical calculations. After the first lift, a balance is also aimed for construction lift height, foundation conditions, and lift duration. It is usually the intent to stay within the ROW limits for additional lifts.

5 CONCLUSION

WBV levees can require a number of lifts to maintain the 1% of 2073 intermediate project grade. Lift schedules and estimated quantities are in Appendix A (Civil).

Lift Schedule Projections

LPV-WBV GRR Future Levee Lift Analysis
Table of Representative Levee, Latest Lift, Armor, and Prior Analysis
WBV

Survey Reach	Levee	Representative Levee	Lift Year	Lift Elevation	Armor Year	Note
1	WBV-17b.2, 18.2, 71 and 72	71 Western tie-in (north-south)	2013	11.5	2016	
2	WBV-15a.2 (Lake Cataouatche PS#1 to Segnette State Park)		2011	13.5		
3	WBV-14c.2 (New Westwego PS to Orleans Village)		2011	13.5		
4	WBV-14b.2, 14e.2a, 14f.2, 14i.2	14b.2 (Orleans Village to Hwy 45)	2011	14		
5	WBV-14a.2 (Harvey canal westbank levee)		2012	12		
6	WBV-06a.2 (Belle Chasse Hwy to Hero cutoff (west))		exist	10		
7	WBV-47.1 (Algiers lock to Belle Chasse Hwy (west))		2011	9.2		
8	WBV-48.2, 49.1	48.2 (Belle Chasse to Algiers Lock (east))	2014	8.8		
9	WBV-48.2	48.2 (Belle Chasse to Algiers Lock (east))	2014	8.8		
10	WBV-09a, 12, 90	12 (Hero canal reach 1)	2018	13		
11	WBV-MRL 1.2b & 3.2	1.2b (Augusta to Oakville)	2017	22.5	2018	No prior lift schedules for 3.2
12	WBV-MRL 5.2 & 6.1	6.1 (Parish Line to English Turn Bend)	2011	21	Armored	No prior lift schedules for 5.2
13	WBV-MRL 7.1, 9, 10, 11	7.1 (West Crossover Point to Parish Line)	2012	21	2017	No prior lift schedules for 9, 10, 11

Hurricane & Storm Damage Risk Reduction System (HSDRRS) Map

Structure #	Structure Name	Structure #	Structure Name
S-1	Cross Bayou Drainage Structure	S-14	Bayou Bienvenue Floodgate
S-2	St. Rose Drainage Structure	S-15	IHNC Surge Barrier
S-3	Almedia Drainage Structure	S-16	Bayou Dupre Floodgate
S-4	Walker Drainage Structure	S-17	Caernarvon Structure
S-5	17th Street Canal ICS	S-18	Western Tie-in Closure Structure
S-6	Orleans Avenue Canal ICS	S-19	Bayou Segnette Complex
S-7	London Avenue Canal ICS	S-20	Harvey Lock
S-8	Seabrook Closure Complex	S-21	Harvey Sector Gate
S-9	WCS-1	S-22	GIWW Western Closure Complex
S-10	WCS-2	S-23	Algiers Lock
S-11	WCS-3	S-24	Eastern Tie-in Water Control Structure
S-12	WCS-4	S-25	Estelle Canal Water Control Structure
S-13	IHNC Lock	S-26	Western Tie-in Sluice Gate Structure

Pump Station #	Pump Station Name	Pump Station #	Pump Station Name	Pump Station #	Pump Station Name
1	Engineers Canal PS	33	OP#3 PS	65	Westminster PS
2	Bayou Trepagnier PS	34	OP#4 PS	66	Ames PS
3	New Sarpy PS	35	London Ave. Canal ICS PS	67	Mt. Kennedy PS
4	Schexnaydre PS	36	OP#17 PS (Station D)	68	Estelle #1PS (Old Estelle)
5	Destrehan II (Ormond II) PS	37	OP#19 PS	69	Estelle #2 PS
6	Destrehan I (Ormond I) PS	38	Dwyer Rd. PS	70	Cousins #1 PS
7	Bank One Portable PS	39	OP#16 PS (St. Charles)	71	Cousins #2 PS
8	4th Street PS	40	OP#10 PS (Citrus)	72	Cousins #3 PS
9	Oak Street PS	41	OP#14 PS (Jahncke)	73	Harvey PS
10	Diane PS	42	OP#15 PS	74	Hero PS
11	Turtle Pond PS	43	OP#18 PS (Maxent)	75	Whitney Barataria PS
12	Almedia Road PS	44	Grant St. PS	76	Planters PS
13	Fox Lane PS	45	Elaine St. PS	77	N.O.S.&W.B. #13 PS
14	Oakland PS	46	OP#20 PS (Amid)	78	OP#11 PS
15	Walker Canal PS	47	OP#5 PS	79	Belle Chasse #2 PS
16	Fairfield PS	48	Jean Lafie #6 PS	80	Barriere Road PS
17	Parish Line PS	49	Fortification #1 PS	81	Belle Chasse #1 PS
18	JP#4 PS (Duncan)	50	Guichard #2 PS	82	West Closure Complex PS
19	JP#3 PS (Elmwood)	51	Bayou Villere #3 PS	83	Eastern Tie-in PS #1
20	JP#2 PS (Suburban)	52	Bayou Ducros #7 PS	84	Eastern Tie-in PS #2
21	JP#1 PS (Bonnabel)	53	Meraux #4 PS	85	Cross Bayou PS
22	Prichard PS	54	E.J. Gore #5 PS	86	Almedia Drainage Structure PS
23	Montegut PS	55	St. Mary #8 PS	87	Walker Drainage Structure PS
24	OP#6 PS	56	Ama PS	88	Motor PS
25	Canal Street PS	57	New Highway 90 PS	89	Englewood PS
26	17th Street Canal ICS PS	58	Lake Cataouatche #1 PS	90	Airline PS
27	I-10 Underpass PS	59	Lake Cataouatche #2 PS	91	LaBarre North and South PS
28	OP#12 PS	60	Bayou Segnette #1 PS	92	Oak Cove PS
29	OP#1 PS (Broad St.)	61	Bayou Segnette #2 PS	93	Harvey Sector Gate Pumps
30	OP#2 PS	62	Bayou Segnette Complex PS	94	WL&F PS #1
31	OP#7 PS	63	Old Westwego PS	95	WL&F PS #2
32	Orleans Ave. Canal ICS PS	64	Westwego #2 PS	96	WL&F CTU #6 PS

U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
Engineering Office

Legend

- HSDRRS Pump Station
- HSDRRS Structures
- Other Levees
- HSDRRS System
- Parishes (GDT)

H&H BASIN

- LPV Inner Harbor Navigation Canal (IHNC) Basin
- LPV Jefferson East Bank Basin
- LPV Lower 9th Ward and St. Bernard Basin
- LPV New Orleans Metro Basin
- LPV New Orleans East Basin
- LPV St. Charles Basin
- WBV Algiers Basin
- WBV Ames, Westwego Basin
- WBV Belle Chasse Basin
- WBV Catauoatche Basin
- WBV East of Harvey Basin
- WBV GIWW West Closure Complex Basin
- WBV Lower Coast Algiers Basin
- WBV Harvey Estelle, Cousins Basin

Last Modified : 3/10/2013

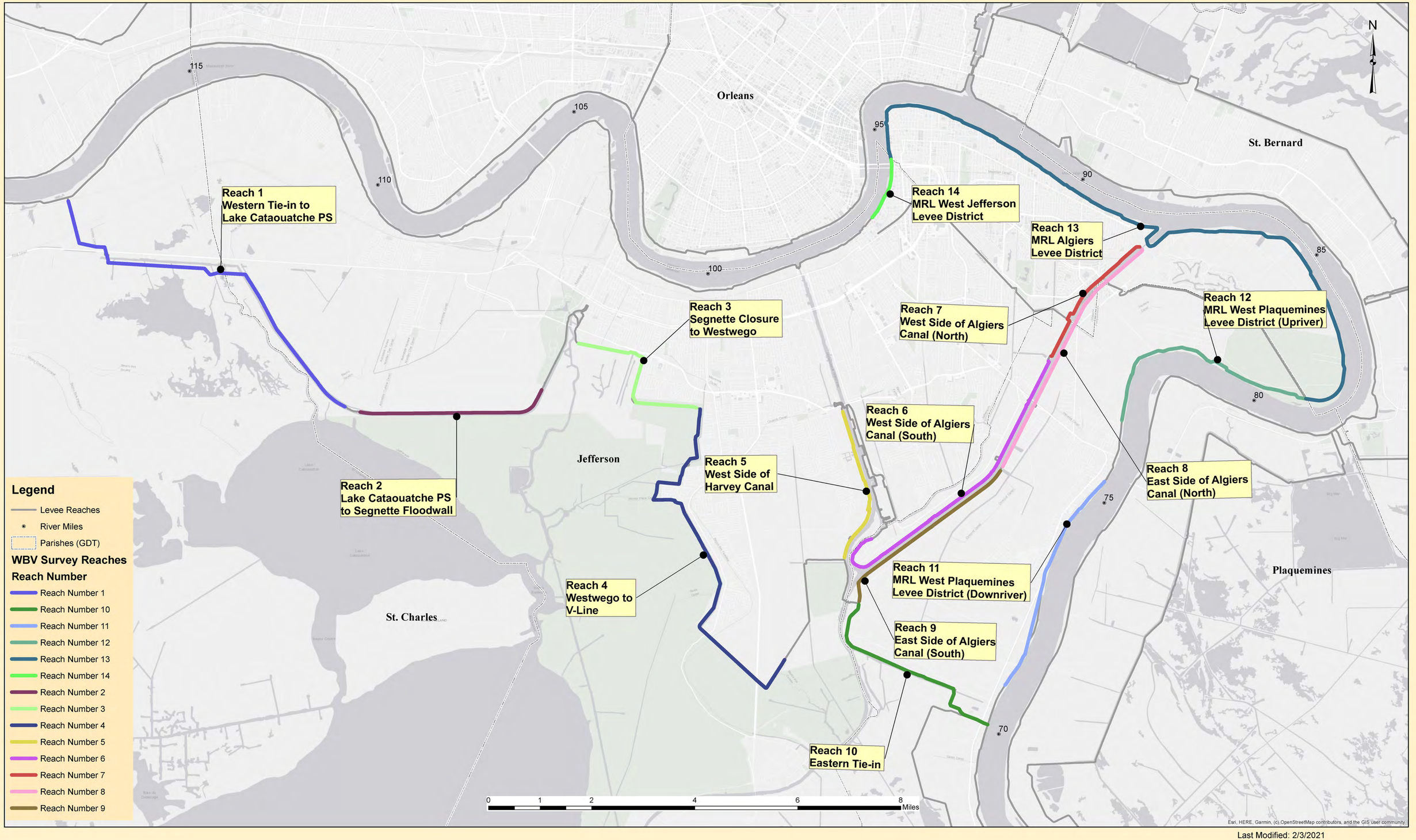
Location Map

IMAGERY
Projected coordinate system name: NAD_1983_UTM_Zone_15N
Geographic coordinate system name: GCS_North_American_1983
Resolution: 1.000000

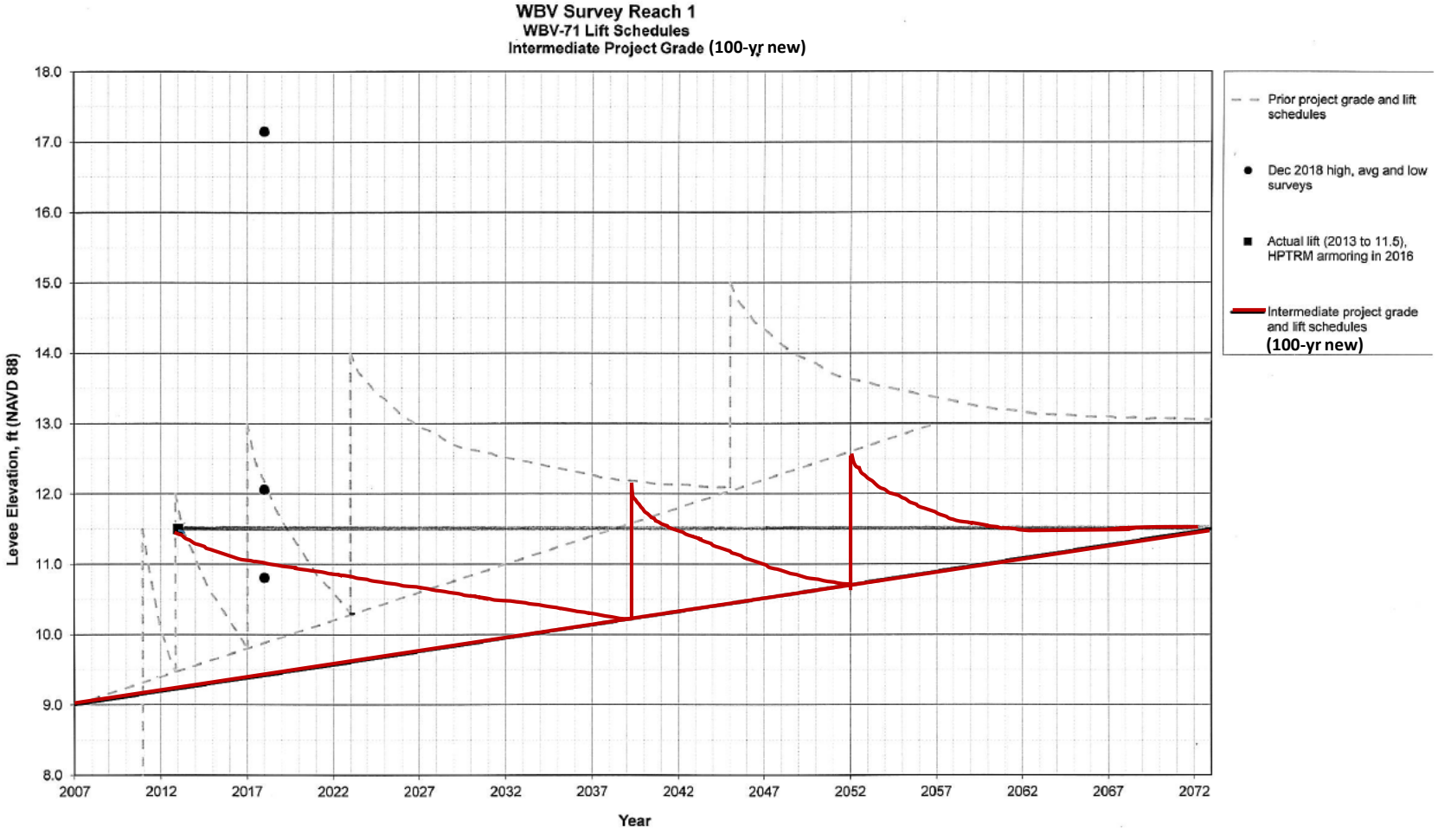
Hurricane & Storm Damage Risk Reduction System (HSDRRS) Map

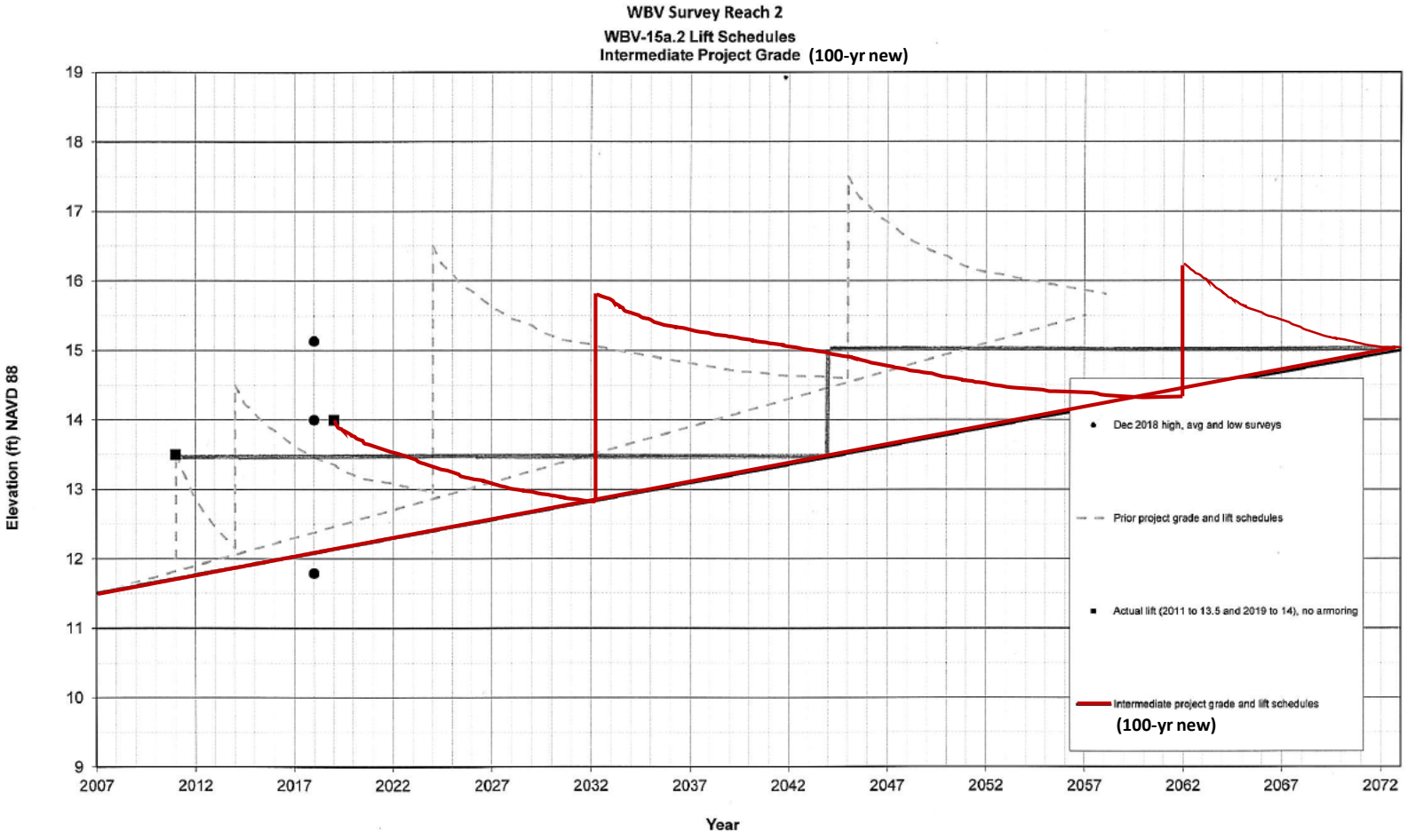
EGIS Map ID No. 11-004

Survey Reaches for WBV GRR Study



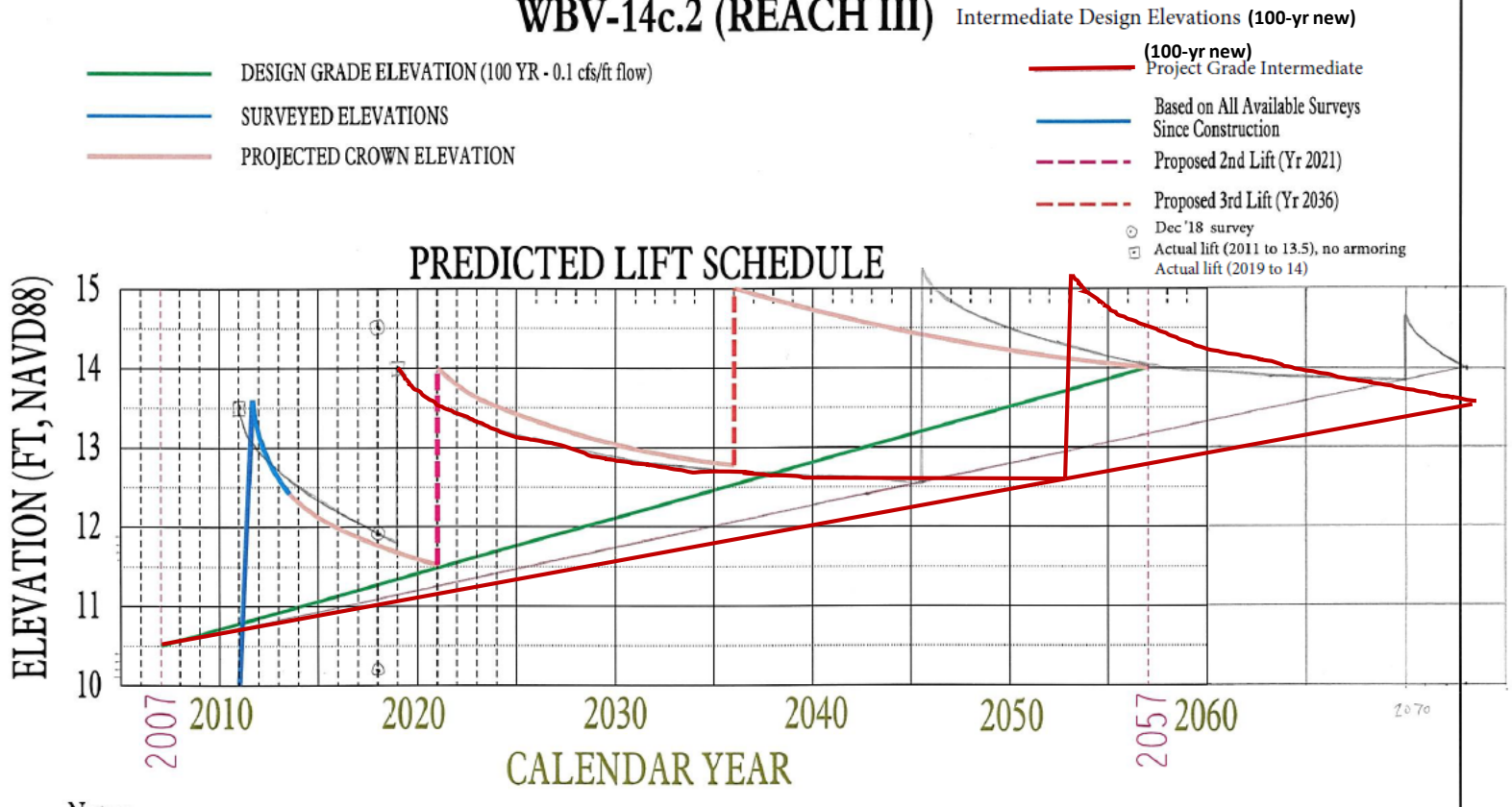
Last Modified: 2/3/2021
EGIS Map ID. 19-002-002


WBV Survey Reach 1
WBV-71 Lift Schedules
Intermediate Project Grade (100-yr new)
Levee Elevation, ft (NAVD 88)
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
Year
Prior project grade and lift schedules
Dec 2018 high, avg and low surveys
Actual lift (2013 to 11.5), HPTRM armoring in 2016
Intermediate project grade and lift schedules
(100-yr new)


WBV Survey Reach 2
WBV-15a.2 Lift Schedules
Intermediate Project Grade (100-yr new)
Elevation (ft) NAVD 88
Year
19
18
17
16
15
14
13
12
11
10
9
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
Dec 2018 high, avg and low surveys
Prior project grade and lift schedules
Actual lift (2011 to 13.5 and 2019 to 14), no armoring
Intermediate project grade and lift schedules
(100-yr new)

WBV Survey Reach 3

WBV-14c.2 (REACH III)



Notes:

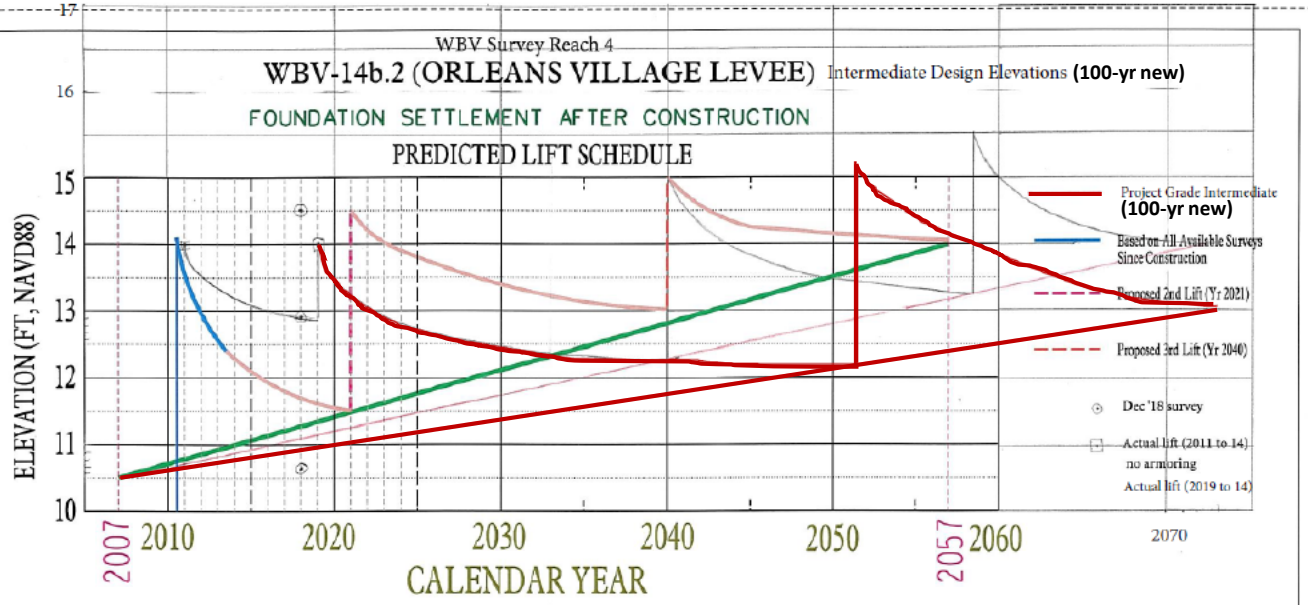
- Prior to 2010 Lift, Existing Elevation of Approx. EL +5 to +7 at new offset Centerline
- Time Rate Settlement Calculations are an Estimate and Should be Only be used for Planning Purposes

WBV-14c

Westwego to Westmister Levees

THEORETICAL SETTLEMENT ANALYSIS

B/L STA 69+95 to 253+10



Note: Prior to 2010 Lift, Existing Centerline Approx. EL +1 from STA 260+00 TO 320+17

DESIGN GRADE ELEVATION (100 YR - 0.1 cfs/ft flow)

SURVEYED ELEVATIONS

PROJECTED CROWN ELEVATION

Notes:

- Levee STA 260+00 TO 355+45 will experience significantly more settlement than the levee portions resting on a natural ridge from STA. 355+45 to 425+00.
- Time Rate Settlement Calculations are an Estimate and Should be Only be used for Planning Purposes

WBV-14b.2

WEST JEFFERSON PARISH, LOUISIANA

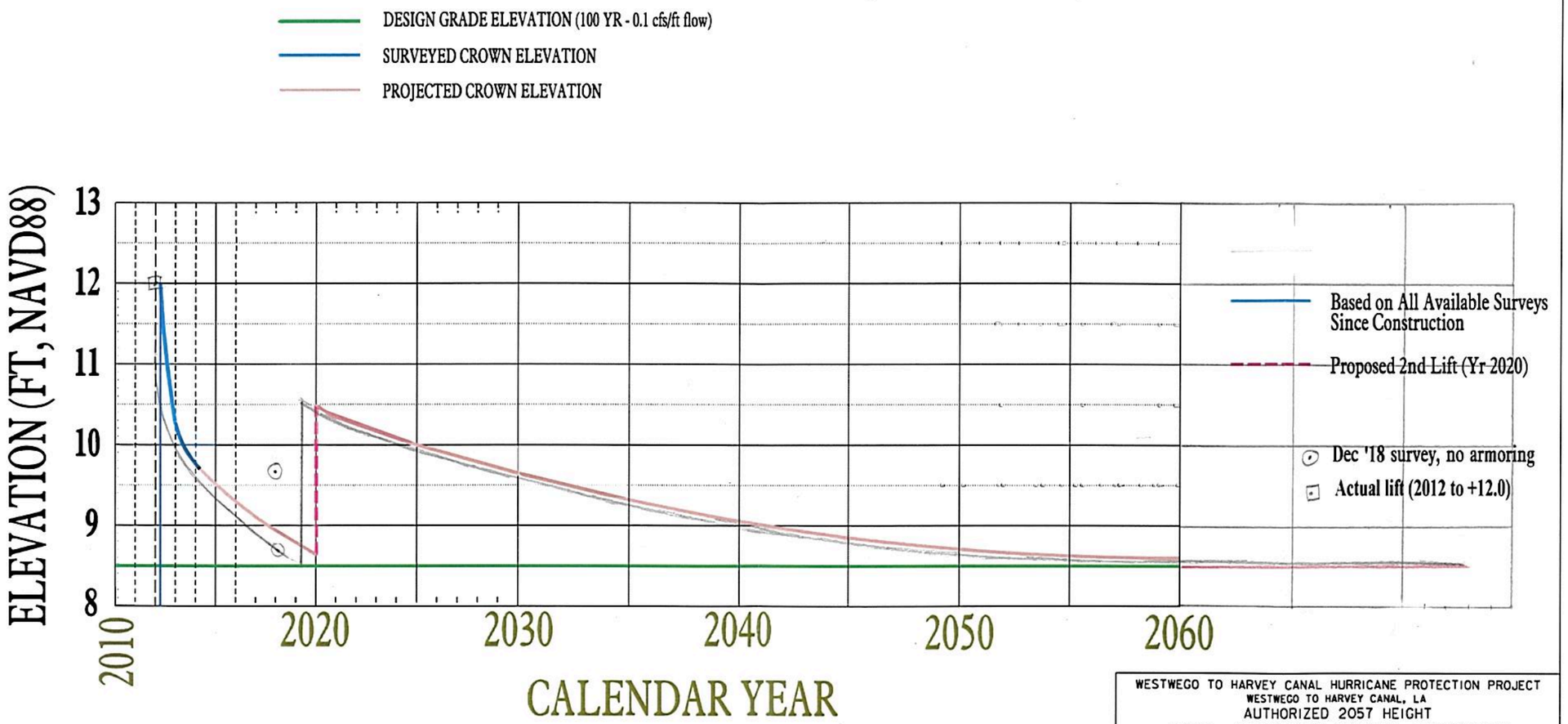
ORLEANS VILLAGE LEVEE REACH

THEORETICAL SETTLEMENT ANALYSIS

STA 260+00 TO 355+45

WBV Survey Reach 5

WBV-14a.2 Lift Schedules Projections



Natural Grnd at New Centerline (for setback) is Approx. EL -2

NOTE:
Time Rate Settlement Calculations are an Estimate and Should be Only be used for Planning Purposes

WESTWEGO TO HARVEY CANAL HURRICANE PROTECTION PROJECT
WESTWEGO TO HARVEY CANAL, LA
AUTHORIZED 2057 HEIGHT
WEST JEFFERSON PARISH, LOUISIANA
HARVET CANAL SETBACK LEVEE REACH
PREDICTED SETTLEMENT
B/L STA 906+3200 TO 915+16 and 935+24 TO 973+04

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
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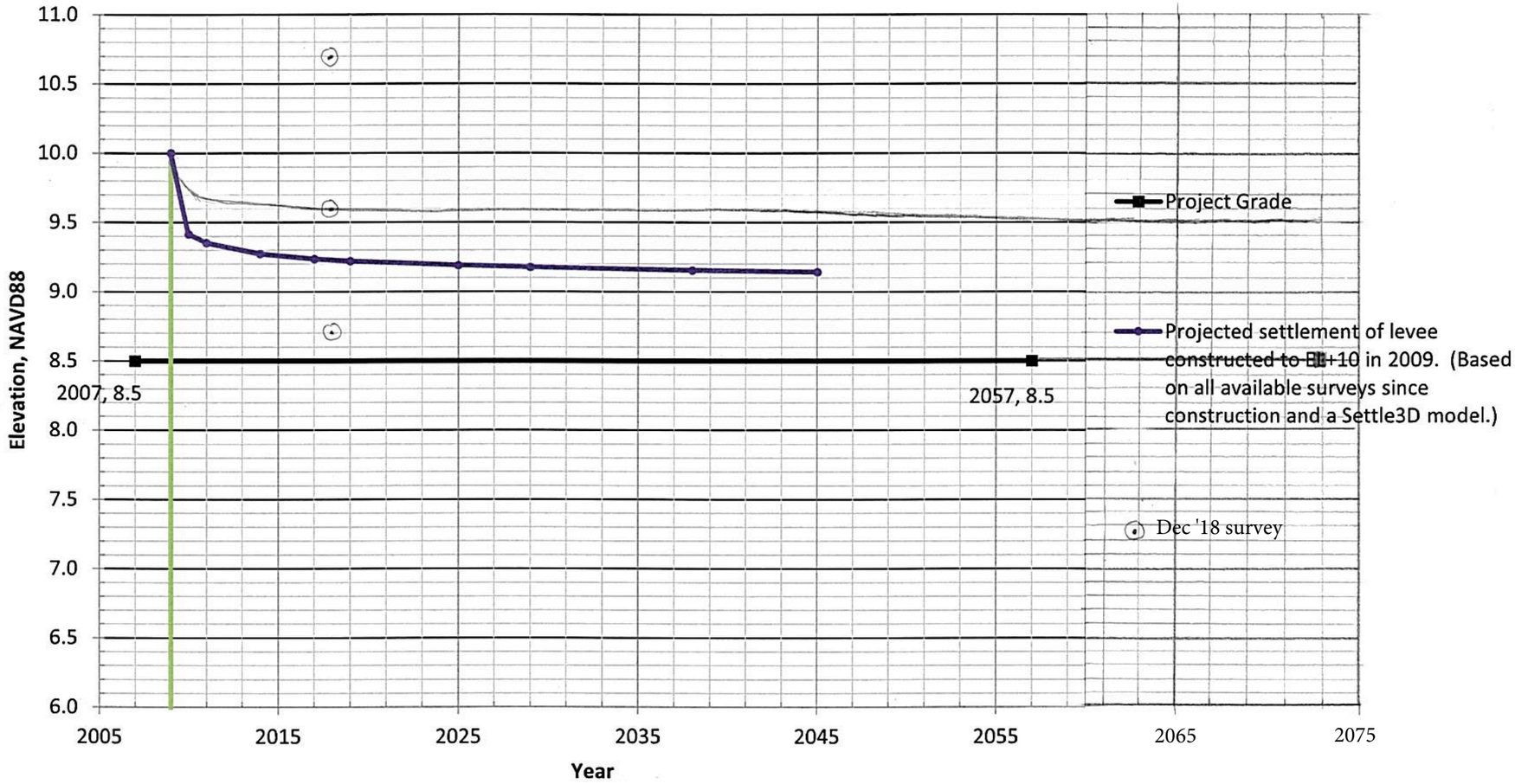
NEW ORLEANS, LOUISIANA

DESIGNED BY: J. J.	PLOT SCALE: 10	PLOT DATE: Oct 13	CADD FILE:	
DRAWN BY: J. J.			FILE NO.	
CHECKED BY: K. J. T	DATE: OCT 2013			

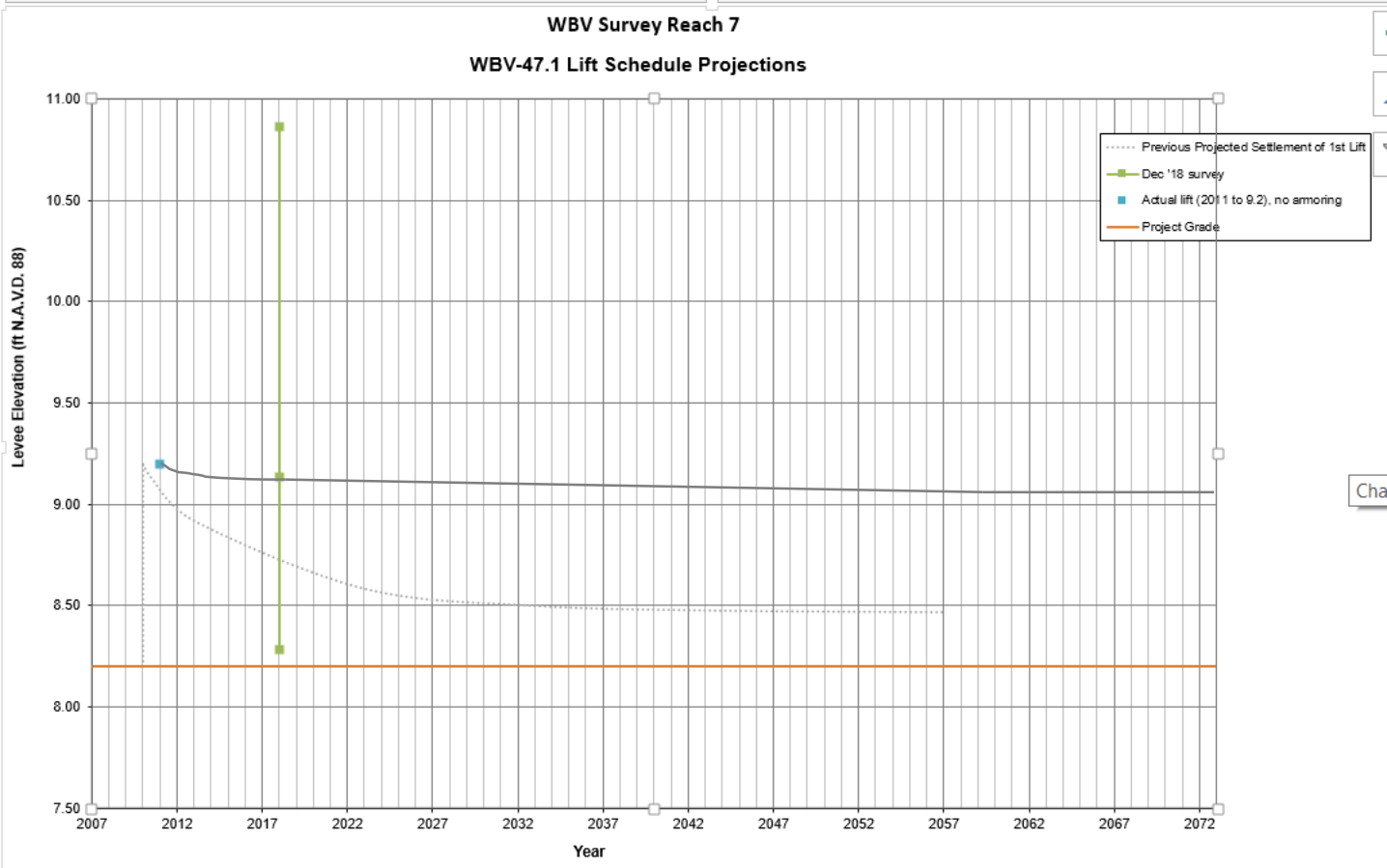
Westbank and Vicinity HSDRRS Survey Reach 6

Algiers Canal, WBV 6A.2

Reach 4 - Lift Schedule (updated 10/7/14)

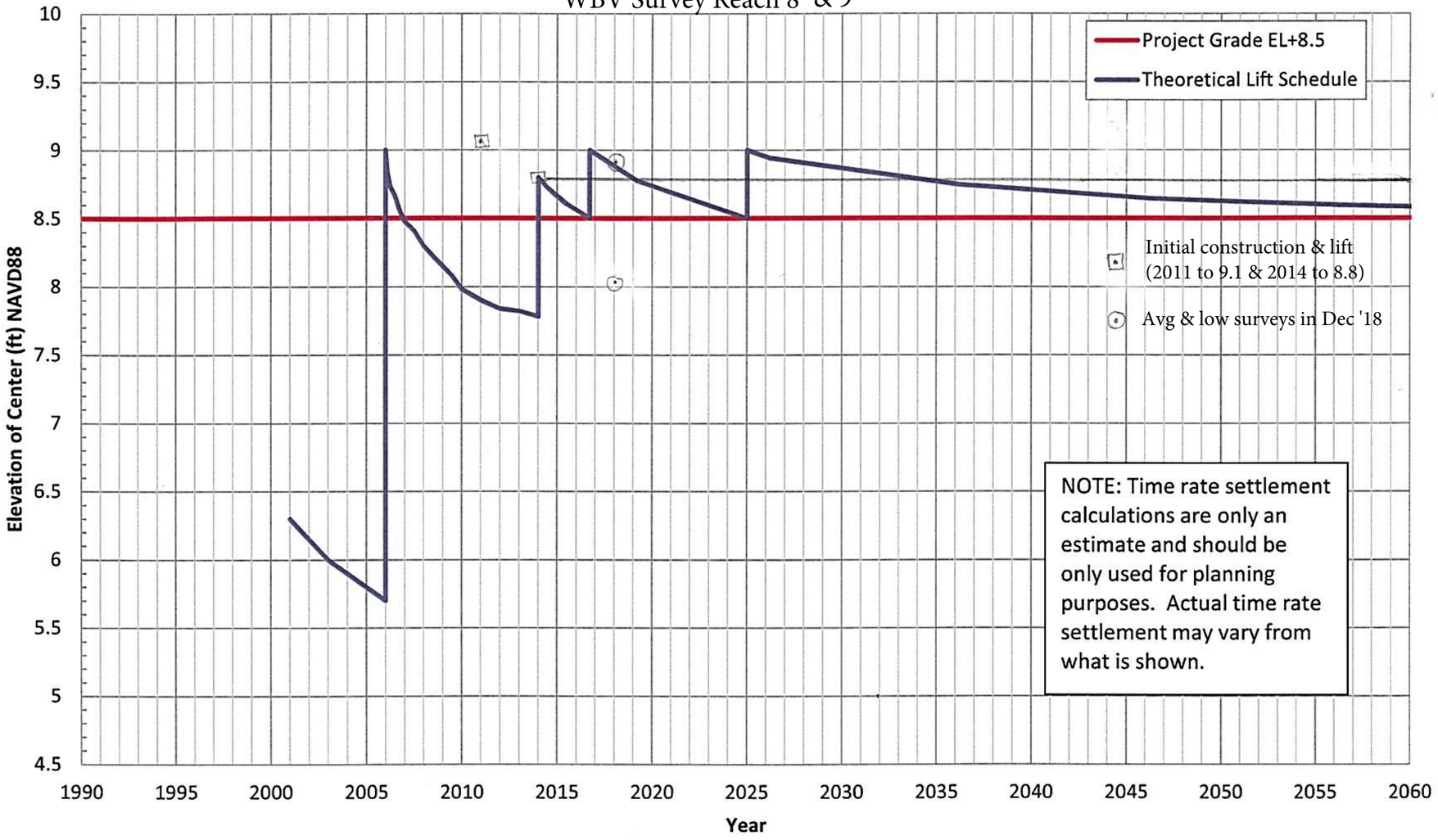


Note: Time rate settlement calculations are only an estimate. Time rate settlement may vary from what is shown and is only develped for planning purposes.


WBV Survey Reach 7
WBV-47.1 Lift Schedule Projections
Levee Elevation (ft N.A.V.D. 88)
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
Year
Previous Projected Settlement of 1st Lift
Dec '18 survey
Actual lift (2011 to 9.2), no armoring
Project Grade

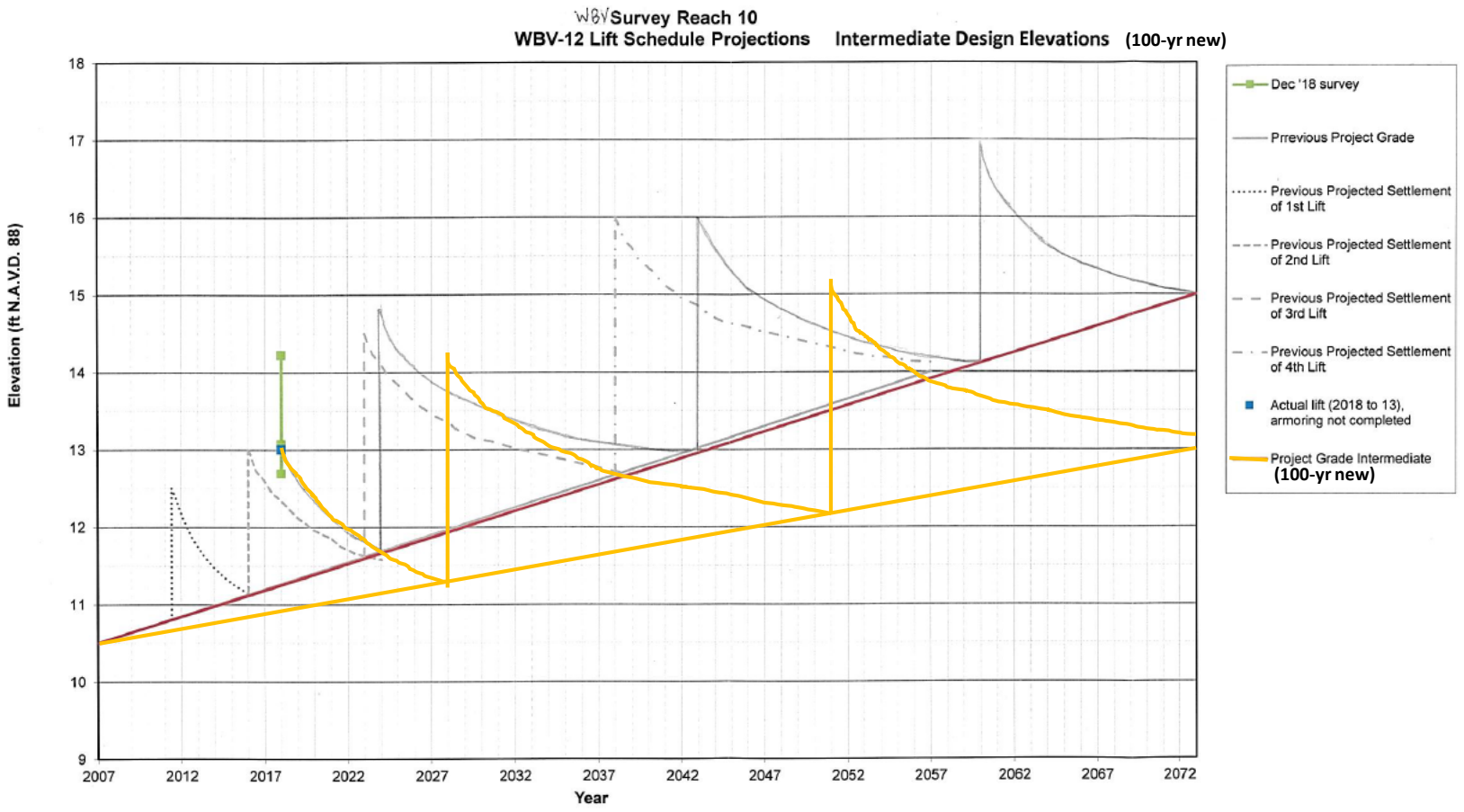
Algiers Canal, East Bank Levees (WBV-48 and WBV-49) Lift Schedule

WBV Survey Reach 8 & 9



-The raise in 2014 was to EL+8.8 and P/S berm only was added in 2010.

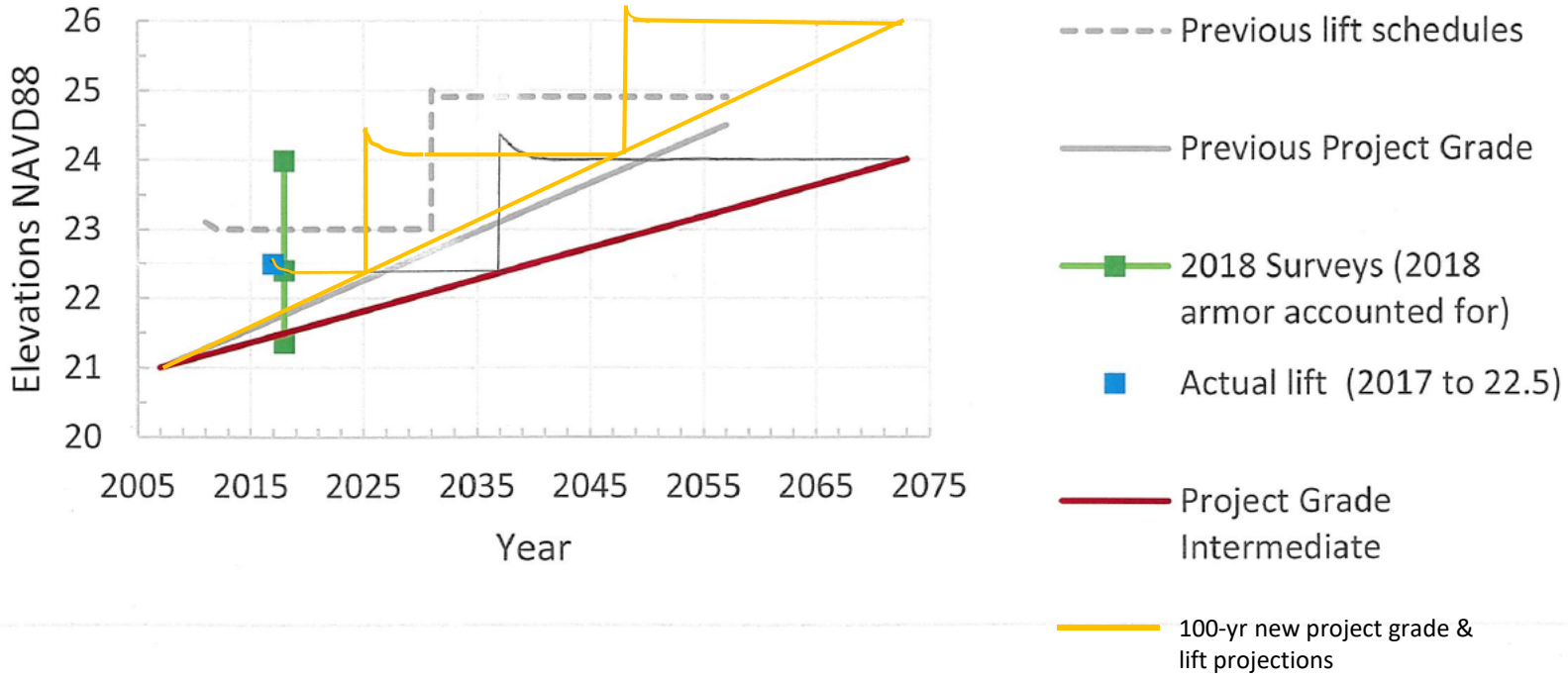
-The reach presented is the reach that would theoretically require a maintenance lift the soonest. Other reaches may also require a lift but would require one at a later time than this lift schedule is indicating. Therefore, the lift schedule presented will conservatively apply to WBV-48.2, WBV-49.1, and WBV-49.2a projects.

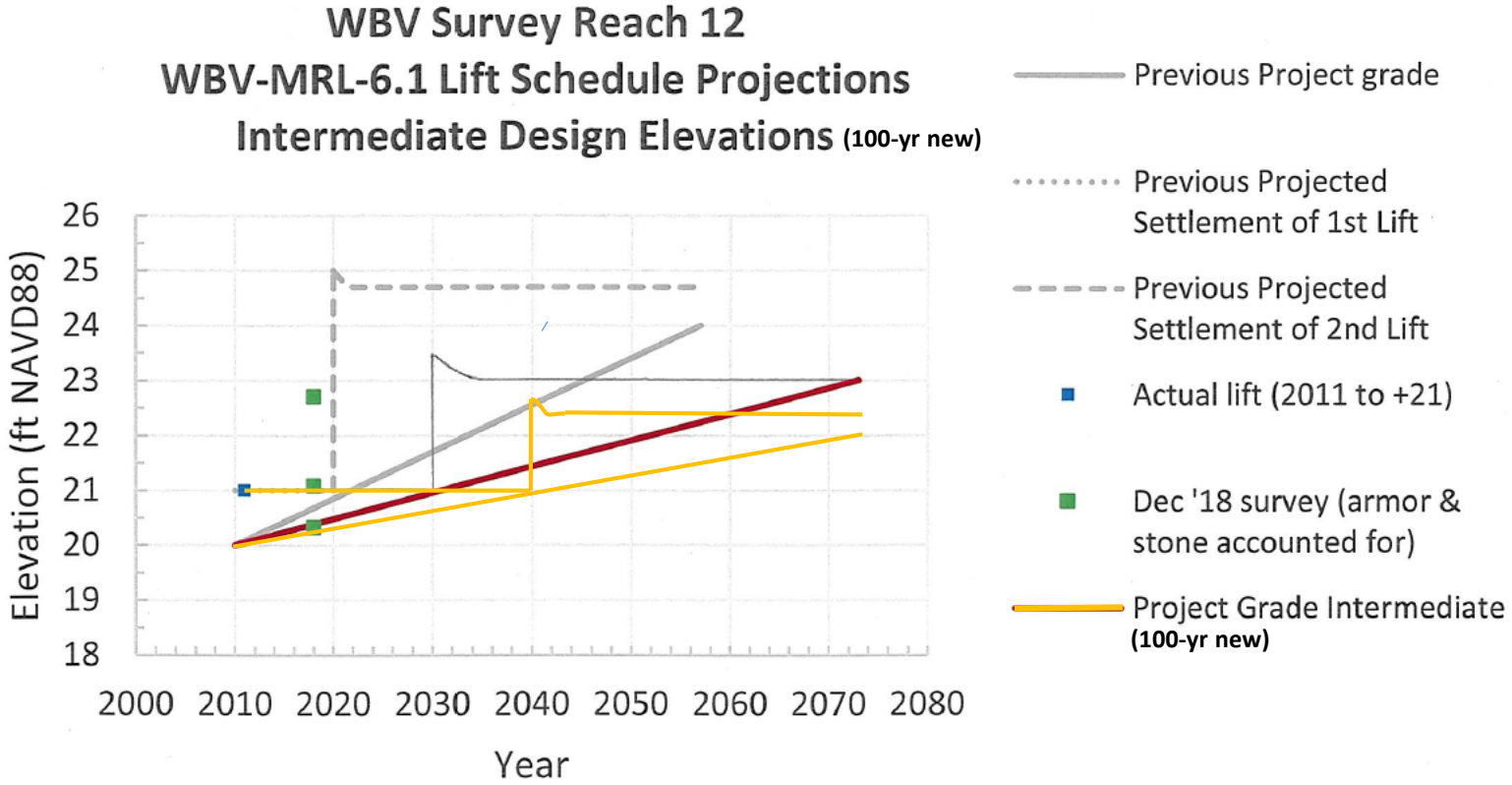

WBV Survey Reach 10
WBV-12 Lift Schedule Projections Intermediate Design Elevations (100-yr new)
Elevation (ft N.A.V.D. 88)
18
17
16
15
14
13
12
11
10
9
2007
2012
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
Year
Dec '18 survey
Prrevious Project Grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Previous Projected Settlement of 3rd Lift
Previous Projected Settlement of 4th Lift
Actual lift (2018 to 13), armoring not completed
Project Grade Intermediate (100-yr new)

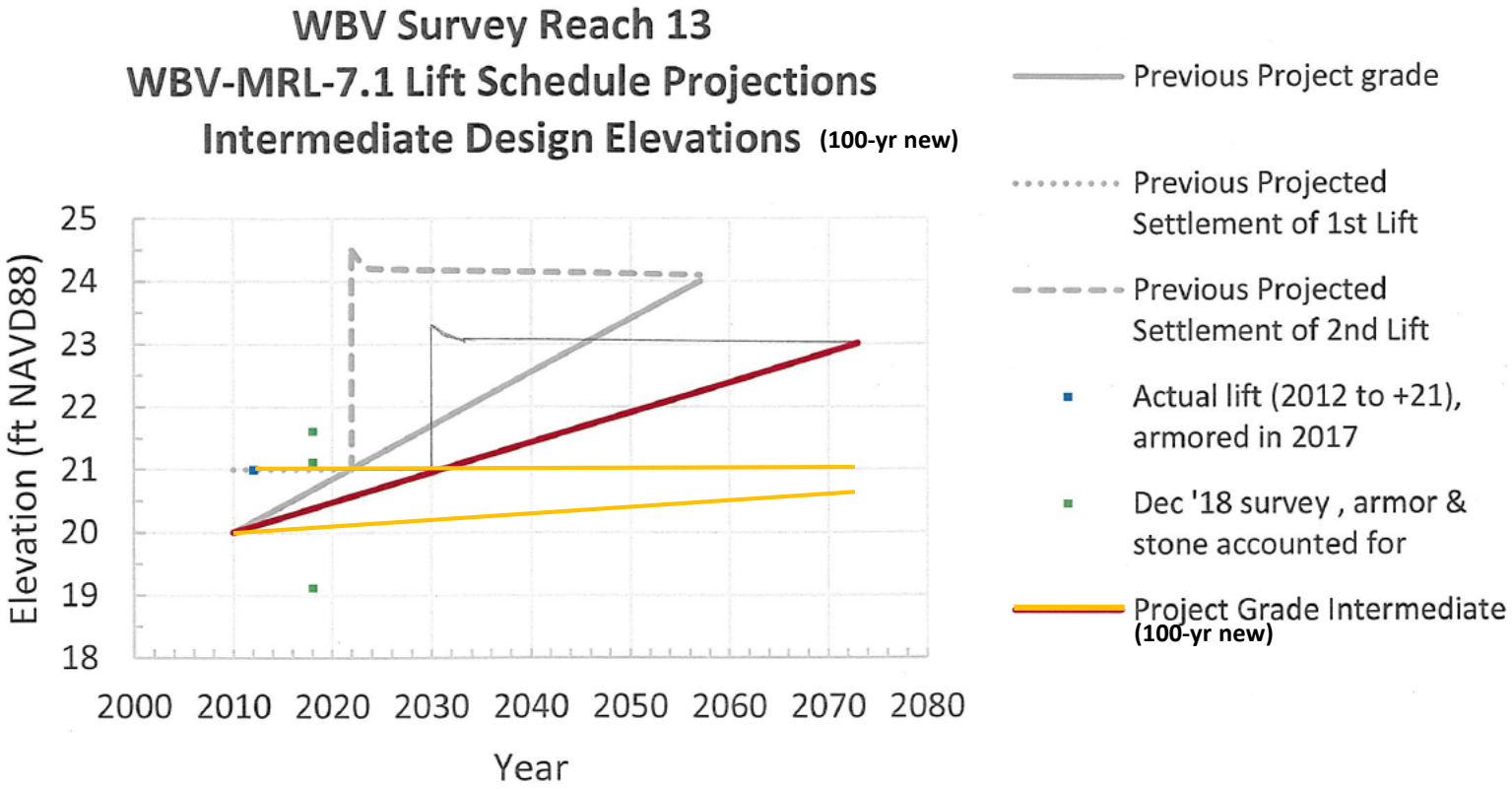
WBV Survey Reach 11

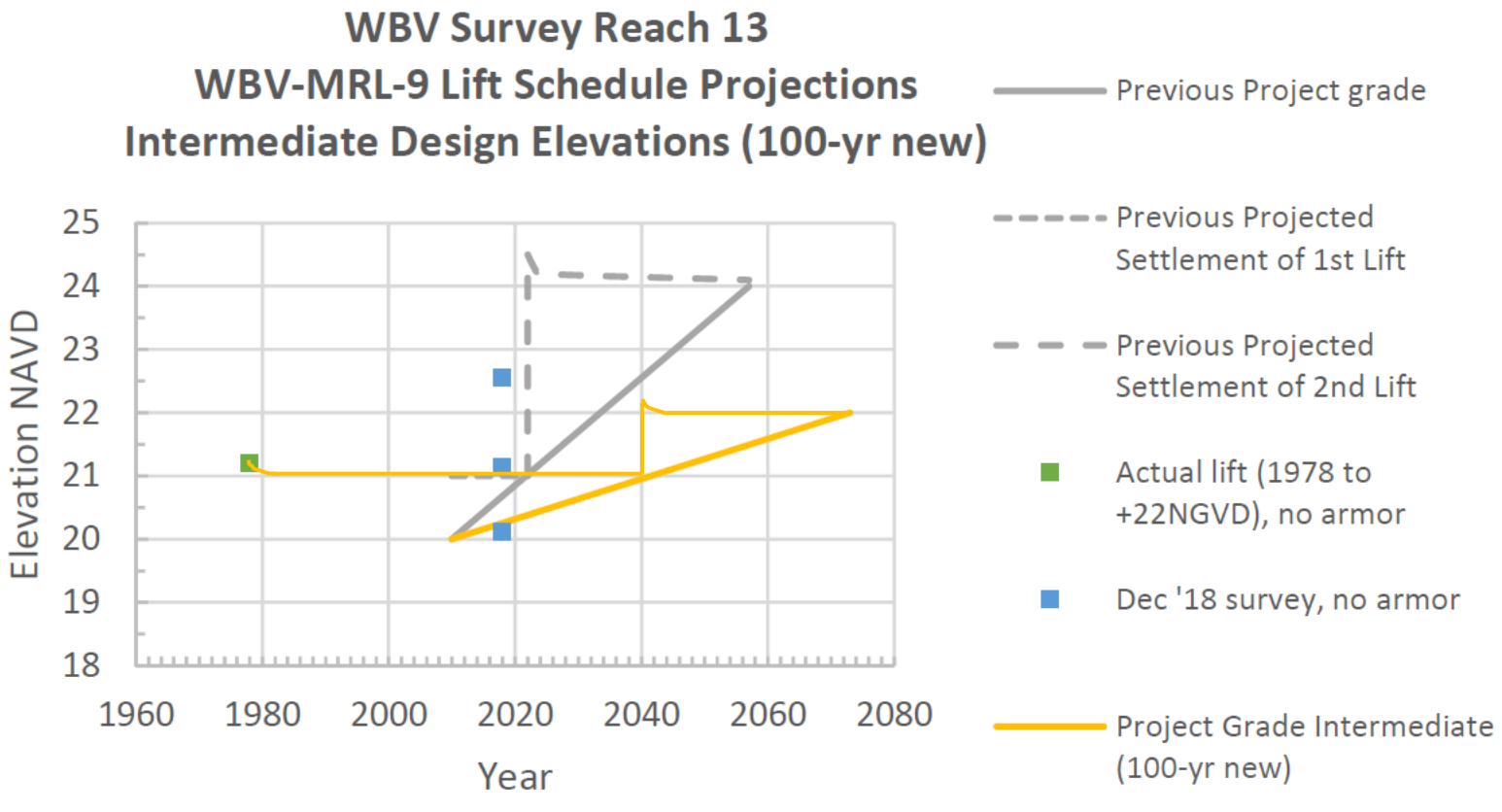
WBV-MRL-1.2b Lift Schedules Projections

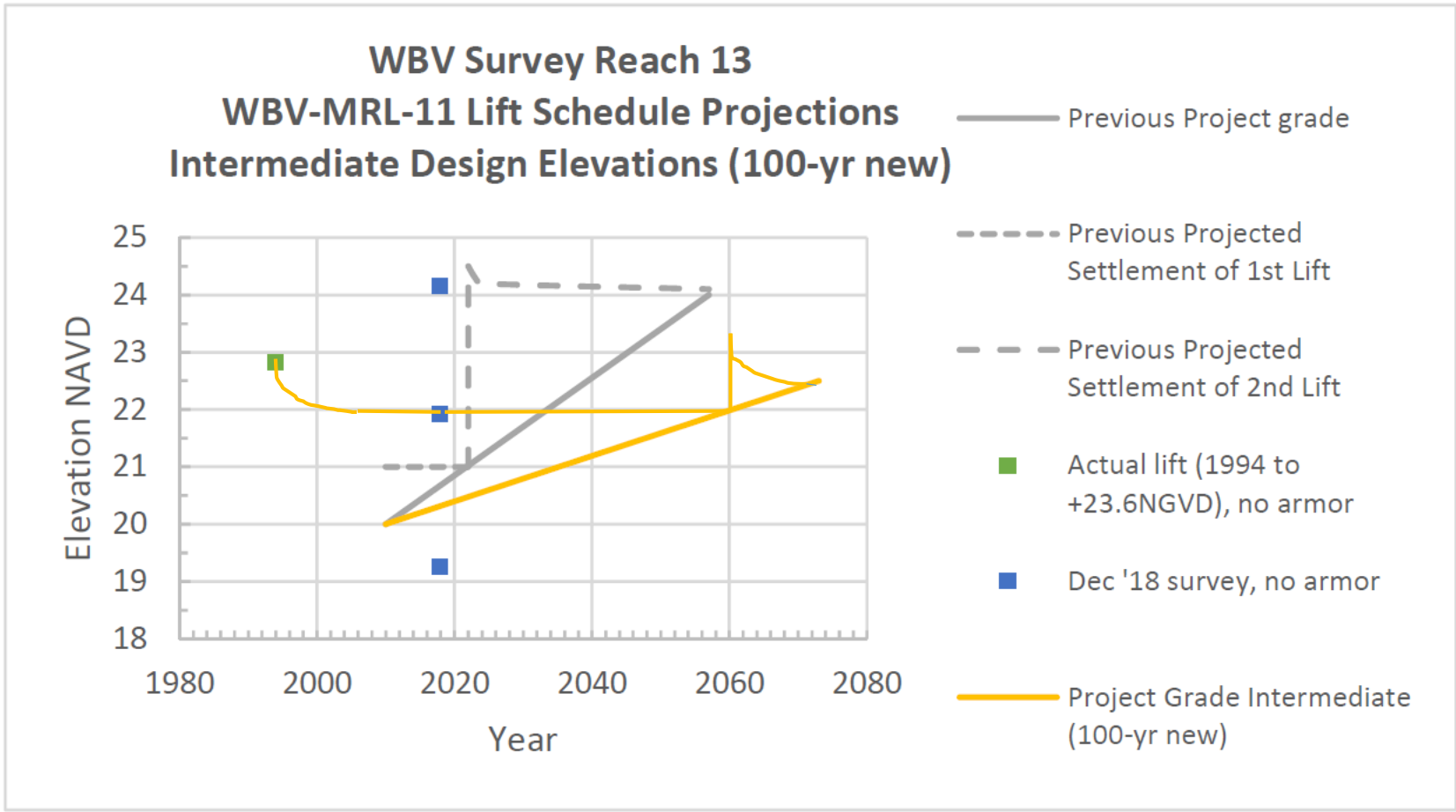
Intermediate Design Elevations (100-yr new)



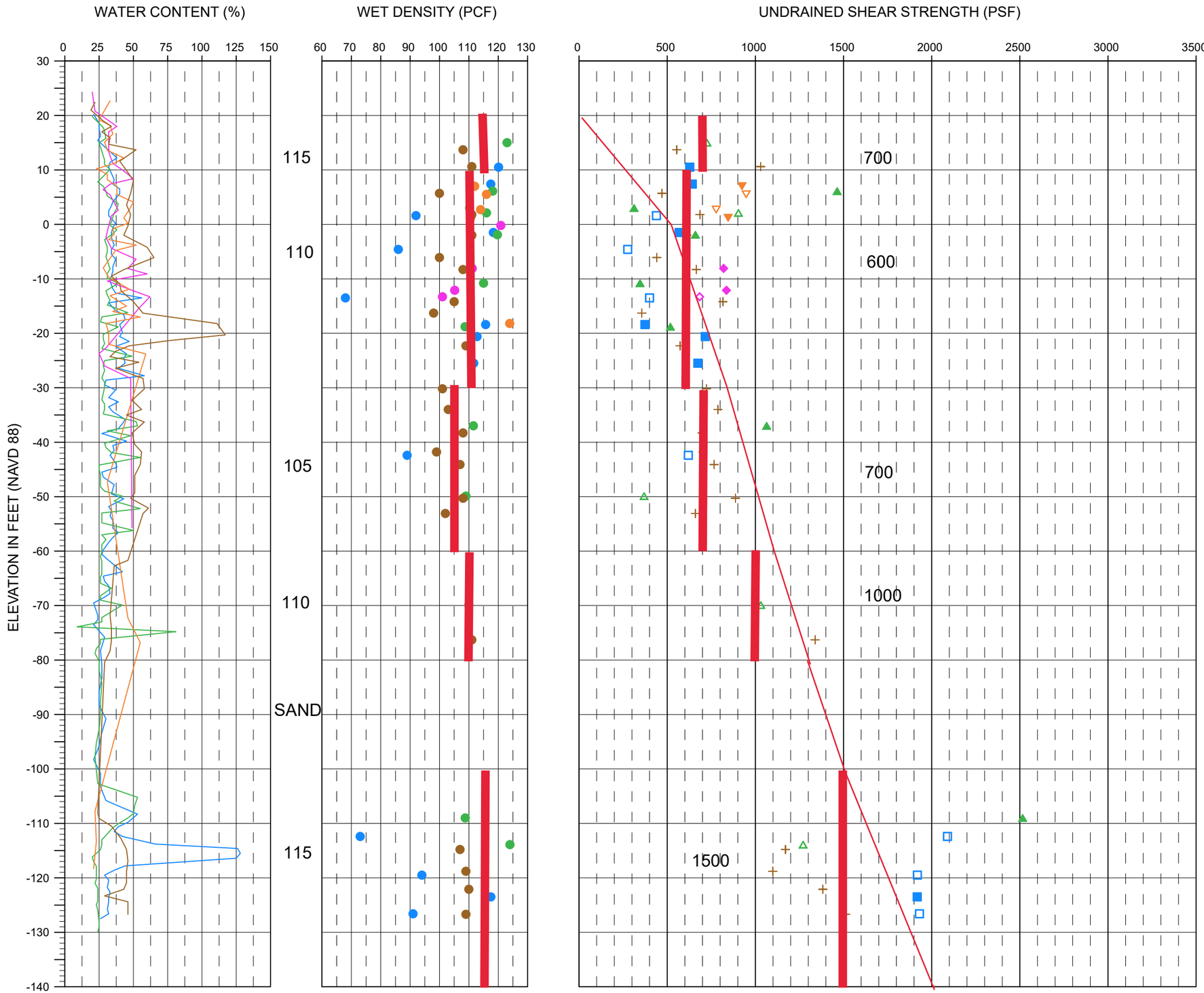

WBV Survey Reach 12
WBV-MRL-6.1 Lift Schedule Projections
Intermediate Design Elevations (100-yr new)
Elevation (ft NAVD88)
26
25
24
23
22
21
20
19
18
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year
Previous Project grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Actual lift (2011 to +21)
Dec '18 survey (armor & stone accounted for)
Project Grade Intermediate (100-yr new)


WBV Survey Reach 13
WBV-MRL-7.1 Lift Schedule Projections
Intermediate Design Elevations (100-yr new)
Elevation (ft NAVD88)
25
24
23
22
21
20
19
18
2000
2010
2020
2030
2040
2050
2060
2070
2080
Year
Previous Project grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Actual lift (2012 to +21), armored in 2017
Dec '18 survey , armor & stone accounted for
Project Grade Intermediate (100-yr new)


WBV Survey Reach 13
WBV-MRL-9 Lift Schedule Projections
Intermediate Design Elevations (100-yr new)
Elevation NAVD
25
24
23
22
21
20
19
18
1960
1980
2000
2020
2040
2060
2080
Year
Previous Project grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Actual lift (1978 to +22NGVD), no armor
Dec '18 survey, no armor
Project Grade Intermediate (100-yr new)


WBV Survey Reach 13
WBV-MRL-11 Lift Schedule Projections
Intermediate Design Elevations (100-yr new)
Elevation NAVD
25
24
23
22
21
20
19
18
1980
2000
2020
2040
2060
2080
Year
Previous Project grade
Previous Projected Settlement of 1st Lift
Previous Projected Settlement of 2nd Lift
Actual lift (1994 to +23.6NGVD), no armor
Dec '18 survey, no armor
Project Grade Intermediate (100-yr new)

Levee Stability Analyses



Legend

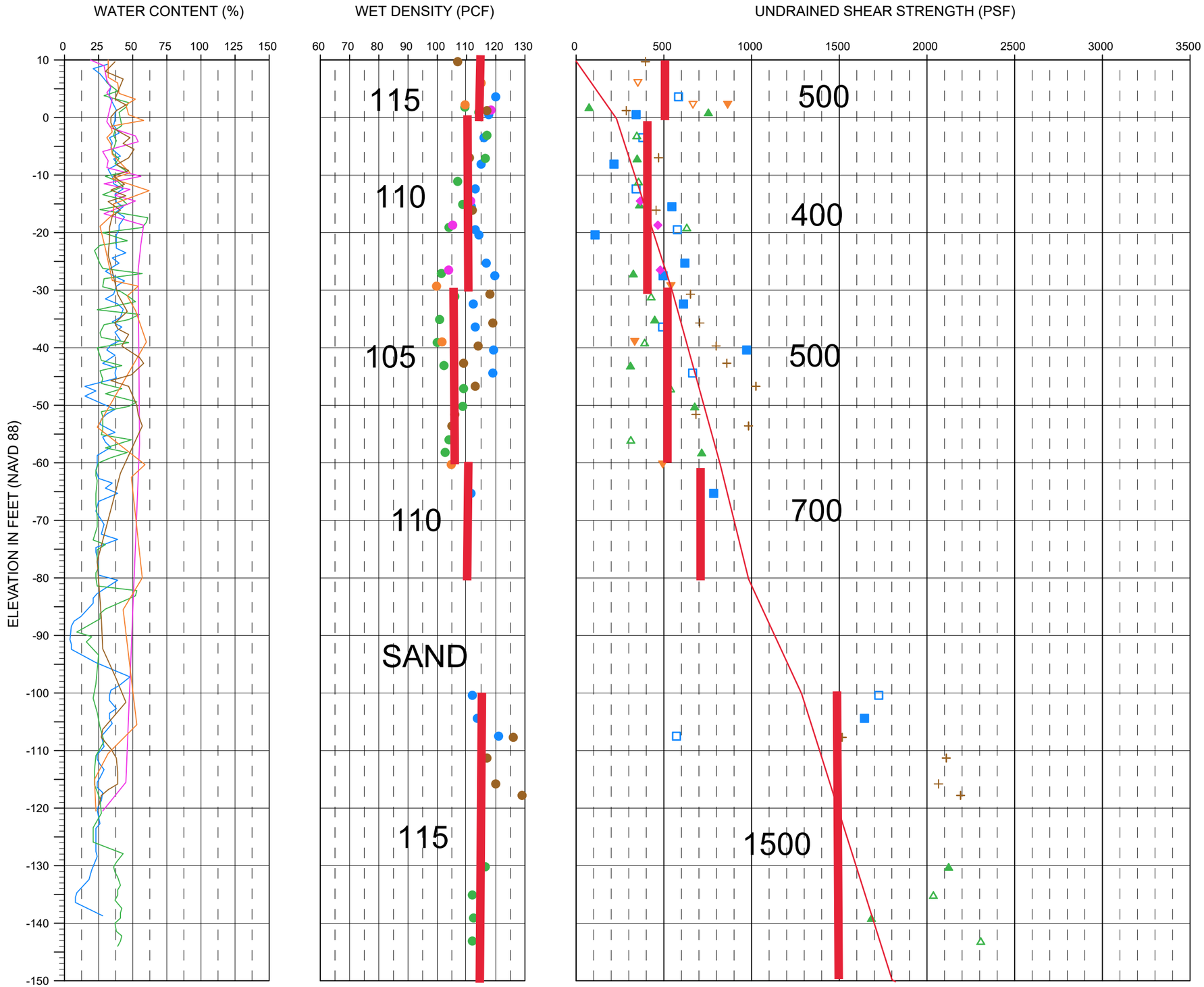
- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- WB-85.3U (MVN-2007-022119)
- WB-84.5CU (MVN-2007-022119)
- R-85.75-RUC (MVN-1982-32)
- R-84.5-RUC (MVN-1982-30)
- W-87.4-U (MVN-1971-575)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-9

Levee CL Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		22 June 2020	



Legend

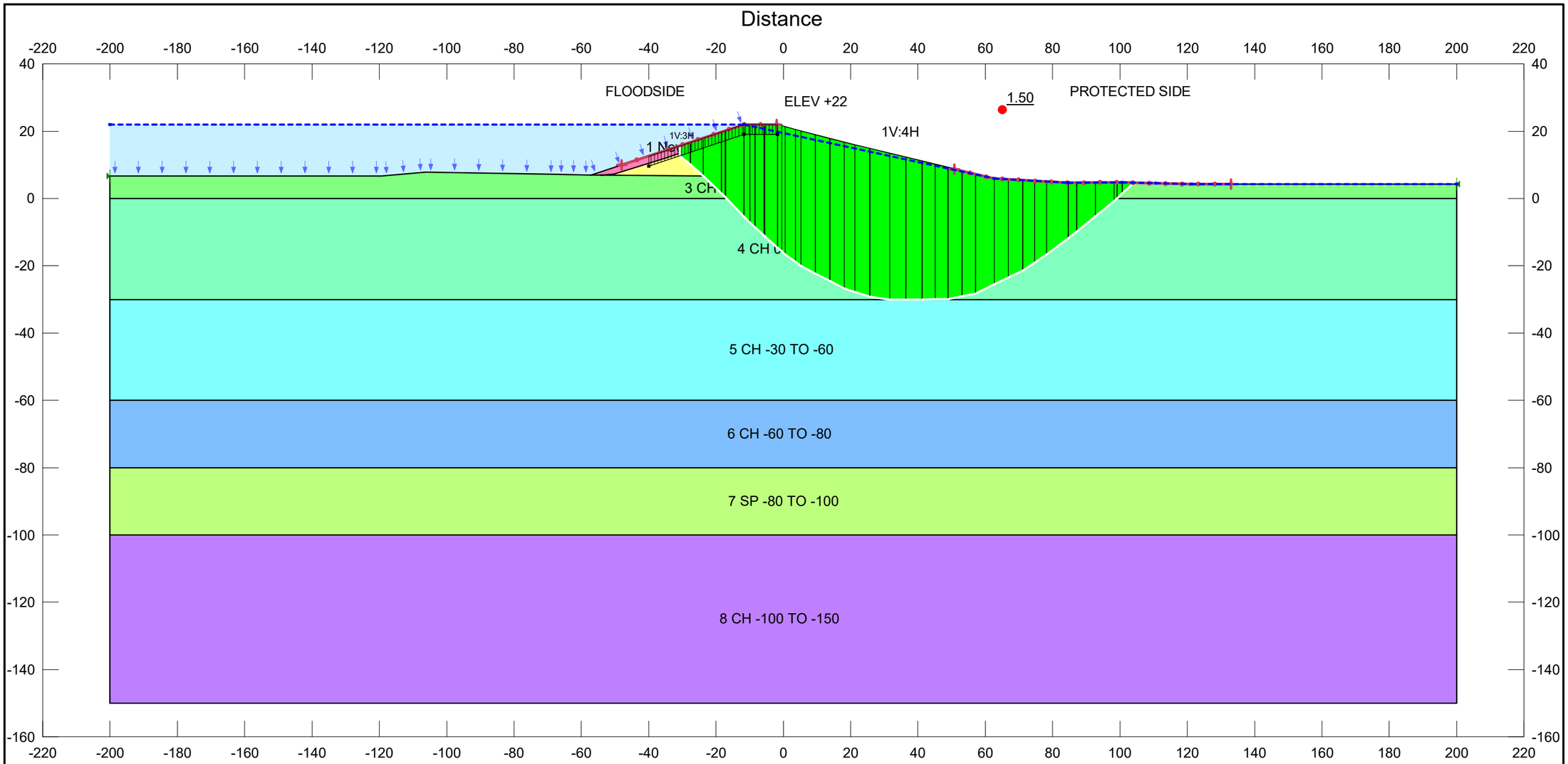
- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- WB-84.75UPT (MVN-2007-022119)
- WB-84.2UPT (MVN-2007-022119)
- R-85.75-RUT (MVN-1982-32)
- R-84.5-RUT (MVN-1982-30)
- R-86.8-UR (MVN-1968-521)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-9

Levee TOE Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		23 June 2020	



Color	Name	Model	Unit Weight (pcf)	Cohesion Fn	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line
	1 New Levee	Mohr-Coulomb	115		600	0	0	1
	2 Levee	Mohr-Coulomb	115		600	0	0	1
	3 CH TO 0	Spatial Mohr-Coulomb	115	CH TO 0		0	0	1
	4 CH 0 TO -30	Spatial Mohr-Coulomb	110	CH 0 TO -30		0	0	1
	5 CH -30 TO -60	Spatial Mohr-Coulomb	105	CH -30 TO -60		0	0	1
	6 CH -60 TO -80	Spatial Mohr-Coulomb	110	CH -60 TO -80		0	0	1
	7 SP -80 TO -100	Mohr-Coulomb	120		0	30	0	1
	8 CH -100 TO -150	Mohr-Coulomb	115		1,500	0	0	1

LPV-WBV GRR
WBV-MRL-9
RAISE AND FLOODSIDE SHIFT

HWL ENTRY EXIT

EE HWL

WBV-MRL-9 FS shift.gsz

11/06/2020 1:384.80315

EE HWL

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File Information

File Version: 10.00
Title: WBV-MRL-9
Created By: Quach, Bich N CIV USARMY CEMVN (USA)
Last Edited By: Quach, Bich N CIV USARMY CEMVN (USA)
Revision Number: 42
Date: 11/06/2020
Time: 12:42:57 PM
Tool Version: 10.0.0.17401
File Name: WBV-MRL-9 FS shift.gsz
Directory: G:\F&MHOME\QuachB\LPV-WBV GRR levee lifts\FLD LPV-WBV-MRL\WBV-MRL\WBV-MRL-9\
Last Solved Date: 11/13/2020
Last Solved Time: 01:14:00 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

EE HWL

Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions from: Piezometric Line
  - Apply Phreatic Correction: No
  - Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: Tension Crack Line
  - Filled with water (0 to 1): 0
  - Tension Crack Fluid Unit Weight: 62.430189 pcf

Distribution
F of S Calculation Option: Constant
Advanced
Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

2 Levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

7 SP -80 TO -100

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

3 CH TO 0

Model: Spatial Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion Fn: CH TO 0
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4 CH 0 TO -30

Model: Spatial Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion Fn: CH 0 TO -30
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

5 CH -30 TO -60

Model: Spatial Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion Fn: CH -30 TO -60
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

6 CH -60 TO -80

Model: Spatial Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion Fn: CH -60 TO -80
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

8 CH -100 TO -150

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 1,500 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

1 New Levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (-48.05153, 10) ft
Left-Zone Right Coordinate: (-2, 22) ft
Left-Zone Increment: 10
Right Type: Range
Right-Zone Left Coordinate: (50.79211, 8.74789) ft
Right-Zone Right Coordinate: (133, 4.26) ft
Right-Zone Increment: 17
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-200, 6.68) ft

Right Coordinate: (200, 4.26) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X	Y
Coordinate 1	-200 ft	22 ft
Coordinate 2	-11.7 ft	22 ft
Coordinate 3	62.7 ft	5.89 ft
Coordinate 4	84.6 ft	4.69 ft
Coordinate 5	100.7 ft	4.78 ft
Coordinate 6	110.7 ft	4.5 ft
Coordinate 7	121.2 ft	4.26 ft
Coordinate 8	200 ft	4.26 ft

Tension Crack Line

	X	Y
Coordinate 1	-40 ft	9.6 ft
Coordinate 2	-11.7 ft	19 ft
Coordinate 3	-1.7 ft	19 ft

Cohesion Functions

CH TO 0

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 700 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 500)
Data Point: (-54.2, 500)
Data Point: (0, 700)
Data Point: (62.7, 500)
Data Point: (200, 500)

CH 0 TO -30

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 600 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 400)

Data Point: (-54.2, 400)
Data Point: (0, 600)
Data Point: (62.7, 400)
Data Point: (200, 400)

CH -30 TO -60

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 700 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 500)
Data Point: (-54.2, 500)
Data Point: (0, 700)
Data Point: (62.7, 500)
Data Point: (200, 500)

CH -60 TO -80

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 1,000 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 700)
Data Point: (-54.2, 700)
Data Point: (0, 1,000)
Data Point: (62.7, 700)
Data Point: (200, 700)

Points

	X	Y
Point 1	-200 ft	6.68 ft
Point 2	-119.4 ft	6.68 ft
Point 3	-106.3 ft	7.77 ft
Point 4	-67.5 ft	7.16 ft
Point 5	-54.2 ft	6.93 ft
Point 6	-50.8 ft	7.17 ft
Point 7	-50.1 ft	7.35 ft
Point 8	-34.7 ft	12.07 ft
Point 9	-17.3 ft	18.13 ft
Point 10	-17.1 ft	18.23 ft
Point 11	-8.4 ft	20.54 ft
Point 12	-5.5 ft	20.75 ft
Point 13	-0.5 ft	20.57 ft
Point 14	3.6 ft	20.48 ft
Point 15	21.2 ft	15.94 ft
Point 16	41.2 ft	11.05 ft

Point 17	62.7 ft	5.89 ft
Point 18	84.6 ft	4.69 ft
Point 19	100.7 ft	4.78 ft
Point 20	110.7 ft	4.5 ft
Point 21	121.2 ft	4.26 ft
Point 22	200 ft	4.26 ft
Point 23	-200 ft	0 ft
Point 24	200 ft	0 ft
Point 25	-200 ft	-30 ft
Point 26	200 ft	-30 ft
Point 27	-200 ft	-60 ft
Point 28	200 ft	-60 ft
Point 29	-200 ft	-80 ft
Point 30	200 ft	-80 ft
Point 31	-200 ft	-100 ft
Point 32	200 ft	-100 ft
Point 33	-200 ft	-150 ft
Point 34	200 ft	-150 ft
Point 35	-11.7 ft	22 ft
Point 36	-1.7 ft	22 ft
Point 37	-57.2 ft	6.98 ft

Regions

	Material	Points	Area
Region 1	2 Levee	5,6,7,8,9,10,11,12,13,14,15,16,17	884.11 ft²
Region 2	3 CH TO 0	1,23,24,22,21,20,19,18,17,5,37,4,3,2	2,385.9 ft²
Region 3	4 CH 0 TO -30	23,24,26,25	12,000 ft²
Region 4	5 CH -30 TO -60	25,26,28,27	12,000 ft²
Region 5	6 CH -60 TO -80	27,28,30,29	8,000 ft²
Region 6	7 SP -80 TO -100	29,30,32,31	8,000 ft²
Region 7	8 CH -100 TO -150	31,32,34,33	20,000 ft²
Region 8	1 New Levee	37,5,6,7,8,9,10,11,12,14,36,35	109.92 ft²

Slip Results

Slip Surfaces Analysed: 684 of 991 converged

Current Slip Surface

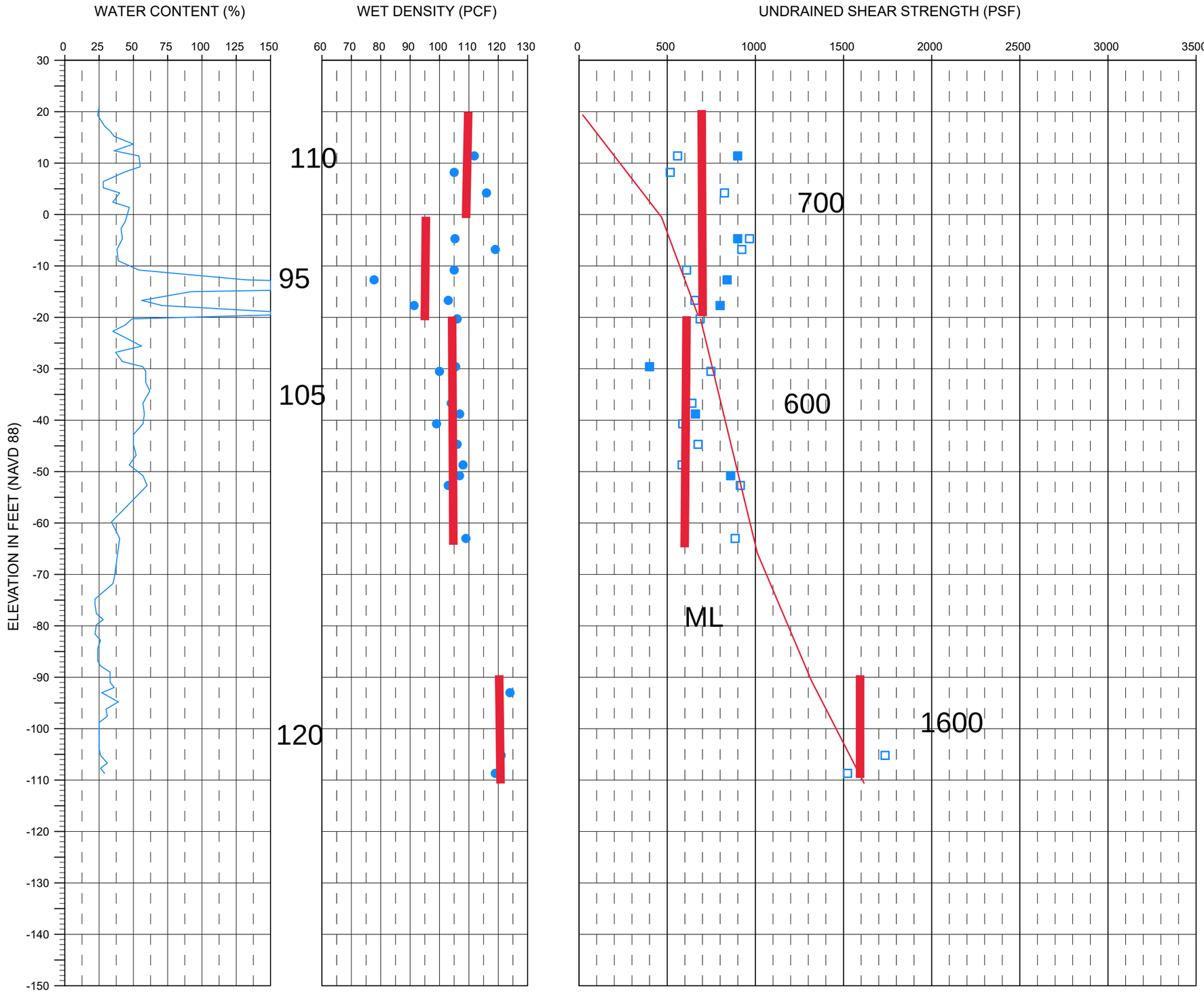
Slip Surface: 991
Factor of Safety: 1.50
Volume: 3,913.661 ft³
Weight: 438,333.41 lbf
Resisting Moment: 5,376,690.5 lbf·ft
Activating Moment: 3,589,513.7 lbf·ft
Resisting Force: 66,550.804 lbf

Activating Force: 44,432.832 lbf
Slip Rank: 1 of 991 slip surfaces
Exit: (104.21495, 4.6815815) ft
Entry: (-30.762101, 12.668419) ft
Radius: 60.134601 ft
Center: (39.649972, 38.287478) ft

Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Slice 1	-29.17017 ft	11.367764 ft	663.77247 psf	582.2477 psf	-0 psf	600 psf	0 psf	2 Levee
Slice 2	-25.727365 ft	8.3636686 ft	851.31874 psf	927.74236 psf	0 psf	600 psf	0 psf	2 Levee
Slice 3	-21.11202 ft	4.1159636 ft	1,116.5038 psf	1,459.8083 psf	0 psf	622.09587 psf	0 psf	3 CH TO 0
Slice 4	-17.823775 ft	1.0224585 ft	1,309.6319 psf	1,785.1142 psf	0 psf	634.22961 psf	0 psf	3 CH TO 0
Slice 5	-17.2 ft	0.36835496 ft	1,350.4677 psf	1,865.4897 psf	0 psf	636.53137 psf	0 psf	3 CH TO 0
Slice 6	-14.4 ft	-2.5677839 ft	1,533.7714 psf	2,276.6003 psf	0 psf	546.86347 psf	0 psf	4 CH 0 TO -30
Slice 7	-10.84482 ft	-6.2958203 ft	1,754.9529 psf	2,703.2782 psf	0 psf	559.98221 psf	0 psf	4 CH 0 TO -30
Slice 8	-9.19482 ft	-7.904707 ft	1,833.0911 psf	2,944.072 psf	0 psf	566.07077 psf	0 psf	4 CH 0 TO -30
Slice 9	-7.1100645 ft	-9.7725646 ft	1,921.5198 psf	3,136.2937 psf	0 psf	573.7636 psf	0 psf	4 CH 0 TO -30
Slice 10	-5.6600645 ft	-11.071707 ft	1,983.0241 psf	3,269.9888 psf	0 psf	579.11415 psf	0 psf	4 CH 0 TO -30
Slice 11	-3.6 ft	-12.917442 ft	2,070.4055 psf	3,458.6122 psf	0 psf	586.71587 psf	0 psf	4 CH 0 TO -30
Slice 12	-1.1 ft	-15.157342 ft	2,176.4475 psf	3,668.4695 psf	0 psf	595.94096 psf	0 psf	4 CH 0 TO -30
Slice 13	0.021715 ft	-16.162354 ft	2,224.0271 psf	3,736.6442 psf	0 psf	599.93073 psf	0 psf	4 CH 0 TO -30
Slice 14	2.071715 ft	-17.752133 ft	2,295.565 psf	3,937.0288 psf	0 psf	593.39166 psf	0 psf	4 CH 0 TO -30
Slice 15	4.4219 ft	-19.478063 ft	2,371.545 psf	4,052.483 psf	0 psf	585.89506 psf	0 psf	4 CH 0 TO -30
Slice 16	7.395835 ft	-21.199478 ft	2,438.8112 psf	4,279.5968 psf	0 psf	576.40882 psf	0 psf	4 CH 0 TO -30
Slice 17	11.699905 ft	-23.435135 ft	2,520.2006 psf	4,398.921 psf	0 psf	562.67973 psf	0 psf	4 CH 0 TO -30
Slice 18	16.003975 ft	-25.670792 ft	2,601.59 psf	4,518.2453 psf	0 psf	548.95064 psf	0 psf	4 CH 0 TO -30

Slice 19	19.678005 ft	-27.257784 ft	2,651.0002 psf	4,709.5123 psf	0 psf	537.23124 psf	0 psf	4 CH 0 TO -30
Slice 20	23.46499 ft	-28.425144 ft	2,672.6856 psf	4,730.8157 psf	0 psf	525.15155 psf	0 psf	4 CH 0 TO -30
Slice 21	28.64613 ft	-29.56149 ft	2,673.5885 psf	4,804.6973 psf	0 psf	508.62478 psf	0 psf	4 CH 0 TO -30
Slice 22	33.97171 ft	-29.996343 ft	2,628.7445 psf	4,791.3421 psf	0 psf	491.63729 psf	0 psf	4 CH 0 TO -30
Slice 23	38.79057 ft	-29.989749 ft	2,563.1908 psf	4,654.5684 psf	0 psf	476.26612 psf	0 psf	4 CH 0 TO -30
Slice 24	43.13533 ft	-29.983804 ft	2,504.0865 psf	4,532.2526 psf	0 psf	462.40724 psf	0 psf	4 CH 0 TO -30
Slice 25	47.00599 ft	-29.978508 ft	2,451.4317 psf	4,424.3949 psf	0 psf	450.06064 psf	0 psf	4 CH 0 TO -30
Slice 26	50.978197 ft	-29.537888 ft	2,370.2268 psf	4,376.5863 psf	0 psf	437.39012 psf	0 psf	4 CH 0 TO -30
Slice 27	55.051952 ft	-28.661942 ft	2,260.4717 psf	4,163.1091 psf	0 psf	424.39569 psf	0 psf	4 CH 0 TO -30
Slice 28	59.894415 ft	-26.86247 ft	2,082.6692 psf	3,955.528 psf	0 psf	408.94923 psf	0 psf	4 CH 0 TO -30
Slice 29	64.795435 ft	-24.484092 ft	1,889.0922 psf	3,590.909 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 30	68.986305 ft	-22.450337 ft	1,747.7882 psf	3,334.3487 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 31	72.868972 ft	-20.256422 ft	1,597.5397 psf	3,138.0274 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 32	76.443438 ft	-17.902348 ft	1,438.3467 psf	2,846.63 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 33	81.415335 ft	-14.286572 ft	1,195.6052 psf	2,446.1092 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 34	85.863885 ft	-10.879982 ft	972.47799 psf	2,035.8823 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 35	89.916817 ft	-7.622465 ft	770.52502 psf	1,685.8419 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 36	95.494912 ft	-3.043135 ft	486.58328 psf	1,163.525 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 37	98.695071 ft	-0.376735 ft	321.23624 psf	890.56972 psf	0 psf	400 psf	0 psf	4 CH 0 TO -30
Slice 38	99.903091 ft	0.73027331 ft	252.54709 psf	827.56567 psf	0 psf	500 psf	0 psf	3 CH TO 0
Slice 39	102.45747 ft	3.0710641 ft	103.61705 psf	539.57928 psf	0 psf	500 psf	0 psf	3 CH TO 0



Legend

- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- R-88.2-AU (MVN-1973-568)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-10

Levee CL Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		22 June 2020	

WATER CONTENT (%)

WET DENSITY (PCF)

UNDRAINED SHEAR STRENGTH (PSF)

ELEVATION IN FEET (NAVD 88)

110

95

100

120

600

350

500

ML

1600

Legend

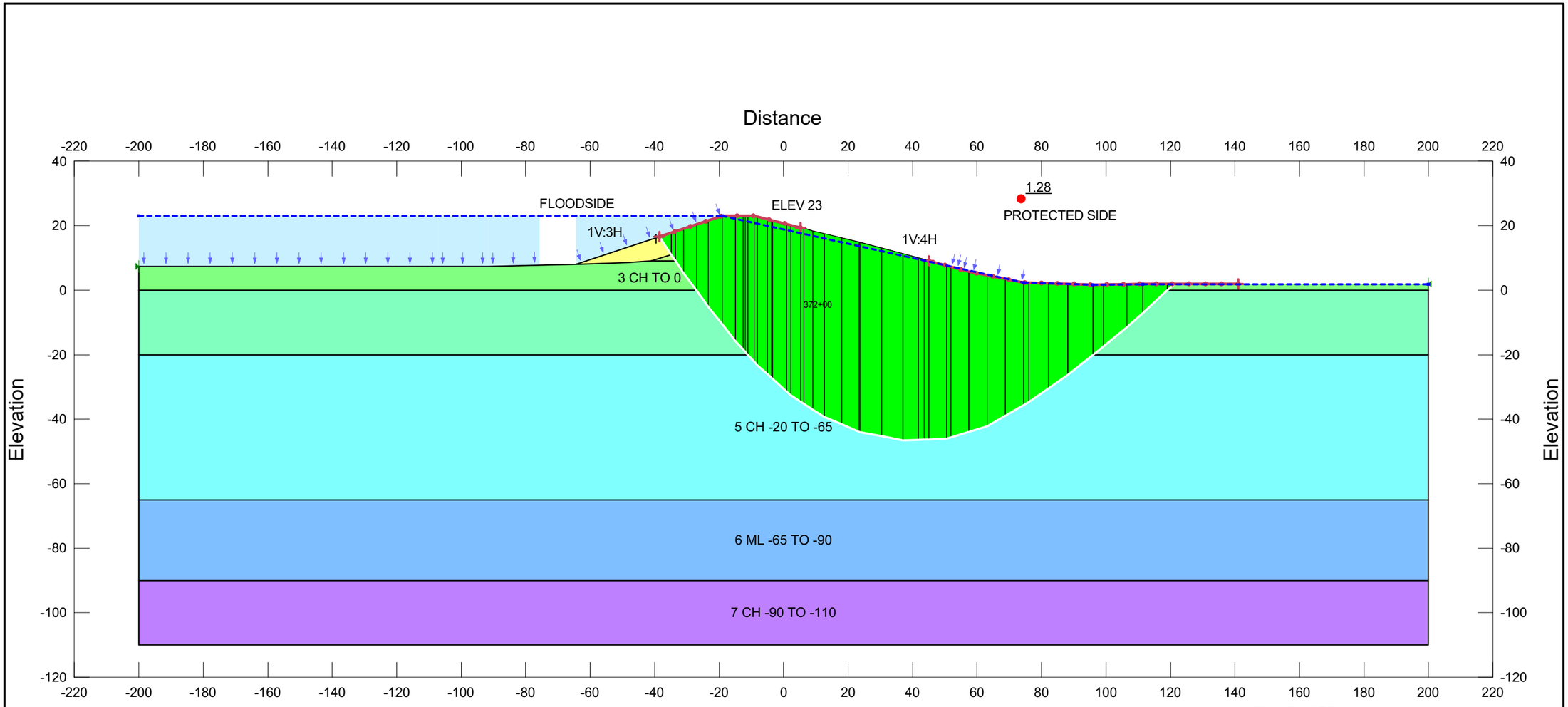
- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- ACT-2UT (MVN-2002-202)
- R-88.2-AUT (MVN-1973-568)
- 5-UL (MVN-1952-514)
- 4-UL (MVN-1952-514)
- 1-U (MVN-1951-528)
- U-1 (MVN-1947-503)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-10

Levee TOE Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		22 June 2020	



LPV-WBV-GRR
WBV-MRL-10 RAISE AND FLOODSIDE SHIFT

HWL ENTRY EXIT

Color	Name	Model	Weight Fn	Unit Weight (pcf)	Cohesion Fn	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line
	1 New levee	Mohr-Coulomb		115		600	0	0	1
	2 Levee	Mohr-Coulomb		115		600	0	0	1
	3 CH TO 0	Spatial Mohr-Coulomb		110	CH TO 0		0	0	1
	4 CH 0 TO -20	Spatial Mohr-Coulomb		95	CH 0 TO -20		0	0	1
	5 CH -20 TO -65	Spatial Mohr-Coulomb	CH -20 TO -65		CH -20 TO -65		0	0	1
	6 ML -65 TO -90	Mohr-Coulomb		117		200	15	0	1
	7 CH -90 TO -110	Mohr-Coulomb		120		1,600	0	0	1

HWL EE FS TO PS

WBV-MRL-10 FS shift.gsz

08/11/2020 1:401.81102

HWL EE FS TO PS

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File Information

File Version: 10.00
Created By: Quach, Bich N CIV USARMY CEMVN (USA)
Last Edited By: Quach, Bich N CIV USARMY CEMVN (USA)
Revision Number: 35
Date: 08/11/2020
Time: 07:07:21 PM
Tool Version: 10.0.0.17401
File Name: WBV-MRL-10 FS shift.gsz
Directory: G:\F&MHOME\QuachB\LPV-WBV GRR levee lifts\FLD LPV-WBV-MRL\WBV-MRL\WBV-MRL-10\
Last Solved Date: 08/11/2020
Last Solved Time: 07:08:42 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

HWL EE FS TO PS

Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions from: Piezometric Line
  - Apply Phreatic Correction: No
  - Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: (none)

Distribution
- F of S Calculation Option: Constant

Advanced

Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

1 New levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

2 Levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

3 CH TO 0

Model: Spatial Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion Fn: CH TO 0
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4 CH 0 TO -20

Model: Spatial Mohr-Coulomb
Unit Weight: 95 pcf
Cohesion Fn: CH 0 TO -20
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

5 CH -20 TO -65

Model: Spatial Mohr-Coulomb
Weight Fn: CH -20 TO -65
Cohesion Fn: CH -20 TO -65
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

6 ML -65 TO -90

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion': 200 psf
Phi': 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

7 CH -90 TO -110

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 1,600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (-38.49266, 16.58825) ft
Left-Zone Right Coordinate: (5.3, 19.41) ft
Left-Zone Increment: 9
Right Type: Range
Right-Zone Left Coordinate: (45.09, 9.12) ft
Right-Zone Right Coordinate: (141.00004, 1.95) ft
Right-Zone Increment: 19
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (-200, 7.43) ft
Right Coordinate: (200, 1.95) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X	Y

Coordinate 1	-200 ft	23 ft
Coordinate 2	-19.06 ft	23 ft
Coordinate 3	74.4 ft	2.31 ft
Coordinate 4	95.9 ft	1.7 ft
Coordinate 5	111.3 ft	1.9 ft
Coordinate 6	200 ft	1.9 ft

Cohesion Functions

CH TO 0

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 700 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 600)
Data Point: (-41, 600)
Data Point: (0, 700)
Data Point: (74.4, 600)
Data Point: (200, 600)

CH 0 TO -20

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 700 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 350)
Data Point: (-41, 350)
Data Point: (0, 700)
Data Point: (74.4, 350)
Data Point: (200, 350)

CH -20 TO -65

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 600 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 500)
Data Point: (-41, 500)
Data Point: (0, 600)
Data Point: (74.4, 500)
Data Point: (200, 500)

Unit Weight Functions

CH -20 TO -65

Model: Spline Data Point Function
Function: Unit Weight vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 105 pcf
Data Points: X (ft), Unit Weight (pcf)
Data Point: (-200, 100)
Data Point: (-41, 100)
Data Point: (0, 105)
Data Point: (74.4, 100)
Data Point: (200, 100)

Points

	X	Y
Point 1	-200 ft	7.43 ft
Point 2	-107.4 ft	7.43 ft
Point 3	-91.8 ft	7.43 ft
Point 4	-75.7 ft	7.83 ft
Point 5	-63.8 ft	8.07 ft
Point 6	-48.4 ft	8.56 ft
Point 7	-41 ft	9.12 ft
Point 8	-36 ft	10.61 ft
Point 9	-22.8 ft	14.43 ft
Point 10	-12.6 ft	17.25 ft
Point 11	-11.9 ft	17.43 ft
Point 12	-5.1 ft	19.59 ft
Point 13	-3.5 ft	19.61 ft
Point 14	0.9 ft	19.58 ft
Point 15	5.3 ft	19.41 ft
Point 16	6.3 ft	19.21 ft
Point 17	9.1 ft	18.34 ft
Point 18	23.5 ft	14.84 ft
Point 19	41.7 ft	10.03 ft
Point 20	57.4 ft	5.81 ft
Point 21	74.4 ft	2.31 ft
Point 22	95.9 ft	1.75 ft
Point 23	111.3 ft	1.95 ft
Point 24	200 ft	1.95 ft
Point 25	-200 ft	0 ft
Point 26	200 ft	0 ft
Point 27	-200 ft	-20 ft
Point 28	200 ft	-20 ft
Point 29	-200 ft	-65 ft
Point 30	200 ft	-65 ft

Point 31	-200 ft	-90 ft
Point 32	200 ft	-90 ft
Point 33	-200 ft	-110 ft
Point 34	200 ft	-110 ft
Point 35	-19.06 ft	23 ft
Point 36	-9.06 ft	23 ft
Point 37	45.09 ft	9.12 ft
Point 38	-64.34 ft	8.06 ft

Regions

	Material	Points	Area
Region 1	4 CH 0 TO -20	25,26,28,27	8,000 ft²
Region 2	5 CH -20 TO -65	27,28,30,29	18,000 ft²
Region 3	6 ML -65 TO -90	29,30,32,31	10,000 ft²
Region 4	7 CH -90 TO -110	31,32,34,33	8,000 ft²
Region 5	2 Levee	7,37,19,18,17,16,15,14,13,12,11,10,8	501.06 ft²
Region 6	3 CH TO 0	1,25,26,24,23,22,21,20,37,7,6,5,4,3,2	2,406 ft²
Region 7	1 New levee	38,35,36,15,14,13,12,11,10,8,7,6,5	323.23 ft²

Slip Results

Slip Surfaces Analysed: 735 of 1001 converged

Current Slip Surface

Slip Surface: 1,001
Factor of Safety: 1.28
Volume: 6,070.0028 ft³
Weight: 618,492.33 lbf
Resisting Moment: 8,913,292.6 lbf·ft
Activating Moment: 6,939,354.6 lbf·ft
Resisting Force: 83,134.502 lbf
Activating Force: 64,711.046 lbf
Slip Rank: 1 of 1,001 slip surfaces
Exit: (121.13488, 1.95) ft
Entry: (-38.492661, 16.588252) ft
Radius: 76.146824 ft
Center: (44.18642, 43.110342) ft

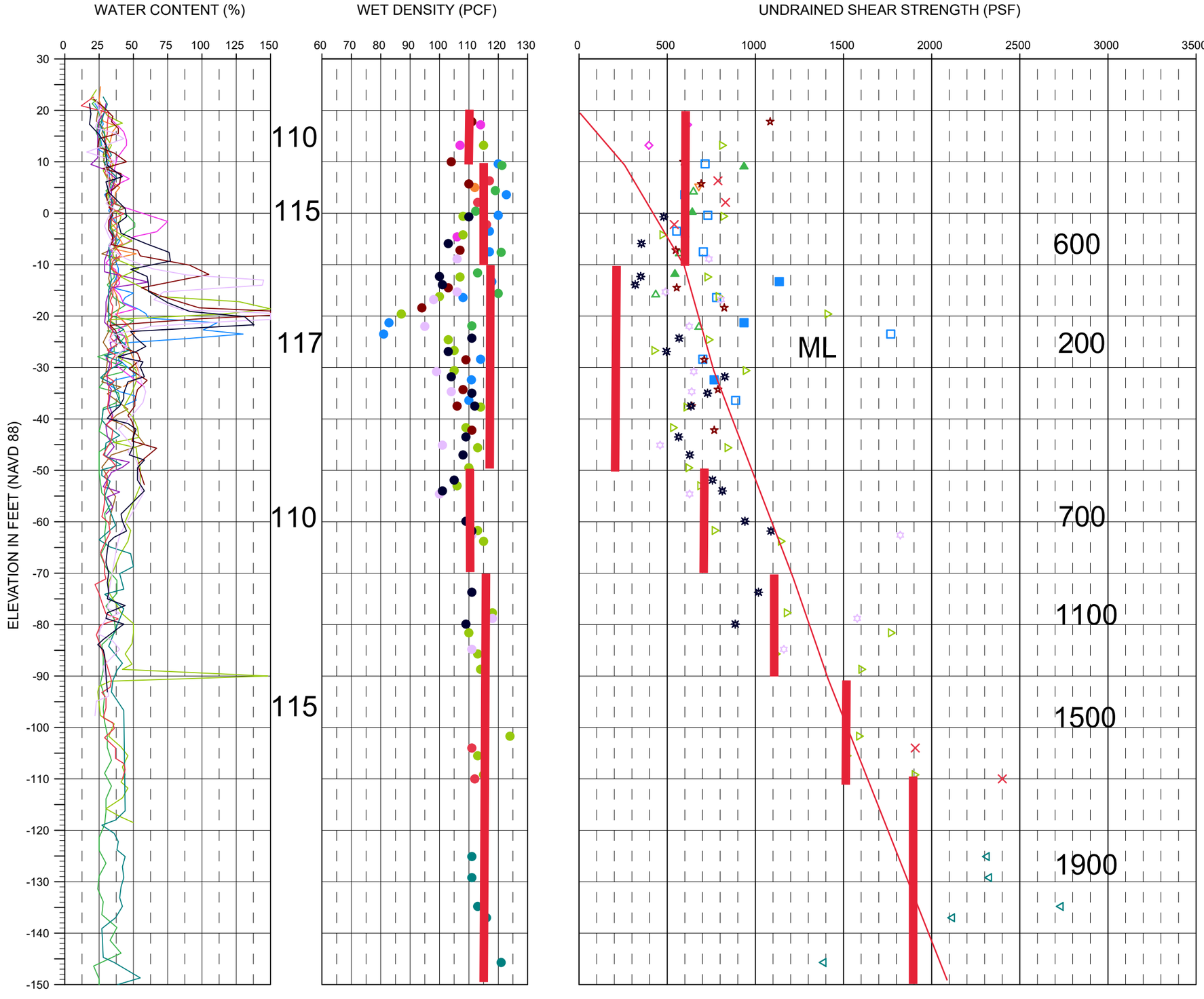
Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Slice 1	-36.629833 ft	13.774064 ft	575.97695 psf	64.714516 psf	-0 psf	600 psf	0 psf	1 New levee
Slice	-	10.039938	809.09914	500.76372				

2	34.158061 ft	ft	psf	psf	-0 psf	600 psf	0 psf	2 Levee
Slice 3	-32.252138 ft	7.160645 ft	988.85392 psf	805.70787 psf	-0 psf	621.33625 psf	0 psf	3 CH TO 0
Slice 4	-29.035997 ft	2.600645 ft	1,273.5356 psf	1,393.7463 psf	0 psf	629.1805 psf	0 psf	3 CH TO 0
Slice 5	-25.213787 ft	-2.578805 ft	1,596.8896 psf	2,085.6278 psf	0 psf	484.76036 psf	0 psf	4 CH 0 TO -20
Slice 6	-21.18537 ft	-7.8705019 ft	1,927.2513 psf	2,627.0236 psf	0 psf	519.14928 psf	0 psf	4 CH 0 TO -20
Slice 7	-17.00911 ft	-13.201217 ft	2,231.7041 psf	3,102.9599 psf	0 psf	554.80028 psf	0 psf	4 CH 0 TO -20
Slice 8	-13.77911 ft	-17.088344 ft	2,429.7374 psf	3,544.8616 psf	0 psf	582.37345 psf	0 psf	4 CH 0 TO -20
Slice 9	-12.25 ft	-18.734422 ft	2,511.369 psf	3,682.5066 psf	0 psf	595.42683 psf	0 psf	4 CH 0 TO -20
Slice 10	-11.487176 ft	-19.555597 ft	2,552.0924 psf	3,751.1733 psf	0 psf	601.93874 psf	0 psf	4 CH 0 TO -20
Slice 11	-10.067176 ft	-21.084218 ft	2,627.8991 psf	3,916.8687 psf	0 psf	575.44591 psf	0 psf	5 CH -20 TO -65
Slice 12	-8.5349 ft	-22.733703 ft	2,709.6997 psf	4,061.6833 psf	0 psf	579.18317 psf	0 psf	5 CH -20 TO -65
Slice 13	-6.5549 ft	-24.620531 ft	2,800.1298 psf	4,300.9255 psf	0 psf	584.01244 psf	0 psf	5 CH -20 TO -65
Slice 14	-4.4168209 ft	-26.562659 ft	2,891.8275 psf	4,433.2901 psf	0 psf	589.22727 psf	0 psf	5 CH -20 TO -65
Slice 15	-3.6168209 ft	-27.289341 ft	2,926.1378 psf	4,483.0644 psf	0 psf	591.17849 psf	0 psf	5 CH -20 TO -65
Slice 16	-1.3 ft	-29.39383 ft	3,025.5014 psf	4,627.9728 psf	0 psf	596.82927 psf	0 psf	5 CH -20 TO -65
Slice 17	1.581705 ft	-32.011432 ft	3,149.0917 psf	4,810.1474 psf	0 psf	597.87405 psf	0 psf	5 CH -20 TO -65
Slice 18	3.781705 ft	-33.609693 ft	3,218.466 psf	5,097.6475 psf	0 psf	594.91706 psf	0 psf	5 CH -20 TO -65
Slice	5.8 ft	-34.911139	3,271.8212	5,175.2133	0 psf	592.2043	0 psf	5 CH -20

19		ft	psf	psf		psf		TO -65
Slice 20	7.7 ft	-36.136304 ft	3,322.0493 psf	5,238.6526 psf	0 psf	589.65054 psf	0 psf	5 CH -20 TO -65
Slice 21	10.8551 ft	-38.170789 ft	3,405.4569 psf	5,346.3079 psf	0 psf	585.40981 psf	0 psf	5 CH -20 TO -65
Slice 22	15.33265 ft	-40.445865 ft	3,485.6075 psf	5,617.8413 psf	0 psf	579.3916 psf	0 psf	5 CH -20 TO -65
Slice 23	20.77755 ft	-42.732554 ft	3,553.1138 psf	5,695.3106 psf	0 psf	572.07319 psf	0 psf	5 CH -20 TO -65
Slice 24	23.635845 ft	-43.932949 ft	3,588.5511 psf	5,734.9998 psf	0 psf	568.23139 psf	0 psf	5 CH -20 TO -65
Slice 25	27.082798 ft	-44.631768 ft	3,584.5392 psf	5,869.0956 psf	0 psf	563.59839 psf	0 psf	5 CH -20 TO -65
Slice 26	33.705013 ft	-45.915303 ft	3,573.1471 psf	5,790.541 psf	0 psf	554.69756 psf	0 psf	5 CH -20 TO -65
Slice 27	39.35806 ft	-46.459843 ft	3,529.0139 psf	5,842.7354 psf	0 psf	547.09938 psf	0 psf	5 CH -20 TO -65
Slice 28	42.669077 ft	-46.322384 ft	3,474.6718 psf	5,721.0903 psf	0 psf	542.64909 psf	0 psf	5 CH -20 TO -65
Slice 29	44.364077 ft	-46.252015 ft	3,446.8526 psf	5,658.267 psf	0 psf	540.37086 psf	0 psf	5 CH -20 TO -65
Slice 30	47.823875 ft	-46.108379 ft	3,390.0686 psf	5,533.6253 psf	0 psf	535.7206 psf	0 psf	5 CH -20 TO -65
Slice 31	51.206469 ft	-45.79684 ft	3,323.8694 psf	5,588.0786 psf	0 psf	531.1741 psf	0 psf	5 CH -20 TO -65
Slice 32	54.627594 ft	-44.752445 ft	3,211.3854 psf	5,378.5731 psf	0 psf	526.57581 psf	0 psf	5 CH -20 TO -65
Slice 33	60.238605 ft	-43.039525 ft	3,026.8995 psf	5,047.7144 psf	0 psf	519.03413 psf	0 psf	5 CH -20 TO -65
Slice 34	65.907908 ft	-40.542204 ft	2,792.6377 psf	4,829.6077 psf	0 psf	511.4141 psf	0 psf	5 CH -20 TO -65
Slice 35	71.569303 ft	-37.280693 ft	2,510.7766 psf	4,341.6454 psf	0 psf	503.8047 psf	0 psf	5 CH -20 TO -65
Slice 36	75.22124 ft	-35.176824 ft	2,338.8548 psf	4,047.2919 psf	0 psf	500 psf	0 psf	5 CH -20 TO -65

Slice 37	79.064525 ft	-32.596038 ft	2,170.9283 psf	3,845.2017 psf	0 psf	500 psf	0 psf	5 CH -20 TO -65
Slice 38	85.108615 ft	-28.380692 ft	1,897.0578 psf	3,388.3587 psf	0 psf	500 psf	0 psf	5 CH -20 TO -65
Slice 39	92.01533 ft	-23.189971 ft	1,560.7664 psf	2,882.6949 psf	0 psf	500 psf	0 psf	5 CH -20 TO -65
Slice 40	97.578465 ft	-18.774816 ft	1,279.6075 psf	2,313.8147 psf	0 psf	350 psf	0 psf	4 CH 0 TO -20
Slice 41	102.904 ft	-14.47593 ft	1,015.5451 psf	1,902.1087 psf	0 psf	350 psf	0 psf	4 CH 0 TO -20
Slice 42	108.92553 ft	-9.3177959 ft	698.40394 psf	1,438.0693 psf	0 psf	350 psf	0 psf	4 CH 0 TO -20
Slice 43	115.16097 ft	-3.5632209 ft	341.06991 psf	864.90777 psf	0 psf	350 psf	0 psf	4 CH 0 TO -20
Slice 44	120.05131 ft	0.95 ft	59.308679 psf	598.61687 psf	0 psf	600 psf	0 psf	3 CH TO 0
Slice 45	121.10779 ft	1.925 ft	-1.5607547 psf	485.47051 psf	0 psf	600 psf	0 psf	3 CH TO 0



Legend

- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- ASA-5UCL (MVN-2007-022129)
- ASA-2UCL (MVN-2007-022129)
- W-92.2-UC (MVN-1983-08)
- W-94.8-U (MVN-1975-546)
- W-94.5-U (MVN-1975-546)
- W-93.9-U (MVN-1975-546)
- R-90.25-RU (MVN-1973-553)
- W-94.4-U (MVN-1972-563)
- W-90.8-U (MVN-1971-575)
- R-89.1-RUC (MVN-1971-563)
- R-88.49-UR (MVN-1970-569)
- R-89.7-UR (MVN-1969-592)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-11

Levee CL Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		22 June 2020	

WATER CONTENT (%)

WET DENSITY (PCF)

UNDRAINED SHEAR STRENGTH (PSF)

ELEVATION IN FEET (NAVD 88)

ML

100

117

100

115

110

300

200

600

900

1100

1400

Legend

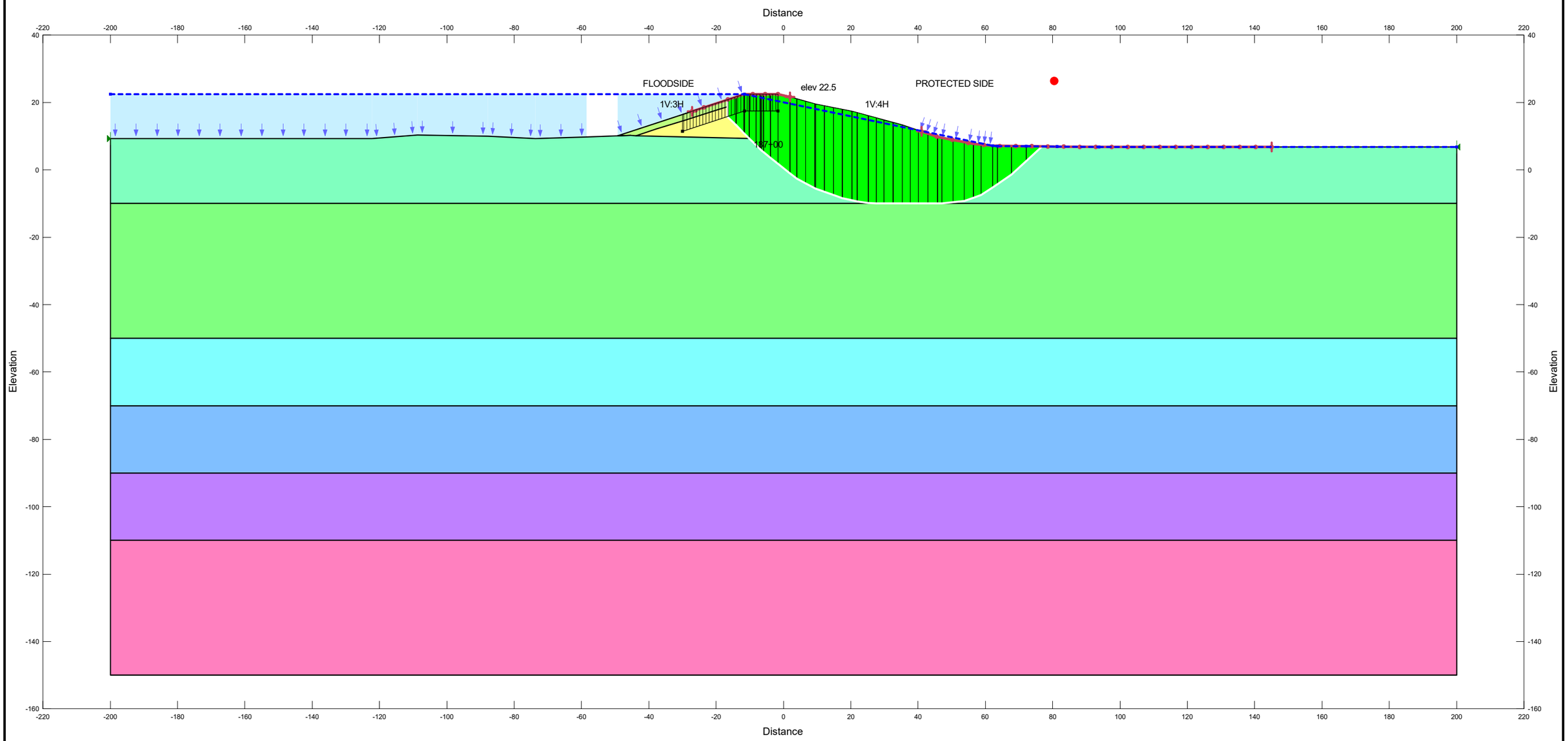
- (Q) Unconsolidated Undrained Triaxial Shear Test
- (UC) Unconfined Compression Test
- c/p = 0.22
- Design Line
- M-94.4-UR (MVN-1981-08)
- M-94.2-UR (MVN-1981-08)
- M-94.0-UR (MVN-1981-08)
- W-95.1-UT (MVN-1975-546)
- W-94.5-UT (MVN-1975-546)
- W-93.9-UT (MVN-1975-546)
- W-94.9-UT (MVN-1972-563)
- W-94.7-UT (MVN-1972-563)
- M-94.6-UL (MVN-1981-08)
- R-89.7-URT (MVN-1969-592)
- R-89.1-RUT (MVN-1971-563)

U.S. Army Corps of Engineers
New Orleans District

WBV-MRL-11

Levee TOE Soil Parameters

DRAWN.	CHECKED.	DATE.	SHEET.
		23 June 2020	



Color	Name	Model	Weight Fn	Cohesion Fn	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line
	1 New levee	Mohr-Coulomb			115	600	0	0	1
	2 Levee	Mohr-Coulomb			115	600	0	0	1
	3 CH TO -10	Spatial Mohr-Coulomb	CH TO -10	CH TO -10			0	0	1
	4 ML -10 TO -50	Mohr-Coulomb			117	200	15	0	1
	5 CH -50 TO -70	Spatial Mohr-Coulomb	CH -50 TO -70	CH -50 TO -70			0	0	1
	6 CH -70 TO -90	Spatial Mohr-Coulomb		CH -70 TO -90	115		0	0	1
	7 CH -90 TO -110	Spatial Mohr-Coulomb	CH -90 TO -110	CH -90 TO -110			0	0	1
	8 CH -110 TO -150	Spatial Mohr-Coulomb	CH -110 TO -150	CH -110 TO -150			0	0	1

WBV-MRL-11
FLOODSIDE SHIFT

HWL EE

WBV-MRL-11 - FS shift.gsz

08/10/2020 1:362

HWL EE

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File Information

File Version: 10.00
Created By: Quach, Bich N CIV USARMY CEMVN (USA)
Last Edited By: Quach, Bich N CIV USARMY CEMVN (USA)
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Directory: G:\F&MHOME\QuachB\LPV-WBV GRR levee lifts\FLD LPV-WBV-MRL\WBV-MRL\WBV-MRL-11\
Last Solved Date: 10/30/2020
Last Solved Time: 12:19:10 PM

Project Settings

Unit System: U.S. Customary Units

Analysis Settings

HWL EE

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions from: Piezometric Line
  - Apply Phreatic Correction: No
  - Use Staged Rapid Drawdown: No
- Unit Weight of Water: 62.430189 pcf

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Optimizations Settings
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-07
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
  - Driving Side Maximum Convex Angle: 5 °
  - Resisting Side Maximum Convex Angle: 1 °
- Tension Crack Option: Tension Crack Line
  - Filled with water (0 to 1): 0

Tension Crack Fluid Unit Weight: 62.430189 pcf
Distribution
F of S Calculation Option: Constant
Advanced
Geometry Settings
Minimum Slip Surface Depth: 0.1 ft
Number of Slices: 30
Factor of Safety Convergence Settings
Maximum Number of Iterations: 100
Tolerable difference in F of S: 0.001
Solution Settings
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

2 Levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

1 New levee

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion': 600 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4 ML -10 TO -50

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion': 200 psf
Phi': 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

3 CH TO -10

Model: Spatial Mohr-Coulomb
Weight Fn: CH TO -10
Cohesion Fn: CH TO -10
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

5 CH -50 TO -70

Model: Spatial Mohr-Coulomb
Weight Fn: CH -50 TO -70
Cohesion Fn: CH -50 TO -70
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

6 CH -70 TO -90

Model: Spatial Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion Fn: CH -70 TO -90
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

7 CH -90 TO -110

Model: Spatial Mohr-Coulomb
Weight Fn: CH -90 TO -110
Cohesion Fn: CH -90 TO -110
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

8 CH -110 TO -150

Model: Spatial Mohr-Coulomb
Weight Fn: CH -110 TO -150
Cohesion Fn: CH -110 TO -150
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Type: Range
Left-Zone Left Coordinate: (-27.11322, 17.39751) ft
Left-Zone Right Coordinate: (2, 21.6) ft
Left-Zone Increment: 8
Right Type: Range
Right-Zone Left Coordinate: (41.05066, 11.38311) ft
Right-Zone Right Coordinate: (145, 6.8) ft
Right-Zone Increment: 22
Radius Increments: 6

Slip Surface Limits

Left Coordinate: (-200, 9.3) ft
Right Coordinate: (200, 6.8) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X	Y
Coordinate 1	-200 ft	22.5 ft
Coordinate 2	-11.6 ft	22.5 ft
Coordinate 3	62.1 ft	7.1 ft
Coordinate 4	63.6 ft	7 ft
Coordinate 5	72.1 ft	7 ft
Coordinate 6	81.3 ft	6.9 ft
Coordinate 7	93.7 ft	6.8 ft
Coordinate 8	200 ft	6.8 ft

Tension Crack Line

	X	Y
Coordinate 1	-30 ft	11.4 ft
Coordinate 2	-11.6 ft	17.5 ft
Coordinate 3	-1.6 ft	17.5 ft

Cohesion Functions

CH -110 TO -150

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 1,900 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 1,400)
Data Point: (-43, 1,400)
Data Point: (0, 1,900)
Data Point: (62, 1,400)
Data Point: (200, 1,400)

CH -90 TO -110

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 1,500 psf
Data Points: X (ft), Cohesion (psf)

Data Point: (-200, 1,100)
Data Point: (-43, 1,100)
Data Point: (0, 1,500)
Data Point: (62, 1,100)
Data Point: (200, 1,100)

CH -70 TO -90

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 1,100 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 900)
Data Point: (-43, 900)
Data Point: (0, 1,100)
Data Point: (62, 900)
Data Point: (200, 900)

CH -50 TO -70

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 700 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 600)
Data Point: (-43, 600)
Data Point: (0, 700)
Data Point: (62, 600)
Data Point: (200, 600)

CH TO -10

Model: Spline Data Point Function
Function: Cohesion vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 600 psf
Data Points: X (ft), Cohesion (psf)
Data Point: (-200, 300)
Data Point: (-43, 300)
Data Point: (0, 600)
Data Point: (62, 300)
Data Point: (200, 300)

Unit Weight Functions

CH TO -10

Model: Spline Data Point Function
Function: Unit Weight vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %

Y-Intercept: 115 pcf
Data Points: X (ft), Unit Weight (pcf)
Data Point: (-200, 100)
Data Point: (-43, 100)
Data Point: (0, 115)
Data Point: (62, 100)
Data Point: (200, 100)

CH -50 TO -70

Model: Spline Data Point Function
Function: Unit Weight vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 110 pcf
Data Points: X (ft), Unit Weight (pcf)
Data Point: (-200, 100)
Data Point: (-43, 100)
Data Point: (0, 110)
Data Point: (62, 100)
Data Point: (200, 100)

CH -90 TO -110

Model: Spline Data Point Function
Function: Unit Weight vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 115 pcf
Data Points: X (ft), Unit Weight (pcf)
Data Point: (-200, 110)
Data Point: (-43, 110)
Data Point: (0, 115)
Data Point: (62, 110)
Data Point: (200, 110)

CH -110 TO -150

Model: Spline Data Point Function
Function: Unit Weight vs. X
Curve Fit to Data: 100 %
Segment Curvature: 0 %
Y-Intercept: 115 pcf
Data Points: X (ft), Unit Weight (pcf)
Data Point: (-200, 110)
Data Point: (-43, 110)
Data Point: (0, 115)
Data Point: (62, 110)
Data Point: (200, 110)

Points

	X	Y
Point 1	-200 ft	9.3 ft
Point 2	-122.3 ft	9.3 ft

Point 3	-108.7 ft	10.4 ft
Point 4	-87.8 ft	10 ft
Point 5	-73.7 ft	9.3 ft
Point 6	-58.5 ft	9.7 ft
Point 7	-45.5 ft	10.2 ft
Point 8	-43.8 ft	10.1 ft
Point 9	-37.8 ft	12.1 ft
Point 10	-28.8 ft	14.9 ft
Point 11	-19.2 ft	17.9 ft
Point 12	-11.7 ft	20.2 ft
Point 13	-8.2 ft	21.4 ft
Point 14	-3.9 ft	21.7 ft
Point 15	2 ft	21.6 ft
Point 16	9.5 ft	19.5 ft
Point 17	20.3 ft	17.4 ft
Point 18	35.3 ft	13.3 ft
Point 19	45.8 ft	9.8 ft
Point 20	56.5 ft	7.7 ft
Point 21	62.1 ft	7.1 ft
Point 22	72.1 ft	7 ft
Point 23	81.3 ft	6.9 ft
Point 24	93.7 ft	6.8 ft
Point 25	200 ft	6.8 ft
Point 26	-200 ft	-10 ft
Point 27	200 ft	-10 ft
Point 28	-200 ft	-30 ft
Point 29	200 ft	-30 ft
Point 30	-200 ft	-50 ft
Point 31	200 ft	-50 ft
Point 32	-200 ft	-70 ft
Point 33	200 ft	-70 ft
Point 34	-200 ft	-90 ft
Point 35	200 ft	-90 ft
Point 36	-200 ft	-110 ft
Point 37	200 ft	-110 ft
Point 38	-200 ft	-150 ft
Point 39	200 ft	-150 ft
Point 40	-11.6 ft	22.5 ft
Point 41	-1.6 ft	22.5 ft
Point 42	-49.3 ft	10.1 ft

Regions

	Material	Points	Area
Region 1	3 CH TO -10	1,26,27,25,24,23,22,21,20,8,7,6,5,4,3,2	7,373.2 ft²
Region 2	5 CH -50 TO -70	30,31,33,32	8,000 ft²

Region 3	6 CH -70 TO -90	32,33,35,34	8,000 ft²
Region 4	7 CH -90 TO -110	34,35,37,36	8,000 ft²
Region 5	8 CH -110 TO -150	36,37,39,38	16,000 ft²
Region 6	4 ML -10 TO -50	26,27,29,31,30,28	16,000 ft²
Region 7	2 Levee	8,20,19,18,17,16,15,13,12,11,10,9	686.38 ft²
Region 8	1 New levee	15,41,40,42,7,8,9,10,11,12,13,14	81.45 ft²

Slip Results

Slip Surfaces Analysed: 921 of 1450 converged

Current Slip Surface

Slip Surface: 1,450
Factor of Safety: 1.580
Volume: 1,721.3096 ft³
Weight: 188,409.12 lbf
Resisting Moment: 3,399,637 lbf·ft
Activating Moment: 2,151,161.1 lbf·ft
Resisting Force: 41,955.343 lbf
Activating Force: 26,550.942 lbf
Slip Rank: 1 of 1,450 slip surfaces
Exit: (76.745701, 6.9495033) ft
Entry: (-16.623694, 15.834536) ft
Radius: 40.934916 ft
Center: (37.513116, 60.374126) ft

Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Slice 1	-16.579217 ft	15.791663 ft	418.80273 psf	319.45665 psf	-0 psf	600 psf	0 psf	2 Levee
Slice 2	-15.326055 ft	14.520283 ft	498.17522 psf	466.31285 psf	-0 psf	600 psf	0 psf	2 Levee
Slice 3	-12.902485 ft	12.056968 ft	651.96044 psf	783.78846 psf	0 psf	600 psf	0 psf	2 Levee
Slice 4	-11.6438 ft	10.779305 ft	731.72521 psf	960.48656 psf	0 psf	600 psf	0 psf	2 Levee
Slice 5	-10.862999 ft	10.015345 ft	769.80508 psf	1,043.9913 psf	0 psf	600 psf	0 psf	2 Levee
Slice 6	-9.1629987 ft	8.3520144 ft	851.47045 psf	1,256.4766 psf	0 psf	536.0721 psf	0 psf	3 CH TO -10
Slice 7	-7.5011831 ft	6.7260442 ft	931.3015 psf	1,413.0883 psf	0 psf	547.66616 psf	0 psf	3 CH TO -10

Slice 8	-6.6490064 ft	5.8922489 ft	972.23876 psf	1,490.5324 psf	0 psf	553.61158 psf	0 psf	3 CH TO -10
Slice 9	-6.2147133 ft	5.4673236 ft	993.10152 psf	1,529.9465 psf	0 psf	556.64154 psf	0 psf	3 CH TO -10
Slice 10	-4.91689 ft	4.387822 ft	1,043.5648 psf	1,705.071 psf	0 psf	565.69612 psf	0 psf	3 CH TO -10
Slice 11	-2.75 ft	2.673241 ft	1,122.339 psf	1,875.4814 psf	0 psf	580.81395 psf	0 psf	3 CH TO -10
Slice 12	0.2 ft	0.3390135 ft	1,229.5822 psf	2,072.7968 psf	0 psf	599.03226 psf	0 psf	3 CH TO -10
Slice 13	2.96337 ft	-1.8475404 ft	1,330.0407 psf	2,221.2791 psf	0 psf	585.66111 psf	0 psf	3 CH TO -10
Slice 14	5.2602075 ft	-3.3263625 ft	1,392.4014 psf	2,427.4217 psf	0 psf	574.54738 psf	0 psf	3 CH TO -10
Slice 15	7.9271425 ft	-4.7594475 ft	1,447.0786 psf	2,488.4148 psf	0 psf	561.64286 psf	0 psf	3 CH TO -10
Slice 16	9.380305 ft	-5.518878 ft	1,475.5334 psf	2,617.2961 psf	0 psf	554.61143 psf	0 psf	3 CH TO -10
Slice 17	10.834715 ft	-6.0400083 ft	1,489.0947 psf	2,637.2681 psf	0 psf	547.57396 psf	0 psf	3 CH TO -10
Slice 18	13.504145 ft	-6.996493 ft	1,513.9852 psf	2,676.0729 psf	0 psf	534.65736 psf	0 psf	3 CH TO -10
Slice 19	16.173575 ft	-7.9529777 ft	1,538.8757 psf	2,715.1816 psf	0 psf	521.74077 psf	0 psf	3 CH TO -10
Slice 20	18.904145 ft	-8.7396836 ft	1,552.3693 psf	2,816.7457 psf	0 psf	508.52833 psf	0 psf	3 CH TO -10
Slice 21	21.08051 ft	-9.2206286 ft	1,554.0038 psf	2,811.7171 psf	0 psf	497.99753 psf	0 psf	3 CH TO -10
Slice 22	23.525315 ft	-9.621205 ft	1,547.1191 psf	2,828.0091 psf	0 psf	486.16783 psf	0 psf	3 CH TO -10
Slice 23	26.36596 ft	-9.923595 ft	1,528.9409 psf	2,815.1166 psf	0 psf	472.42277 psf	0 psf	3 CH TO -10
Slice 24	28.68907 ft	-9.99891 ft	1,503.3376 psf	2,786.2542 psf	0 psf	461.18192 psf	0 psf	3 CH TO -10
Slice 25	31.201873 ft	-9.9999355 ft	1,470.6218 psf	2,705.4847 psf	0 psf	449.0232 psf	0 psf	3 CH TO -10
Slice 26	33.933957 ft	-9.9999466 ft	1,434.9821 psf	2,616.2802 psf	0 psf	435.80343 psf	0 psf	3 CH TO -10
Slice 27	36.506 ft	-9.999957 ft	1,401.4302 psf	2,523.2959 psf	0 psf	423.35806 psf	0 psf	3 CH TO -10
Slice 28	38.918 ft	-9.9999668 ft	1,369.966 psf	2,426.6288 psf	0 psf	411.6871 psf	0 psf	3 CH TO -10
Slice 29	41.543 ft	-9.9999774 ft	1,335.7232 psf	2,332.1101 psf	0 psf	398.98548 psf	0 psf	3 CH TO -10
Slice 30	44.381 ft	-9.9999889 ft	1,298.7019 psf	2,239.5172 psf	0 psf	385.25323 psf	0 psf	3 CH TO -10
Slice 31	46.455175 ft	-9.9999973 ft	1,271.6446 psf	2,175.2676 psf	0 psf	375.2169 psf	0 psf	3 CH TO -10

Slice 32	48.778317 ft	-9.811765 ft	1,229.5875 psf	2,141.5849 psf	0 psf	363.97588 psf	0 psf	3 CH TO -10
Slice 33	52.114253 ft	-9.435295 ft	1,162.5668 psf	2,008.5672 psf	0 psf	347.83426 psf	0 psf	3 CH TO -10
Slice 34	55.14111 ft	-8.7607708 ft	1,080.9704 psf	1,938.4441 psf	0 psf	333.18818 psf	0 psf	3 CH TO -10
Slice 35	57.624835 ft	-7.8719508 ft	993.08075 psf	1,771.6517 psf	0 psf	321.17015 psf	0 psf	3 CH TO -10
Slice 36	60.424835 ft	-6.3463864 ft	861.31316 psf	1,630.1047 psf	0 psf	307.62177 psf	0 psf	3 CH TO -10
Slice 37	62.85 ft	-4.7205514 ft	734.83774 psf	1,404.1566 psf	0 psf	300 psf	0 psf	3 CH TO -10
Slice 38	65.683385 ft	-2.821045 ft	613.12969 psf	1,186.2489 psf	0 psf	300 psf	0 psf	3 CH TO -10
Slice 39	69.933385 ft	0.59626744 ft	399.78623 psf	861.68312 psf	0 psf	300 psf	0 psf	3 CH TO -10
Slice 40	74.42285 ft	4.7831891 ft	136.81966 psf	405.92793 psf	0 psf	300 psf	0 psf	3 CH TO -10