Appendix A. Seepage Analysis

Steady-state seepage analyses were performed on eight cross sections of the proposed Mid-Barataria Sediment Diversion (MBSD) to assess the potential for seepage concerns or problems along the channel alignment from the inlet system to the western end of the conveyance channel. The analyses were performed using the computer program SEEP/W (2012), part of the geotechnical analysis software package GeoStudio 2012, developed by GEO-SLOPE International, Ltd. SEEP/W is a finite-element modeling program that evaluates both levee underseepage and through seepage. To use SEEP/W, section geometry is entered into the program as distinct soil layers. Permeability or hydraulic conductivity values (horizontal and vertical) are then assigned to the layers as soil type designations. Pressure or flow boundary conditions are then applied to the model to define the initial conditions for seepage analyses. Seepage analyses were performed for the sections shown in Table A-1.

Table A-1. Cross sections for stability and seepage analysis

Cross section designation and station location	Rationale for selection	Exploration(s) used to develop stratigraphy and soil properties
18+00 to 45+00	Section along project centerline across MR&T Levee, inlet system, and temporary setback levee at approximately Station 42+00; presence of point bar deposits	B-3C, IS-8A, NL-9A
35+00	Section transverse to the project centerline across the inlet system and temporary excavation setback levees; within the point bar deposits	IS-8A, NL-9A
55+00	Section at conveyance channel and guide levee; presence of abandoned distributary channel deposits	NL-8A
67+00	Section at conveyance channel and guide levee beneath future LA 23 bridge; presence of natural levee deposits	NL-7C, NL-10C
82+00	Section at conveyance channel and guide levee; presence of abandoned distributary channel deposits	NL-6A
90+00	Section at conveyance channel and guide levee; at transition from natural levee deposits to marsh deposits	NL-5C, NL-11C
110+00	Section at conveyance channel and guide levee; presence of marsh deposits	NL-3A, NL-3C
130+00	Section at back structure; presence of marsh deposits	NL-1C

Notes: LA 23 = Belle Chasse Highway; MR&T = Mississippi River and Tributary

Seepage Parameter Selection

Seepage parameter selection was performed based on a review of the exploration logs associated with each cross section. Site-specific or locally based information on soil permeabilities was not available from borings along the conveyance channel alignment. Laboratory testing was performed on samples taken from borings along the Mississippi River and Tributary (MR&T) west bank levee, and those results were considered for selection of seepage properties within the point bar deposits. Horizontal and vertical permeability coefficients were primarily selected based on correlations with soil type and fines content, pump tests and laboratory testing. The Kozeny-Carman formula, as presented by Carrier (2003), was also used to develop vertical permeability estimates using grain size curves from laboratory testing and previous studies. Kozeny-Carman calculations were found to compare well with correlations presented in the pump and laboratory testing from the MR&T west bank levee explorations. The soil stratigraphy and corresponding material properties used are presented on the results figures included in this appendix.

Seepage Analysis Cases and Boundary Conditions

At the inlet system (from Station 18+00 to Station 45+00 and Station 35+00), steady-state seepage analyses were performed for the following cases:

- **Case 1** – Water level in the Mississippi River at elevation +12.25 feet, water level in the inlet system excavation at elevation –50 feet, and water level on the nonexcavation side (polder side) of the temporary setback levee at elevation +3 feet. This case represents the condition when the river is at flood level, the water level within the inlet system area is at the bottom of the excavation, and the water level on the nonexcavation side of the temporary setback levee is at an assumed high groundwater level (ground surface). This analysis case was performed to estimate the rate of flow into the excavation.
- **Case 2** – Water level in the Mississippi River at elevation +12.25 feet, water level in the inlet system excavation at elevation +12.25 feet, and water level on the nonexcavation side (polder side) of the temporary setback levee at elevation –3.5 feet. This case represents the condition when the river is at flood level, the water level within the inlet system excavation matches that of the river, and the water level on the nonexcavation side of the temporary setback levee is at a relatively low groundwater level (estimated based on data recorded in piezometers PZ-13 to PZ-15). This case represents the hypothetical condition where there is a breach (such as in the MR&T Levee), causing flooding of the inlet system excavation. Analyses were performed assuming sufficient time had past after flooding has occurred, allowing for the development of steady-state seepage conditions.

Steady-state seepage analyses for each of the other cross sections (Station 35+00 to Station 130+00) were performed for two water level conditions, based on information provided by the HDR hydraulics team. The two conditions analyzed were:

- **Case 1** – Water level in the channel at elevation 10 feet and water level landside of the guide levee taken as corresponding to typical low groundwater level, which ranges from about elevation –3.5 feet at Station 55+00 to elevation –6.8 feet at Station 130+00. This case represents the condition when the channel is operating at its full design capacity coupled with relatively low groundwater levels in the adjacent areas. Low groundwater levels were estimated based on data recorded in piezometers PZ-13 to PZ-15.

- **Case 2** – Water level in the channel at elevation 0 feet and water level landside of the guide levee at elevation +10 feet. This case is approximately the inverse of Case 1 and represents the condition when there is flooding outside of the guide levees (such as may occur if there is a breach in one of the other levees) while water in the channel is at a normal operating level.

Underseepage and Exit Gradient Calculations

For evaluation of levee underseepage, exit gradients were calculated at the following locations, judged to be critical for the levee and channel configuration under consideration:

- **Section 18+00 to 45+00 and Section 35+00**
  - **Case 1** – For these cases, exit gradients were not calculated because the phreatic surface does not break out into the excavation under the steady-state conditions analyzed. Therefore, seepage gradients are not critical for this seepage case.
  - **Case 2** – For these cases, exit gradients were calculated at the ditch-side levee toe, ditch-side berm toe, and ditch toe (that is, the toe of the ditch slope). Note that a ditch is not modeled behind the setback levee in Section 18+00 to 45+00.
- **Section 55+00 to Section 130+00**
  - **Case 1** – For these cases, exit gradients were calculated at the ditch-side levee toe, ditch-side berm toe, and ditch toe (that is, the toe of the ditch slope).
  - **Case 2** – For these cases, exit gradients were calculated at the channel-side levee toe, channel-side berm toe, and channel toe (that is, the toe of the channel slope).

The exit gradient was calculated by determining the total head at a specific node (typically the bottom of the blanket layer), then subtracting the total head at a node directly above the initial node at the ground surface, and then dividing by the difference in elevation of the two nodes. The following maximum average vertical exit gradients were selected as target values for evaluating the results of the underseepage analyses:

- At the ditch-side and channel-side levee toes: $i_e \leq 0.5$
- At the ditch-side and channel-side berm toes: $i_e \leq 0.5$ to ≤ 0.8 up to 150 feet from the levee toe
- At the ditch and channel toes: $i_e \leq 0.5$ to ≤ 0.8 up to 150 feet from the levee toe

The average vertical exit gradient criteria presented above are based on blanket soils having a saturated unit weight of at least 112 pounds per cubic foot. Adjustments were made to the calculated average vertical exit gradients for cases where the blanket soils have lower saturated unit weights.

Boundary Conditions and Modeling Assumptions

Boundary conditions and other model assumptions vary between each section depending on the analysis cases, model geometry, and analysis criteria. Nonetheless, three boundary condition types are similar for all models: (1) no-flow boundary conditions (that is, zero total flux boundary condition) were applied along the bottom of each model, (2) potential seepage face boundary conditions were applied at any land-side face where the phreatic surface could potentially break out, and (3) total head boundary conditions corresponding to estimated water levels (groundwater or flood) were applied at vertical edges of the models (except at the channel centerline for Section 35+00). Despite these similarities, each section contains unique features, which are highlighted below:

- **Section 18+00 to 45+00** – This section runs longitudinal to the channel alignment from the Mississippi River to the western boundary of the point bar deposits (approximately Station 45+00). Due to the alignment direction and the spatial distribution of relevant explorations, this is the only analysis section that features nonhorizontal soil layering and is not symmetric. The inclusion of nonhorizontal layering did not have a significant impact on the selection of seepage analysis parameters, but did affect the selection of undrained strength parameters for stability, as will be discussed in Appendix B. The section includes a 3-foot-wide soil-cement cutoff wall extending from the top of the eastern excavation slope (elevation +3 feet) down to the top of a deep clay layer (elevation –131.5 feet), as shown in preliminary drawings. No cut-off wall is modeled on the western side. Instead, a 300-foot-wide clay block is modeled west of the setback levee to simulate interface of the point bar deposits and the more clayey geologic strata to the west. The width of the block was selected to facilitate numerical efficiency of the model. For Case 1, a total head boundary condition was applied at the base of the excavation to simulate a fully dewatered excavation. Steady-state seepage quantities into the excavation were calculated by summing the flux at each node along the bottom and sides of the excavation. It is important to note that the model does not account for the locations of well points, and only models seepage due to gravity into the dewatered excavation. For Case 2 (flooded excavation), total head boundary conditions were applied consisting of the river flood level at the east vertical edge of the model, within the river, and within the excavation. A total head boundary condition of estimated low groundwater levels was applied at the west vertical edge of the clay block. The vertical face within the excavation is modeled as a potential seepage face under the conservative assumption that the cofferdam does not retard groundwater flow.
- **Section 35+00** – This section is transverse to the channel alignment and soil layers are horizontal, and are symmetric with respect to the excavation centerline. To reduce calculation time, one-half of the section was modeled with respect to the excavation centerline (line of symmetry). Steady-state seepage quantities into the excavation were calculated, but the value was doubled to account for modeling only one-half of the section. The model also includes a 3-foot-wide soil-cement cutoff wall located at the setback levee and extending from the existing ground surface (elevation +3 feet) down to the top of a deep clay layer (elevation –114 feet). A no-flow boundary condition was applied at the line of symmetry using the assumption that the seepage conditions for the other side of the excavation are equal and opposite. A total head boundary condition was applied at the horizontal extent of the model at the ground surface or estimated low groundwater level for Case 1 and Case 2, respectively. The vertical face within the excavation is modeled as a potential seepage face. To reduce the potential for numerical errors due to boundary conditions on the seepage analyses results, the model extends 1,600 feet landward from the excavation centerline.

- **Section 55+00 to 130+00** – These sections exhibit significant variations in soil conditions and surface geometry, but they are similar from a numerical modeling standpoint. These models contain horizontal soil layering and are symmetric with respect to the channel centerline. Unlike Section 35+00, both sides of the channel are modeled, and the same boundary conditions are applied at each side of the channel centerline. The models extend 1,600 feet landward from the excavation centerline for total model widths of 3,200 feet. For Case 1, low groundwater total head boundary conditions were applied at the vertical edges of the models with full operation levels in the channel. For Case 2, flood level total head boundary conditions were applied on the polder-side of the guide levees (including vertical edges of the model) with normal operation levels in the channel.

Seepage Analysis Results

Results of the steady-state seepage analyses are presented in the figures within this appendix. For each section, summary figures describe soil layering, seepage parameters, water levels, underseepage results, and section-specific assumptions. Graphical SEEP/W outputs show total head seepage conditions, gradient calculations, and other pertinent result information.

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation[2] (ft)	Bottom Elevation[2] (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	16	3	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	3	-7	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	90
3	-7	-28	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	90
4	-28	-61	ML/SM/CL Interbedded	See Note 1	0.167	5.0E-05	3.0E-04	1.4E-01	8.5E-01	ML/SM/CL	110
5	-61	-91	SM	40	0.25	1.2E-04	4.8E-04	3.4E-01	1.4E+00	Sat. Only	115
6	-91	-107	SP/SM	30	0.25	2.0E-04	8.0E-04	5.7E-01	2.3E+00	Sat. Only	120
7	-107	-180	CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	110
8	3	-180	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	90
9	3	-132	Soil-Cement Cutoff Wall	N/A	1	1.0E-06	1.0E-06	2.8E-03	2.8E-03	Cutoff	120

Note 1 - Kv Assumed to be on non-plastic curve at 70 percent. Kh assumed to be 6 times greater due to the silty sand and clay layers.
Note 2 - Top Elevation and Bottom Elevation for Layers 1 to 7 vary in the model. The elevations noted in the table above correspond to approximate stations 41+00 to 45+00, which is the slope stability area of interest (the temporary setback levee at station 42+00). Seepage analysis parameters are not affected.

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)			Remarks
		Mississippi River	Excavation Area	Setback Polder	
1	Steady-State	12.25	-50	3	Mississippi River WSE at Flood Level; Excavation area WSE at bottom of excavation; Polder WSE at Ground Surface
2	Steady-State	12.25	12.25	-3.5	Mississippi River WSE at Flood Level; Excavation area WSE at Flood Level; Polder WSE from low water observations in PZ-15

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Setback Levee Crown (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
2	2-A	Polder-side Setback Levee Toe	47.5	0.0	0.31	YES	11.63	8.00	3.63	1 - Levee/Berm	120	5.0	2 - CL/CH & 3 - CL	90	31.0	36.0	0.10	31.8	0.51	1.60	**5.05**
1	2-B	Polder-side Setback Berm Toe	130.0	82.5	0.80	YES	11.50	3.00	8.50	2 - CL/CH & 3 - CL	90	31.0				31.0	0.27	27.6	0.44	1.27	**1.61**

NOTES

1. Excavation cross-Section from 30% Civil Design geometry and discussions with the project team.
2. Borings IS-8A and NL-9A and CPT B-3C were considered to develop the stratigraphy shown.
3. Model extends approximately 1100 feet waterside of the MR&T Levee Crown and approximately 600 feet polder-side of the Setback Levee crown.
4. A 300 foot wide clay block is modeled polder-side of the setback levee to simulate the change to more clayey geologic conditions west of the point bar deposits.
5. Constant head conditions are applied at the horizontal extents of the model.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Steady-State Seepage Case 1 for the excavation does not exhibit phreatic surface breakout or positive exit gradients.
8. Average Vertical Exit Gradients (i_ave) are presented on the Seepage Case 2 figures at the appropriate locations.
9. The Soil-Cement Cutoff Wall is 3 feet wide and extends from the top of Layer 2 to the bottom of Layer 6.

NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS
STATIONS: **18+00 to 45+00**
SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

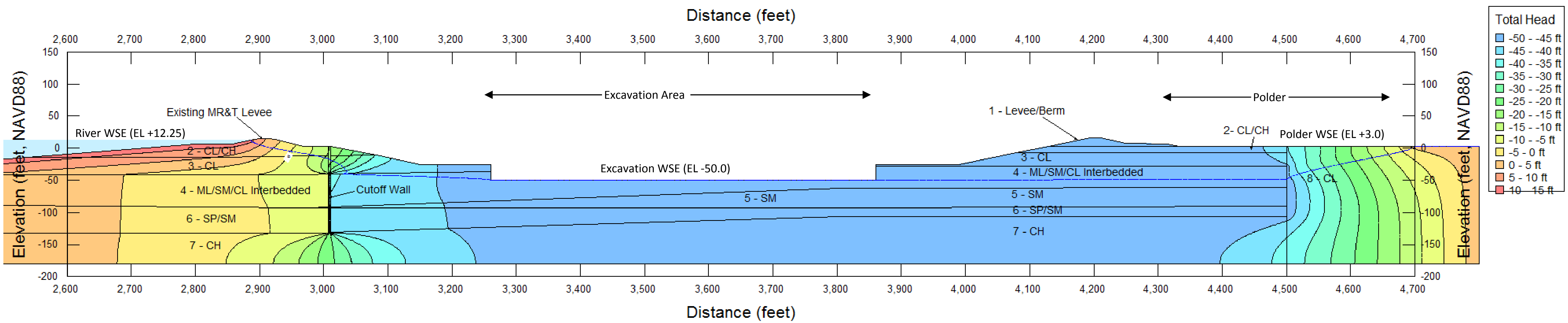
GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
DATE: JULY 2014
DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-1.1

MATERIALS

Created By: Crosariol, Victor
Date: 11/27/2013
File Name: 02_MR&T Levee and Excavation.gsz
Analysis: 01 - Excav w/ cutoff (Steady-State)

1 - Levee (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CL/CH (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
4 - ML/SM/CL Interbedded (Kv=5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: ML/SM/CL Vol. WC. Function: Silt
5 - SM (Kv=1.2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP/SM (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - CL (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
9 - Soil-Cement Cutoff Wall (Kv=1x10-6 cm/sec, Kv/Kh=1.0) Model: Saturated / Unsaturated K-Function: Cutoff Vol. WC. Function: Clay



Calculated Steady State Flow Into Excavation = 3.3 ft^3/day/ft

NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS
STATIONS: **18+00 to 45+00**
SEEPAGE CASE: **1**
WSE In River: **+12.25 feet**
WSE In Excavation: **-50.0 feet**
WSE In Polder: **+3.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: | DESIGNED BY: | APPROVED BY:

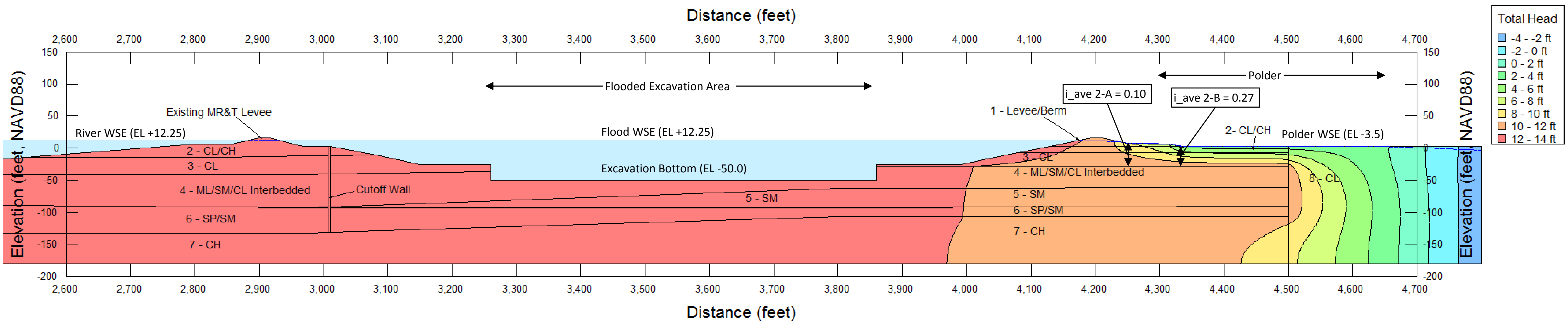
MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-1.2

Created By: Crosariol, Victor
Date: 11/27/2013
File Name: 02_MR&T Levee and Excavation.gsz
Analysis: 02 - Flooded Excav w/ cutoff

MATERIALS

1 - Levee (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CL/CH (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
4 - ML/SM/CL Interbedded (Kv=5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: ML/SM/CL Vol. WC. Function: Silt
5 - SM (Kv=1.2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP/SM (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - CL (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
9 - Soil-Cement Cutoff Wall (Kv=1x10-6 cm/sec, Kv/Kh=1.0) Model: Saturated / Unsaturated K-Function: Cutoff Vol. WC. Function: Clay



NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS
STATIONS: **18+00 to 45+00**
SEEPAGE CASE: **2**
WSE In River: **+12.25 feet**
WSE In Excavation: +**12.25 feet**
WSE In Polder: **-3.5 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-1.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	16	3	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	3	-8.3	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	90
3	-8.3	-32.5	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	90
4	-32.5	-71	ML/SM/CL Interbedded	See Note 1	0.167	5.0E-05	3.0E-04	1.4E-01	8.5E-01	ML/SM/CL	110
5	-71	-92	SM	40	0.25	1.2E-04	4.8E-04	3.4E-01	1.4E+00	Sat. Only	115
6	-92	-114	SP/SM	30	0.25	2.0E-04	8.0E-04	5.7E-01	2.3E+00	Sat. Only	120
7	-114	-130	CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	110
8	3	-114	Soil-Cement Cutoff Wall	N/A	1	1.0E-06	1.0E-06	2.8E-03	2.8E-03	Cutoff	120

Note 1 - Kv Assumed to be on non-plastic curve at 70 percent. Kh assumed to be 6 times greater due to the silty sand and clay layers.

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)			Remarks
		Mississippi River	Excavation Area	Setback Polder	
1	Steady-State	12.25	-50	3	Mississippi River WSE at Flood Level; Excavation area WSE at bottom of excavation; Polder WSE at Ground Surface
2	Steady-State	12.25	12.25	-3.5	Mississippi River WSE at Flood Level; Excavation area WSE at Flood Level; Polder WSE from low water observations in PZ-15

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Setback Levee Crown (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
2	2-A	Polder-side Setback Levee Toe	47.5	0.0	-0.02	NO														1.60	**NA**
2	2-B	Polder-side Setback Berm Toe	130.0	82.5	-0.01	NO														1.27	**NA**
2	2-C	Polder-side Ditch Toe	212.5	165.0	0.56	YES	11.50	3.00	8.50	2 - CL/CH	90	6.7	3 - CL	90	24.2	30.9	0.28	27.6	0.44	1.00	**1.61**

NOTES

1. Excavation Cross-Section at Station 35+00 from 30% Civil Design geometry and discussions with the project team.
2. Borings IS-8A and NL-9A were considered to develop the stratigraphy shown.
3. Symmetry was used to model only one side of the cross-section with respect to the channel centerline.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extent of the model and a no-flow condition is modeled at the channel centerline (allowed by symmetry).
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Steady-State seepage Case 1 for the excavation does not exhibit phreatic surface breakout or positive exit gradients.
8. Average Vertical Exit Gradients (i_ave) are presented on the Seepage Case 2 figures at the appropriate locations.
9. The Soil-Cement Cutoff Wall is 3 feet wide and extends from the top of Layer 2 to the bottom of Layer 6

NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS
STATIONS: **35+00**
SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153

FEDERAL PROJECT NUMBER: BA-153

DATE: JULY 2014

DRAWN BY:

DESIGNED BY:

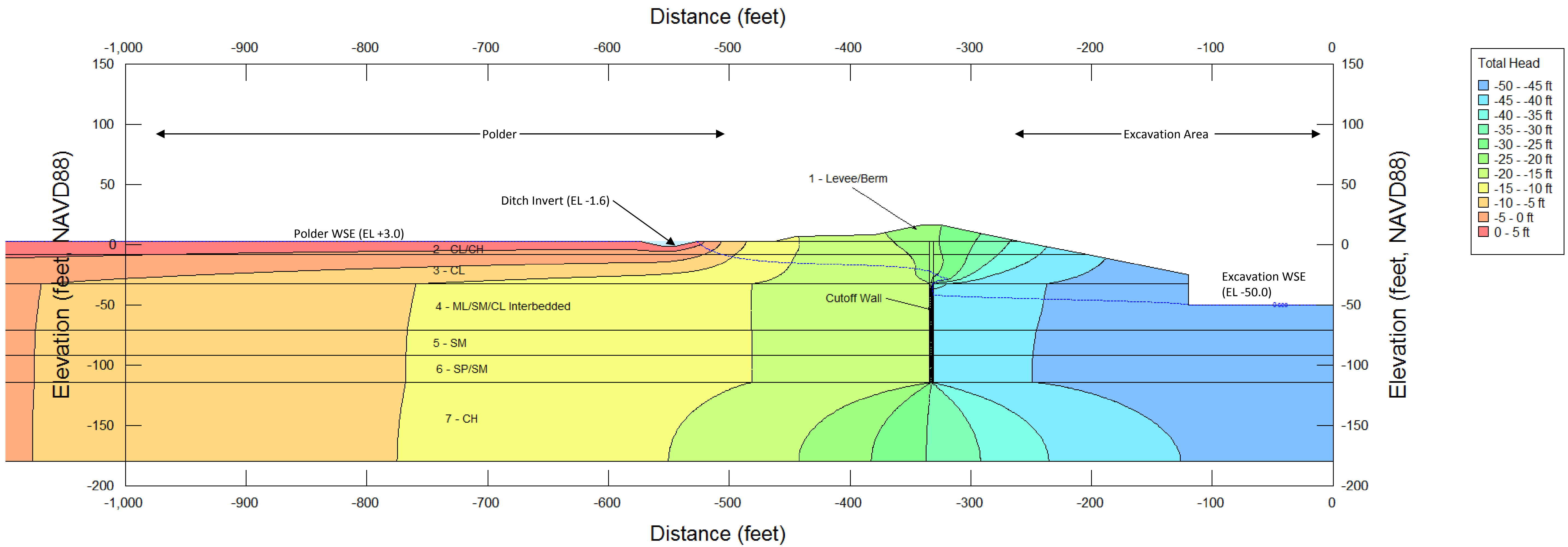
APPROVED BY:

FIGURE: A-2.1

Project: Mid-Barataria Sediment Diversion
Created By: Crosariol, Victor
Date: 12/2/2013
File Name: 03_Station 35+00_30% Levee.gsz
Analysis: 01 - Excav w/ cutoff (Steady-State)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CL/CH +3.0 to -8.3 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL -8.3 to -32.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
4 - ML/SM/CL Interbedded -32.5 to -71.0 (Kv=5x10-5 cm/sec, Kv/Kh=0.167) Model: Saturated / Unsaturated K-Function: ML/SM/CL Vol. WC. Function: Silt
5 - SM -71.0 to -92.0 (Kv=1.2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP/SM -92.0 to -114.0 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH -114.0 to -130.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - Soil-Cement Cutoff Wall (Kv=1x10-6 cm/sec, Kv/Kh=1.0) Model: Saturated / Unsaturated K-Function: Cutoff Vol. WC. Function: Clay



Calculated Steady State Flow Into Excavation = 4.2 ft^3/day/ft

NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS

STATION: **35+00**
SEEPAGE CASE: **1**
WSE In River: **+12.25 feet**
WSE In Excavation: **-50.0 feet**
WSE In Polder: **+3.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY:
DESIGNED BY:

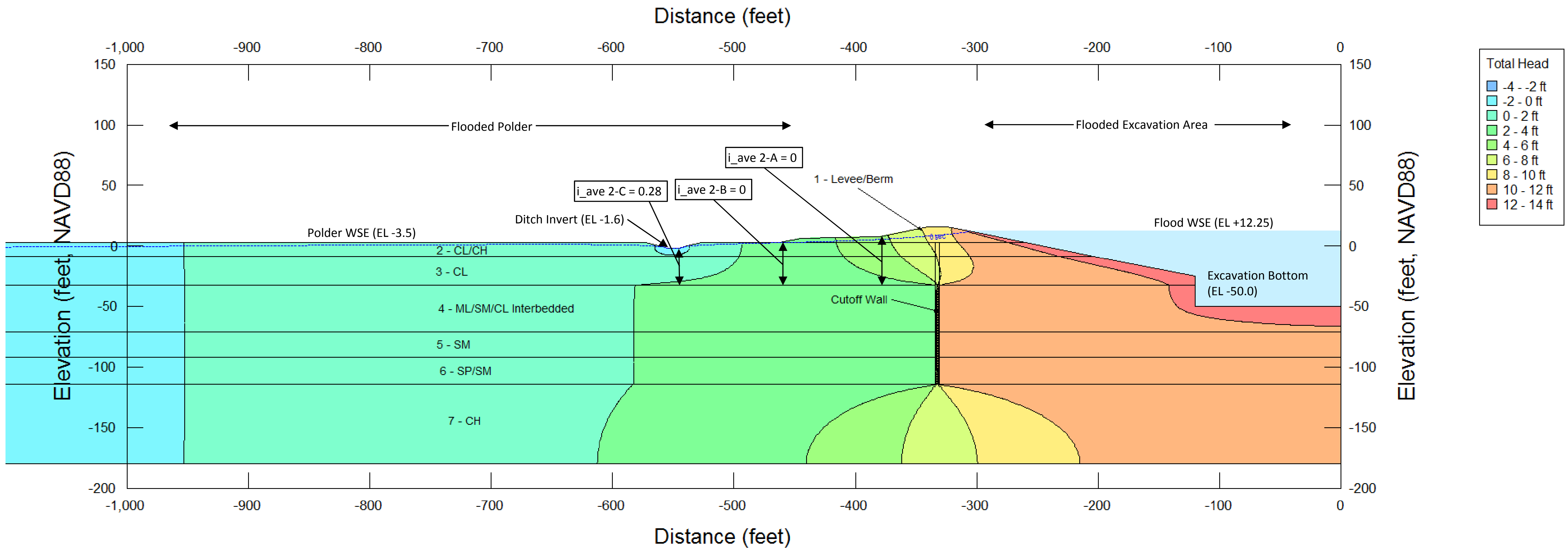
MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-2.2

Project: Mid-Barataria Sediment Diversion
Created By: Crosariol, Victor
Date: 12/2/2013
File Name: 03_Station 35+00_30% Levee.gsz
Analysis: 02 - Flooded Excav w/ cutoff

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CL/CH +3.0 to -8.3 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL -8.3 to -32.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
4 - ML/SM/CL Interbedded -32.5 to -71.0 (Kv=5x10-5 cm/sec, Kv/Kh=0.167) Model: Saturated / Unsaturated K-Function: ML/SM/CL Vol. WC. Function: Silt
5 - SM -71.0 to -92.0 (Kv=1.2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP/SM -92.0 to -114.0 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH -114.0 to -130.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - Soil-Cement Cutoff Wall (Kv=1x10-6 cm/sec, Kv/Kh=1.0) Model: Saturated / Unsaturated K-Function: Cutoff Vol. WC. Function: Clay



NOT TO SCALE

INLET EXCAVATION SEEPAGE ANALYSIS
STATIONS: **35+00**
SEEPAGE CASE: **2**
WSE In River: **+12.25 feet**
WSE In Excavation: +**12.25 feet**
WSE In Polder: **-3.5 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-2.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	13.5	1	Levee/Berm	Approx. 95	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	1	-12.5	CL/CH	Approx. 95*	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	113
3	-12.5	-17.5	SM/CL Interbedded	See Note 1	0.1	5.0E-06	5.0E-05	1.4E-02	1.4E-01	Sat. Only	105
4	-17.5	-23.5	ML/CL Interbedded	See Note 2	0.2	5.0E-06	2.5E-05	1.4E-02	7.1E-02	Sat. Only	105
5	-23.5	-45.5	CL/CH with Sand and Silt Seams	See Note 3	0.2	6.0E-07	3.0E-06	1.7E-03	8.5E-03	Sat. Only	105
6	-45.5	-113	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105
7	-113	-117.3	SM	Approx. 30*	0.25	2.0E-04	8.0E-04	5.7E-01	2.3E+00	Sat. Only	122
8	-117.3	-130	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	100

Note 1 - Kv assumed to be halfway between plastic and non-plastic curves at 85 percent. Kh assumed to be 10 times greater to account for conductivity of the sandy materials.

Note 2 - Kv assumed to be halfway between plastic and non-plastic curves at 85 percent. Kh assumed to be 5 times greater to account for conductivity of the silty materials.

Note 3 - Kv Assumed to be on plastic curve at 95 percent. Lab data in layer has percentage of clay samples within the layer at 98.9 and 93.1 percent. Kh assumed to be 5 times greater.

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-3.5	Polder WSE From low water observations in PZ-15
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	-0.01	NO														1.60	**NA**
1	1-B	Polder-side Berm Toe	530.0	86.5	-0.07	NO														1.25	**NA**
1	1-C	Polder-side Ditch Toe	546.8	103.3	1.33	YES	1.72	-3.20	4.92	2 - CL/CH	113	9.3				9.3	0.53	49.6	0.79	1.19	**1.50**
2	2-A	Channel-side Levee Toe	351.5	0.0	0.12	YES	4.54	4.00	0.54	1 - Levee/Berm	120	3.0	2 - CL/CH	113	13.5	16.5	0.03	49.6	0.79	1.60	**24.33**
2	2-B	Channel-side Berm Toe	267.0	84.5	-0.10	NO														1.26	**NA**
2	2-C	Channel Toe	150.0	201.5	0.10	YES	1.57	0.00	1.57	4 - ML/CL Interbedded	105	20.5				20.5	0.08	42.6	0.68	1.00	**8.90**

NOTES

1. Cross Section at Station 55+00 was developed from 30 Percent Civil Design geometry.
2. Boring NL-8A was considered to develop the stratigraphy shown.
3. Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **55+00**
SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
DATE: JULY 2014

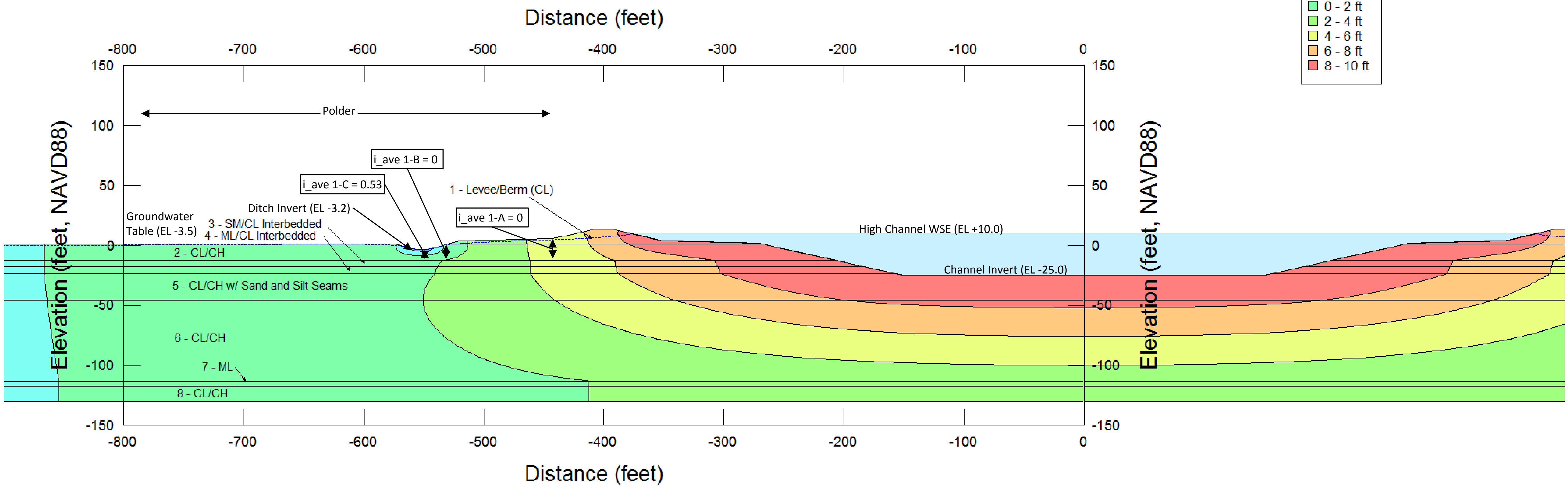
DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-3.1

Created By: Crosariol, Victor
Date: 11/26/2013
File Name: 01_Station 55+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH +1.0 to -12.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM/CL Interbedded -12.5 to -17.5 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
4 - ML/CL Interbedded -17.5 to -23.5 (Kv=5x10-6 cm/sec, Kv/Kh=0.20) Model: Saturated Only
5 - CL/CH w/Sand/Silt Seams -23.5 to -45.5 (Kv=6x10-7 cm/sec, Kv/Kh=0.20) Model: Saturated Only
6 - CL/CH -45.5 to -113.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - SM -113.0 to -117.3 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - CL/CH -117.3 to -130.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head
- -4 - -2 ft
- -2 - 0 ft
- 0 - 2 ft
- 2 - 4 ft
- 4 - 6 ft
- 6 - 8 ft
- 8 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **55+00**
SEEPAGE CASE: **1**
WSE In Channel: +**10 feet**
WSE Outside Channel: **-3.5 feet**

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION AND RESTORATION AUTHORITY CPRA

STATE OF LOUISIANA UNION JUSTICE CONFIDENCE

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-3.2

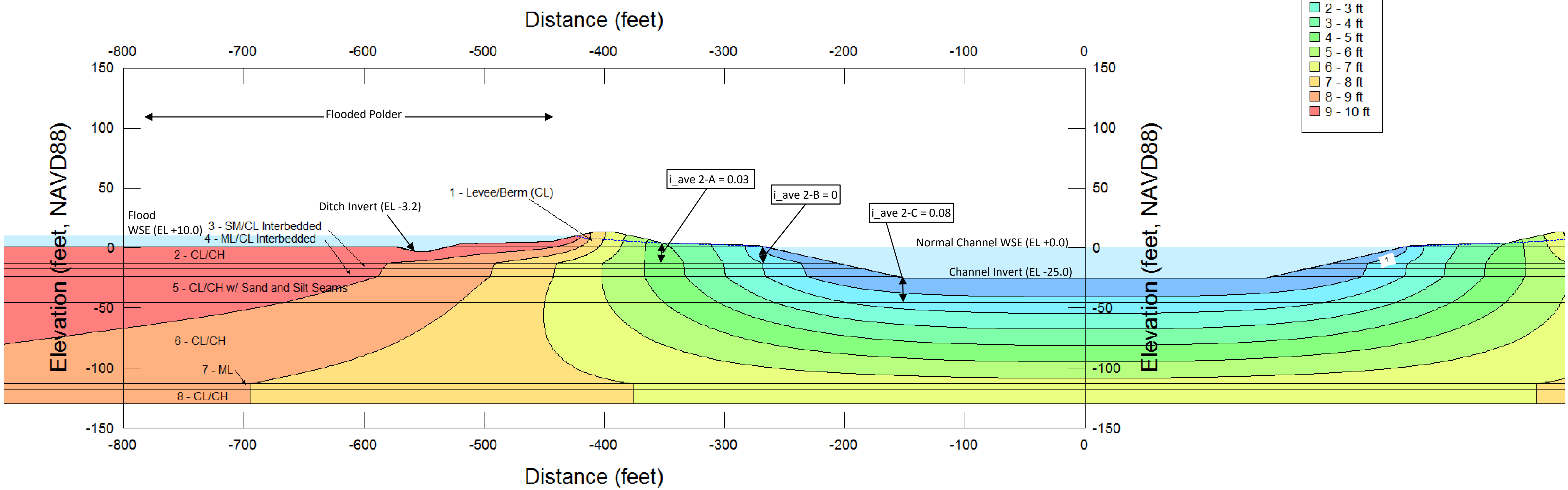
DRAWN BY:
DESIGNED BY:
APPROVED BY:

Created By: Crosariol, Victor
Date: 11/26/2013
File Name: 01_Station 55+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH +1.0 to -12.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM/CL Interbedded -12.5 to -17.5 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
4 - ML/CL Interbedded -17.5 to -23.5 (Kv=5x10-6 cm/sec, Kv/Kh=0.20) Model: Saturated Only
5 - CL/CH w/Sand/Silt Seams -23.5 to -45.5 (Kv=6x10-7 cm/sec, Kv/Kh=0.20) Model: Saturated Only
6 - CL/CH -45.5 to -113.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - SM -113.0 to -117.3 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - CL/CH -117.3 to -130.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head
- 0 - 1 ft
- 1 - 2 ft
- 2 - 3 ft
- 3 - 4 ft
- 4 - 5 ft
- 5 - 6 ft
- 6 - 7 ft
- 7 - 8 ft
- 8 - 9 ft
- 9 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS

STATION: **55+00**
SEEPAGE CASE: **2**
WSE In Channel: +**0.0 feet**
WSE Outside Channel: +**10.0 feet**

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-3.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	13.5	0.5	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	0.5	-11	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	105
3	-11	-20	SM/ML/CL Interbedded	See Note 1	0.1	5.0E-06	5.0E-05	1.4E-02	1.4E-01	Sat. Only	105
4	-20	-28	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105
5	-28	-50	SM/ML Interbedded	See Note 2	0.1	5.0E-06	5.0E-05	1.4E-02	1.4E-01	Sat. Only	110
6	-50	-103	CL/ML	Ass. 85	0.25	5.0E-06	2.0E-05	1.4E-02	5.7E-02	Sat. Only	110
7	-103	-128	ML/SM	Ass. 60	0.25	6.0E-05	2.4E-04	1.7E-01	6.8E-01	Sat. Only	120

Note 1 - Kv assumed to be halfway between plastic and non-plastic curves at 85 percent. Kh assumed to be 10 times greater to account for conductivity of the sandy materials.

Note 2 - Kv Assumed to be on non-plastic curve at 85 percent. Kh assumed to be 10 times greater.

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-3.5	Polder WSE From low water observations in PZ-15
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	-0.01	NO														1.60	**NA**
1	1-B	Polder-side Berm Toe	532.0	88.5	-0.12	NO														1.25	**NA**
1	1-C	Polder-side Ditch Toe	550.8	107.3	1.41	YES	1.75	-3.50	5.25	2 - CL/CH	105	6.8				6.8	0.77	42.6	0.68	1.17	**0.88**
2	2-A	Channel-side Levee Toe	351.5	0.0	0.12	YES	4.34	4.00	0.34	1 - Levee/Berm	120	3.5	2 - CL/CH	105	11.5	15.0	0.02	46.1	0.74	1.60	**32.79**
2	2-B	Channel-side Berm Toe	264.8	86.8	0.04	YES	2.06	0.50	1.56	2 - CL/CH	105	11.5				11.5	0.14	42.6	0.68	1.25	**5.04**
2	2-C	Channel Toe	150.0	201.5	1.37	YES	3.33	0.00	3.33	4- CL	105	3.0				3.0	1.11	42.6	0.68	1.00	**0.62**

NOTES

1. Cross Section at Station 67+00 was developed from 30 Percent Civil Design geometry.
2. CPT's NL-7C and NL-10C were considered to develop the stratigraphy shown.
3. Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS

STATION: **67+00**

SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY:

DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION

STATE PROJECT NUMBER: BA-153

FEDERAL PROJECT NUMBER: BA-153

APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT

DATE: JULY 2014

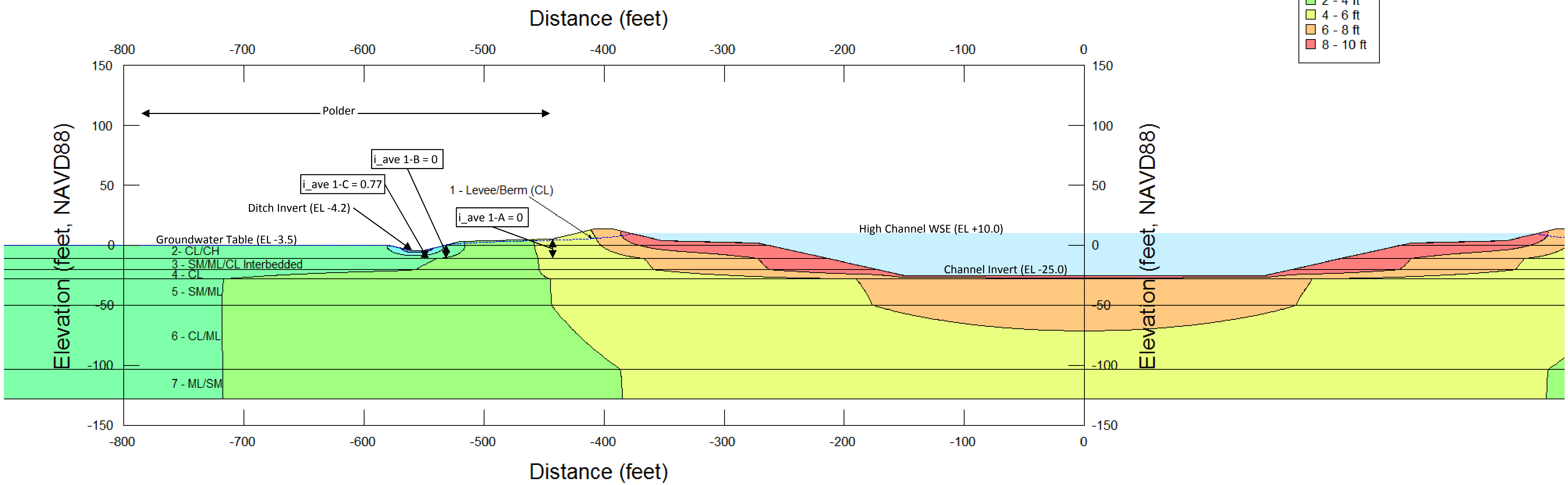
FIGURE: A-4.1

Created By: Crosariol, Victor
Date: 11/15/2013
File Name: 01_Station 67+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH +0.5 to -11.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM/ML/CL Interbedded -11.0 to -20.0 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
4 - CL -20.0 to -28.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SM/ML Interbedded -28.0 to -50.0 (Kv=5x10-5 cm/sec, Kv/Kh=0.10) Model: Saturated Only
6 - CL/ML -50.0 to -103.0 (Kv=5x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - ML/SM -103.0 to -128.0 (Kv=6x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head
- -4 - -2 ft
- -2 - 0 ft
- 0 - 2 ft
- 2 - 4 ft
- 4 - 6 ft
- 6 - 8 ft
- 8 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **67+00**
SEEPAGE CASE: **1**
WSE In Channel: **+10 feet**
WSE Outside Channel: **-3.5 feet**

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

CPRA

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

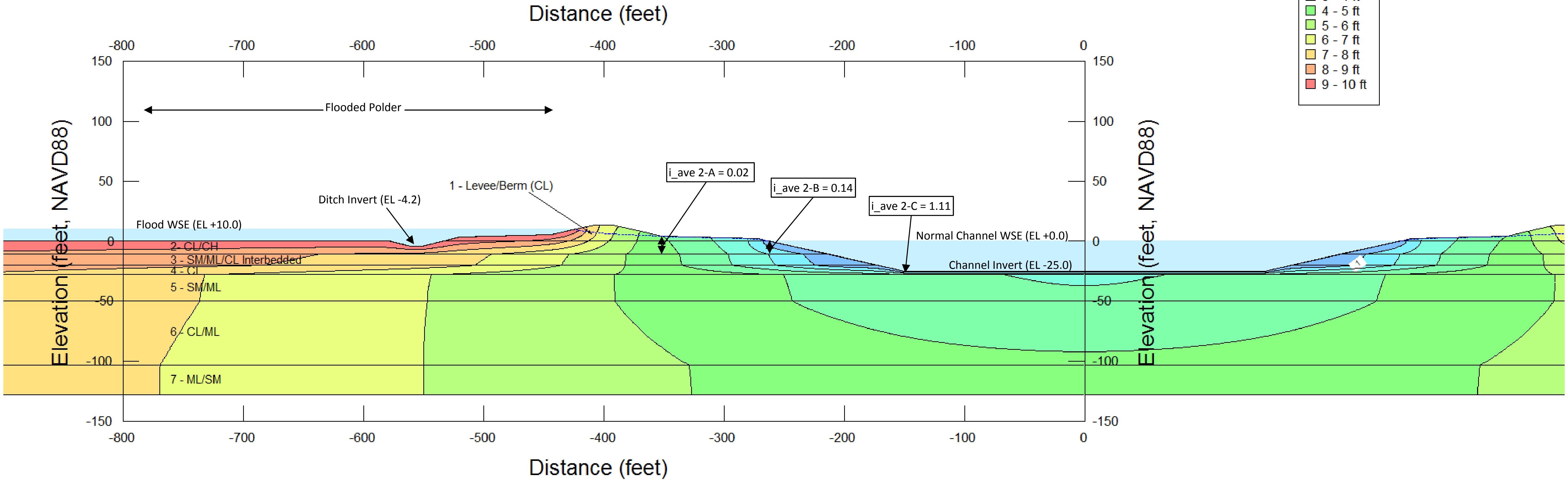
GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014

DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-4.2

Created By: Crosariol, Victor
Date: 11/15/2013
File Name: 01_Station 67+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: 0 ft)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH +0.5 to -11.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM/ML/CL Interbedded -11.0 to -20.0 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
4 - CL -20.0 to -28.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SM/ML Interbedded -28.0 to -50.0 (Kv=5x10-5 cm/sec, Kv/Kh=0.10) Model: Saturated Only
6 - CL/ML -50.0 to -103.0 (Kv=5x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - ML/SM -103.0 to -128.0 (Kv=6x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **67+00**
SEEPAGE CASE: **2**
WSE In Channel: +**0.0 feet**
WSE Outside Channel: +**10.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-4.3

DRAWN BY:
DESIGNED BY:
APPROVED BY:

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	13.5	0	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	0	-11	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	105
3	-11	-14.4	SM	Approx. 45	0.25	8.0E-05	3.2E-04	2.3E-01	9.1E-01	Sat. Only	105
4	-14.4	-19.2	SM/CH/ML Interbedded	See Note 1	0.1	5.0E-06	5.0E-05	1.4E-02	1.4E-01	Sat. Only	105
5	-19.2	-23.4	ML	Approx. 70	0.25	5.0E-05	2.0E-04	1.4E-01	5.7E-01	Sat. Only	105
6	-23.4	-24.4	SP	Ass. 5	0.25	1.0E-02	4.0E-02	2.8E+01	1.1E+02	Sat. Only	120
7	-24.4	-25.4	CH	Ass. 85	0.25	6.0E-07	2.4E-06	1.7E-03	6.8E-03	Sat. Only	110
8	-25.4	-28.9	SM	Approx. 25	0.25	3.0E-04	1.2E-03	8.5E-01	3.4E+00	Sat. Only	120
9	-28.9	-33.4	CL/ML/SM Interbedded	See Note 1	0.1	5.0E-06	5.0E-05	1.4E-02	1.4E-01	Sat. Only	105
10	-33.4	-35.4	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105
11	-35.4	-37.4	ML	Approx. 65	0.25	5.5E-05	2.2E-04	1.6E-01	6.2E-01	Sat. Only	115
12	-37.4	-40.7	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	115
13	-40.7	-47.8	SC	Ass. 30	0.25	9.0E-06	3.6E-05	2.6E-02	1.0E-01	Sat. Only	125
14	-47.8	-131.4	CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105

Note 1 - Kv assumed to be halfway between plastic and non-plastic curves at 85 percent. Kh assumed to be 10 times greater to account for conductivity of the sandy materials

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-4.3	Polder WSE From low water observations in PZ-14 and PZ-15
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	0.29	YES	6.76	5.50	1.26	1 - Levee/Berm	120	5.5	2 - CL/CH	105	11.0	16.5	0.08	47.6	0.76	1.60	**10.01**
1	1-B	Polder-side Berm Toe	534.0	90.5	0.27	YES	5.46	0.00	5.46	2 - CL/CH	105	11.0				11.0	0.50	42.6	0.68	1.24	**1.38**
1	1-C	Polder-side Ditch Toe	555.6	112.1	2.47	YES	5.11	-4.30	9.41	2 - CL/CH	105	5.6				5.6	1.68	42.6	0.68	1.15	**0.41**
2	2-A	Channel-side Levee Toe	351.5	0.0	-0.01	NO														1.60	**NA**
2	2-B	Channel-side Berm Toe	271.5	80.0	-0.02	NO														1.28	**NA**
2	2-C	Channel Toe	150.0	201.5	0.77	YES	0.29	0.00	0.29	7 - CH	110	0.4				0.4	0.73	47.6	0.76	1.00	**1.04**

NOTES

1 Cross Section at Station 82+00 was developed from 30 Percent Civil Design geometry.
2 Boring NL-6A was considered to develop the stratigraphy shown.
3 Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4 Model extends 1600 feet landward of approximate Channel centerline.
5 Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6 Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7 Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **82+00**
SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY:
DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

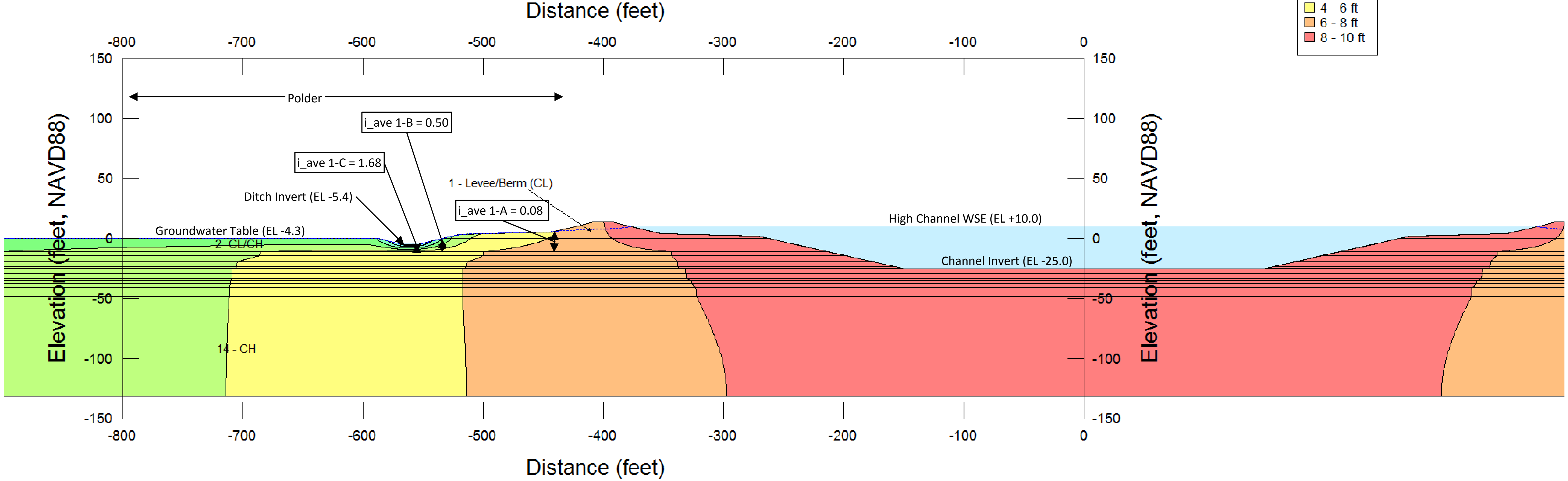
GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-5.1

Created By: Crosariol, Victor
Date: 11/14/2013
File Name: 01_Station 82+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH 0.0 to -11.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM -11.0 to -14.4 (Kv=8x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - SM/CH/ML Interbedded -14.4 to -19.2 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
5 - ML -19.2 to -23.4 (Kv=5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP -23.4 to -24.4 (Kv=1x10-2 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH -24.4 to -25.4 (Kv=6x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - SM -25.4 to -28.9 (Kv=3x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
9 - CL/ML/SM Interbedded -28.9 to -33.4 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
10 - CL -33.4 to -35.4 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
11 - ML -35.4 to -37.4 (Kv=5.5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
12 - CL -37.4 to -40.7 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
13 - SC -40.7 to -47.8 (Kv=9x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
14 - CH -47.8 to -131.4 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head
- -6 - -4 ft
- -4 - -2 ft
- -2 - 0 ft
- 0 - 2 ft
- 2 - 4 ft
- 4 - 6 ft
- 6 - 8 ft
- 8 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **82+00**
SEEPAGE CASE: **1**
WSE In Channel: **+10 feet**
WSE Outside Channel: **-4.3 feet**

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION AND RESTORATION AUTHORITY — CPRA
STATE OF LOUISIANA — UNION JUSTICE CONFIDENCE

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY:
DESIGNED BY:

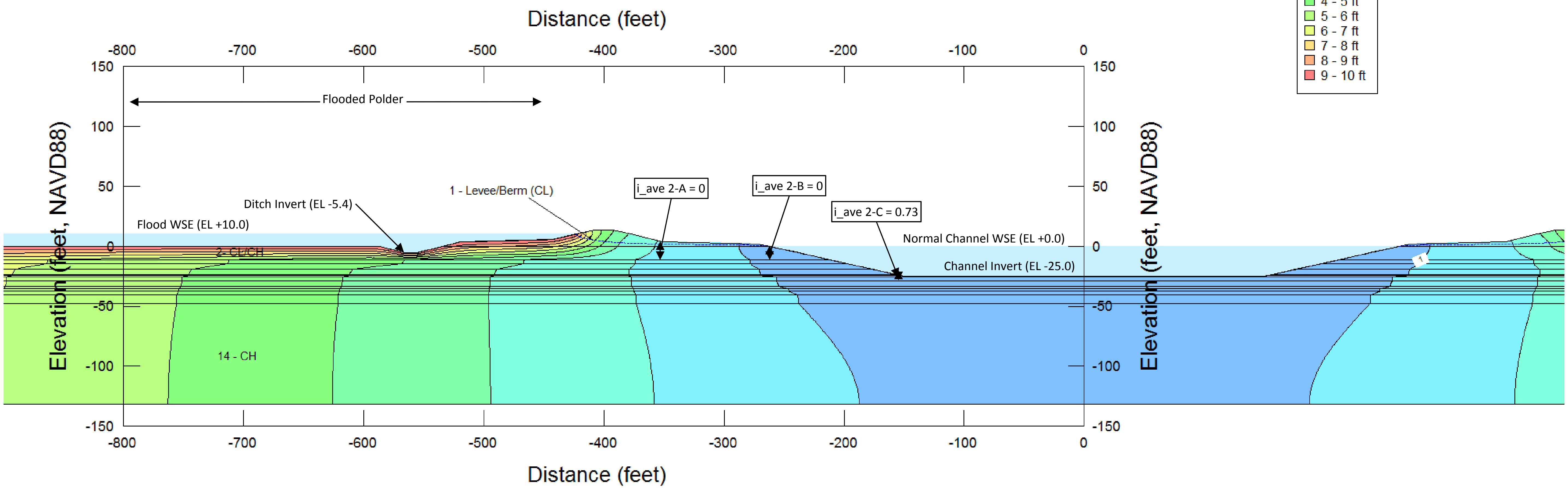
MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-5.2

Created By: Crosariol, Victor
Date: 11/14/2013
File Name: 01_Station 82+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: 0 ft)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
2 - CL/CH 0.0 to -11.0 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay (Kv=5x10-7) Vol. WC. Function: Clay
3 - SM -11.0 to -14.4 (Kv=8x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - SM/CH/ML Interbedded -14.4 to -19.2 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
5 - ML -19.2 to -23.4 (Kv=5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - SP -23.4 to -24.4 (Kv=1x10-2 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - CH -24.4 to -25.4 (Kv=6x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
8 - SM -25.4 to -28.9 (Kv=3x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
9 - CL/ML/SM Interbedded -28.9 to -33.4 (Kv=5x10-6 cm/sec, Kv/Kh=0.10) Model: Saturated Only
10 - CL -33.4 to -35.4 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
11 - ML -35.4 to -37.4 (Kv=5.5x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
12 - CL -37.4 to -40.7 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
13 - SC -40.7 to -47.8 (Kv=9x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
14 - CH -47.8 to -131.4 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **82+00**
SEEPAGE CASE: **2**
WSE In Channel: +**0.0 feet**
WSE Outside Channel: +**10.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014

DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-5.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	14	-2	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	-2	-31.5	CH/OH/CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	100
3	-31.5	-38	ML	Ass. 85	0.25	4.0E-05	1.6E-04	1.1E-01	4.5E-01	Sat. Only	105
4	-38	-108	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105
5	-108	-113	SP/SM	Ass. 12	0.25	1.0E-03	4.0E-03	2.8E+00	1.1E+01	Sat. Only	120
6	-113	-126	CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	110
7	-126	-135	SM	Ass. 30	0.25	2.0E-04	8.0E-04	5.7E-01	2.3E+00	Sat. Only	120

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-4.8	Polder WSE From low water observations in PZ-14 and PZ-15
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	-0.02	NO														1.60	**NA**
1	1-B	Polder-side Berm Toe	540.0	96.5	-0.12	NO														1.21	**NA**
1	1-C	Polder-side Ditch Toe	558.0	114.5	0.61	YES	0.23	-4.80	5.03	2 - CH/OH/CL	100	25.5				25.5	0.20	37.6	0.60	1.14	**3.05**
2	2-A	Channel-side Levee Toe	351.5	0.0	0.31	YES	5.38	4.00	1.38	1 - Levee/Berm	120	5.5	2 - CH/OH/CL	100	30.0	35.5	0.04	40.7	0.65	1.60	**16.84**
2	2-B	Channel-side Berm Toe	255.8	95.8	0.20	YES	3.79	0.00	3.79	2 - CH/OH/CL	100	30.0				30.0	0.13	37.6	0.60	1.22	**4.77**
2	2-C	Channel Toe	150.0	201.5	0.45	YES	2.25	0.00	2.25	2 - CH/OH/CL	100	6.5				6.5	0.35	37.6	0.60	1.00	**1.74**

NOTES

1. Cross Section at Station 90+00 was developed from 30 Percent Civil Design geometry.
2. Borings NL-5C and NL-11C were considered to develop the stratigraphy shown.
3. Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS

STATION: **90+00**

SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION AND RESTORATION AUTHORITY · CPRA · STATE OF LOUISIANA · UNION JUSTICE CONFIDENCE

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

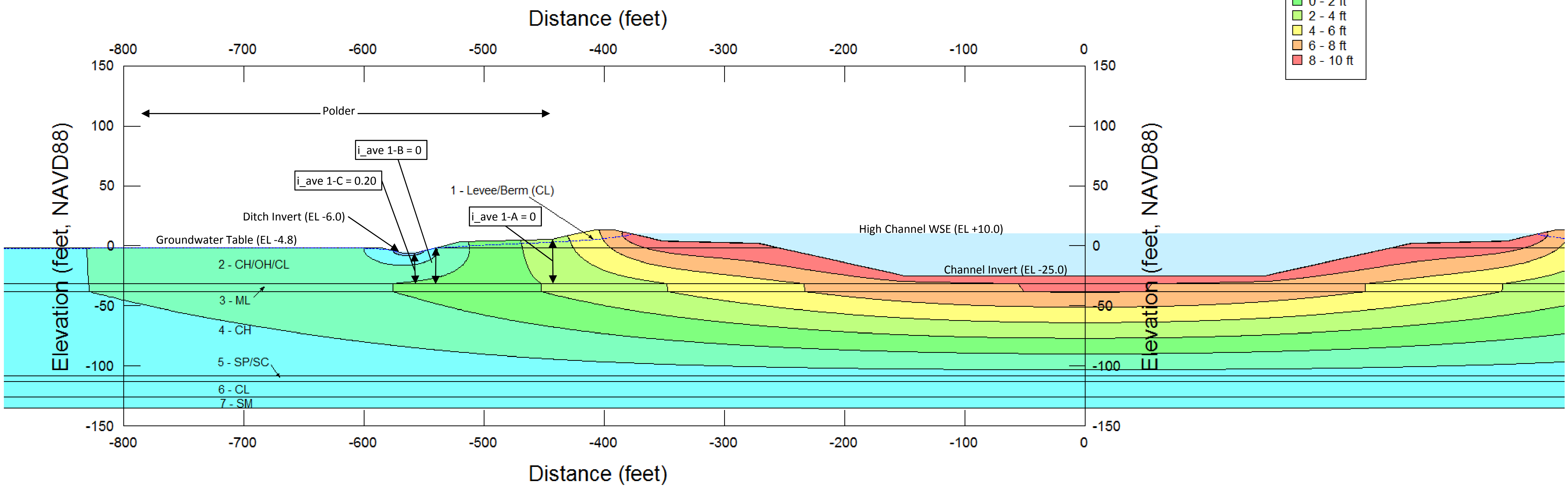
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
DATE: JULY 2014

DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-6.1

Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 90+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH/CL -1.5 to -31.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - ML -31.5 to -38 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CL/CH -38 to -108 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SP/SM -108 to -112.5 (Kv=1x10-3 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - CL -112.5 to -126 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - SM -126 to -135 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **90+00**
SEEPAGE CASE: **1**
WSE In Channel: +**10 feet**
WSE Outside Channel: **-4.8 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153

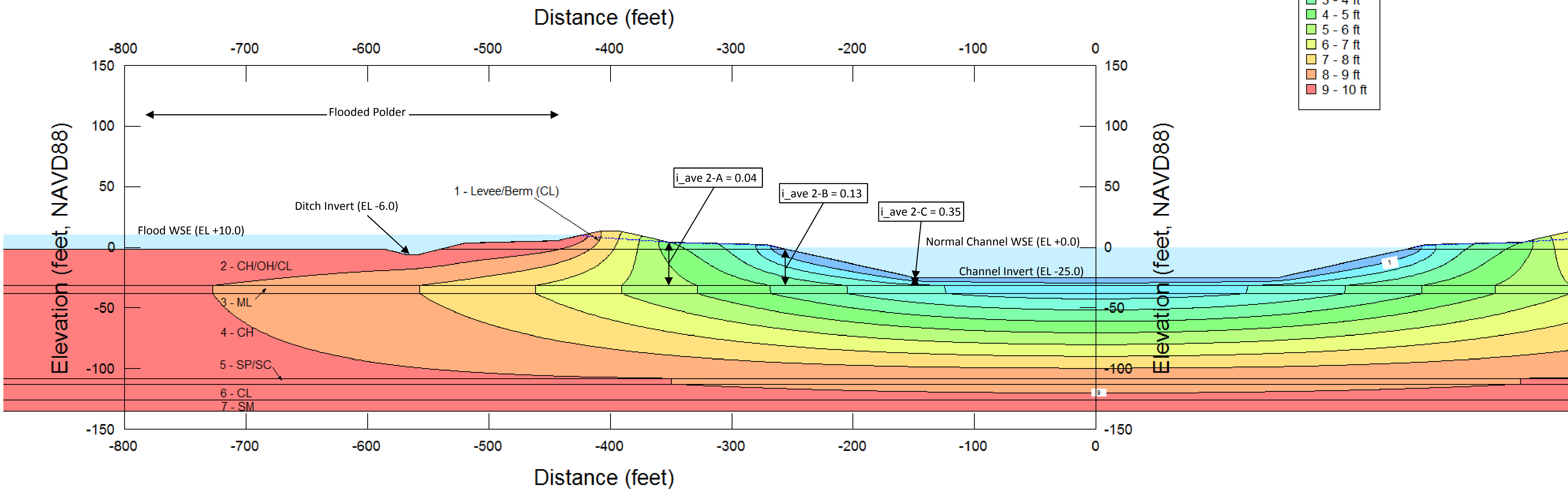
GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-6.2

DRAWN BY:
DESIGNED BY:
APPROVED BY:

Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 90+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: 0 ft)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH/CL -1.5 to -31.5 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - ML -31.5 to -38 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CL/CH -38 to -108 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SP/SM -108 to -112.5 (Kv=1x10-3 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - CL -112.5 to -126 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - SM -126 to -135 (Kv=2x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **90+00**
SEEPAGE CASE: **2**
WSE In Channel: +**0.0 feet**
WSE Outside Channel: +**10.0 feet**

30 PERCENT DESIGN

HDR

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: | DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-6.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	13.5	-3.5	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.42E-03	5.7E-03	Clay	120
2	-3.5	-22	CH/OH/CL	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	100
3	-22	-26	CL/ML	Ass. 85	0.25	5.0E-06	2.0E-05	1.4E-02	5.7E-02	Sat. Only	110
4	-26	-116	CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	100
5	-116	-120	SP/SC	See Note 1	0.25	5.0E-04	2.0E-03	1.4E+00	5.7E+00	Sat. Only	120
6	-120	-135	CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	100

Note 1 - Kv assumed to be halfway between plastic and non-plastic curves at 12 percent.

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-6.1	Polder WSE From low water observations in PZ-13 and PZ-14
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	-0.03	NO														1.60	**NA**
1	1-B	Polder-side Berm Toe	548.0	104.5	-0.09	NO														1.18	**NA**
1	1-C	Polder-side Ditch Toe	564.4	120.9	0.57	YES	-2.91	-6.10	3.19	2 - CH/OH?CL	100	14.4				14.4	0.22	37.6	0.60	1.12	**2.72**
2	2-A	Channel-side Levee Toe	351.5	0.0	0.35	YES	5.37	4.00	1.37	1 - Levee/Berm	120	7.5	2 - CH/OH/CL	100	18.5	26.0	0.05	43.4	0.70	1.60	**13.17**
2	2-B	Channel-side Berm Toe	246.8	104.8	0.14	YES	2.08	0.00	2.08	2 - CH/OH/CL	100	18.5				18.5	0.11	37.6	0.60	1.18	**5.35**
2	2-C	Channel Toe	150.0	201.5	0.02	YES	0.02	0.00	0.02	3 - CL/ML	100	1.0				1.0	0.02	37.6	0.60	1.00	**40.17**

NOTES

1. Cross Section at Station 110+00 was developed from 30 Percent Civil Design geometry.
2. Boring NL-3A and CPT NL-3C were considered to develop the stratigraphy shown.
3. Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **110+00**
SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153

FEDERAL PROJECT NUMBER: BA-153

DATE: JULY 2014

DRAWN BY:

DESIGNED BY:

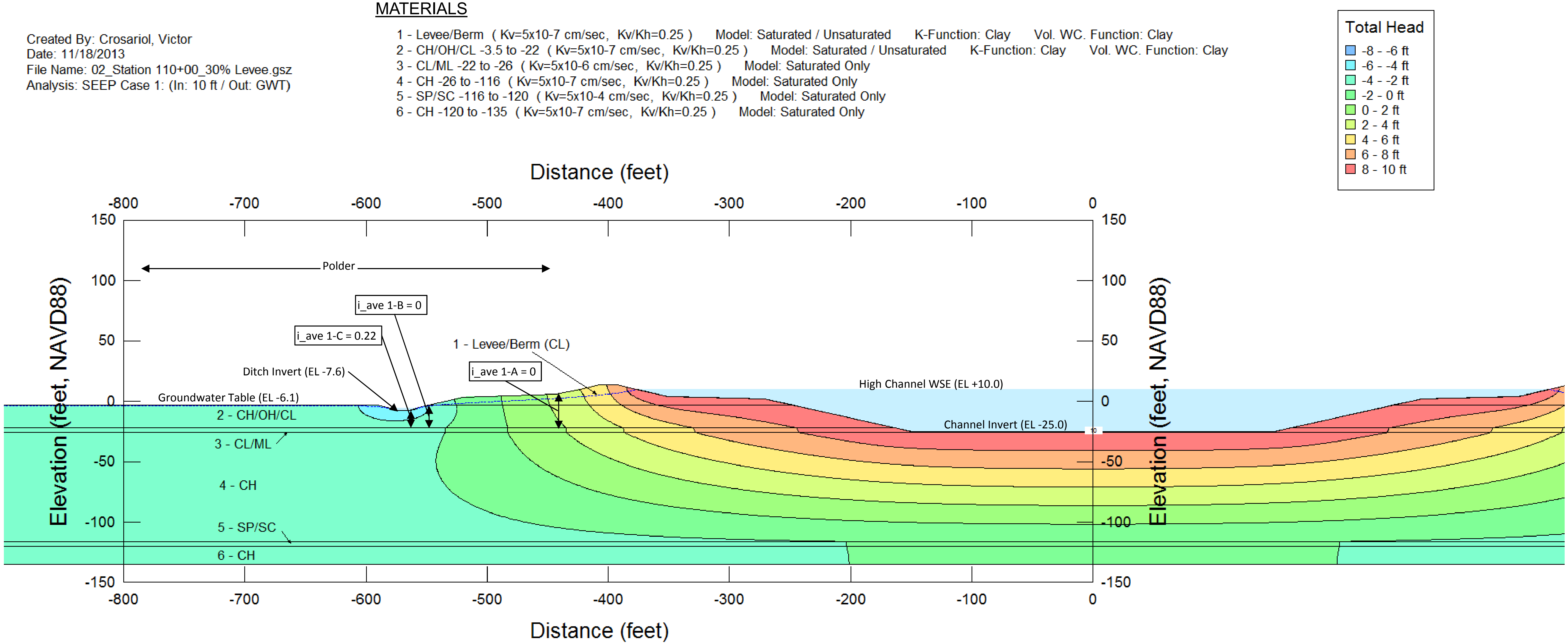
APPROVED BY:

FIGURE: A-7.1

Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 110+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH/CL -3.5 to -22 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL/ML -22 to -26 (Kv=5x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CH -26 to -116 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SP/SC -116 to -120 (Kv=5x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - CH -120 to -135 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **110+00**
SEEPAGE CASE: **1**
WSE In Channel: **+10 feet**
WSE Outside Channel: **-6.1 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

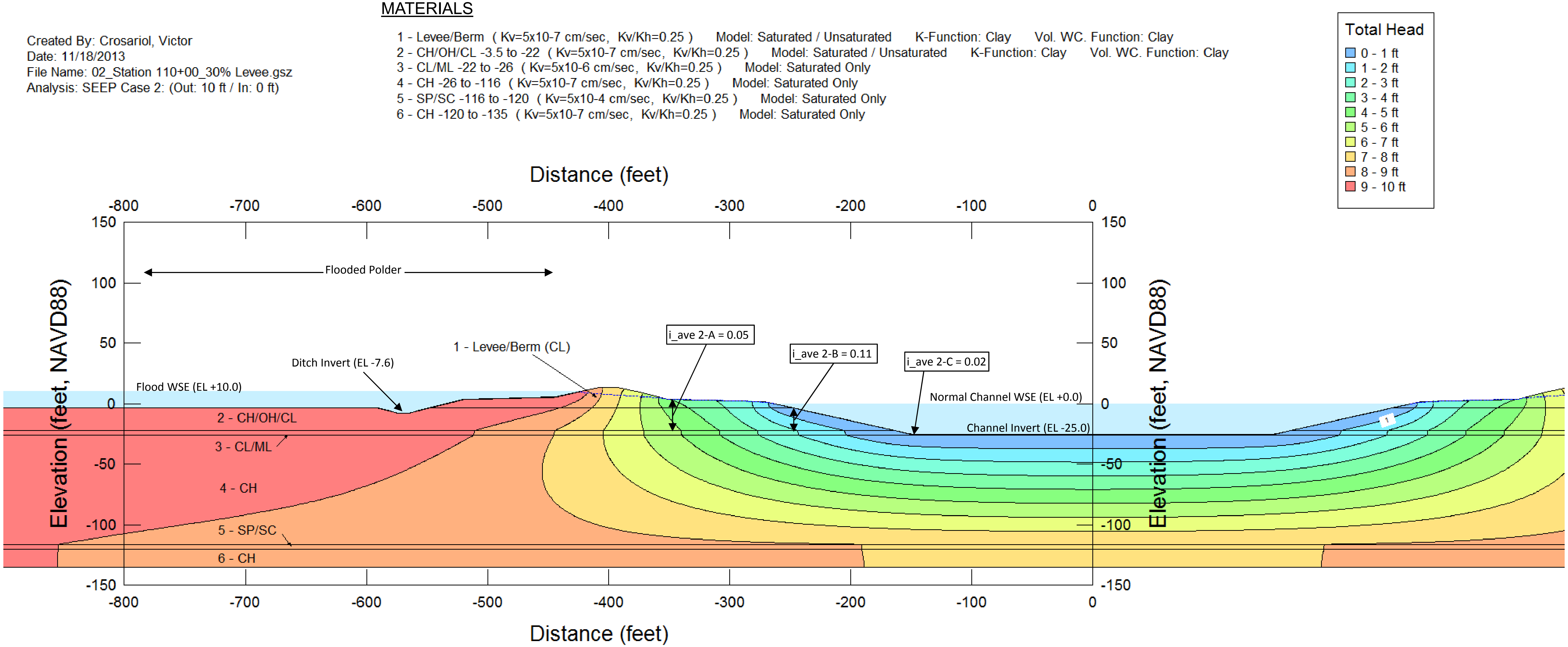
GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
DATE: JULY 2014
DRAWN BY:
DESIGNED BY:
APPROVED BY:
FIGURE: A-7.2

Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 110+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: 0 ft)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH/CL -3.5 to -22 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - CL/ML -22 to -26 (Kv=5x10-6 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CH -26 to -116 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - SP/SC -116 to -120 (Kv=5x10-4 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - CH -120 to -135 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS

STATION: **110+00**

SEEPAGE CASE: **2**

WSE In Channel: +**0.0 feet**

WSE Outside Channel: +**10.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153

FEDERAL PROJECT NUMBER: BA-153

DATE: JULY 2014

DRAWN BY:

DESIGNED BY:

APPROVED BY:

FIGURE: A-7.3

SEEPAGE ANALYSIS PARAMETERS

Layers					Steady-State Seepage						
Layer	Top Elevation (ft)	Bottom Elevation (ft)	Soil Type	%Fines	kv/kh	Kv (cm/sec)	Kh (cm/sec)	Kv (ft/day)	Kh (ft/day)	K-Function	Total Unit Weight (pcf)
1	13.5	-4.5	Levee/Berm	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	120
2	-4.5	-27	CH/OH	Ass.85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Clay	100
3	-27	-33	ML	Ass. 85	0.25	4.0E-05	1.6E-04	1.1E-01	4.5E-01	Sat. Only	105
4	-33	-85	CL/CH	Ass. 85	0.25	5.0E-07	2.0E-06	1.4E-03	5.7E-03	Sat. Only	105
5	-85	-110	ML	Ass. 85	0.25	4.0E-05	1.6E-04	1.1E-01	4.5E-01	Sat. Only	105
6	-110	-120	ML/SM/SP	Ass. 60	0.25	6.0E-05	2.4E-04	1.7E-01	6.8E-01	Sat. Only	120
7	-120	-135	ML	Ass. 85	0.25	4.0E-05	1.6E-04	1.1E-01	4.5E-01	Sat. Only	105

SEEPAGE ANALYSIS CASES

Seepage Case	Flow Regime	Water Surface Elevations (WSE) (feet)		Remarks
		Channel	Polder	
1	Steady-State	10	-6.8	Polder WSE From low water observations in PZ-13
2	Steady-State	0	10	

SEEPAGE GRADIENT CALCULATIONS

Seepage Case	Gradient Designation	Gradient Location	Distance From Channel Center (feet)	Distance From Levee Toe (feet)	Local Exit Gradient	Calculate Average Exit Gradient?	Total Head (Bottom) (feet)	Total Head (Top) (feet)	Total Head Change (feet)	Composite Layer 1	Total Unit Weight (pcf)	Thickness (feet)	Composite Layer 2	Total Unit Weight (pcf)	Thickness (feet)	Total Blanket Thickness (feet)	Average Vert. Exit Gradient (i_ave)	Bouyant Unit weight (pcf)	Critical Gradient	**Req. FOS**	**Calc. FOS**
1	1-A	Polder-side Levee Toe	443.5	0.0	-0.02	NO														1.60	**NA**
1	1-B	Polder-side Berm Toe	552.0	108.5	-0.05	NO														1.17	**NA**
1	1-C	Polder-side Ditch Toe	570.8	127.3	0.66	YES	-1.28	-6.80	5.52	2 - CH/OH	100	17.8				17.8	0.31	37.6	0.60	1.09	**1.94**
2	2-A	Channel-side Levee Toe	351.5	0.0	0.28	YES	4.90	4.00	0.90	1 - Levee/Berm	120	8.5	2 - CH/OH	100	22.5	31.0	0.03	43.1	0.69	1.60	**23.76**
2	2-B	Channel-side Berm Toe	242.5	109.0	0.15	YES	2.81	0.00	2.81	2 - CH/OH	100	22.5				22.5	0.12	37.6	0.60	1.16	**4.83**
2	2-C	Channel Toe	150.0	201.5	0.66	YES	1.16	0.00	1.16	2 - CH/OH	100	2.0				2.0	0.58	37.6	0.60	1.00	**1.04**

NOTES

1. Cross Section at Station 130+00 was developed from 30 Percent Civil Design geometry.
2. CPT NL-1C was considered to develop the stratigraphy shown.
3. Model is symmetric with respect to channel centerline, therefore results are equal on each side of the model.
4. Model extends 1600 feet landward of approximate Channel centerline.
5. Constant head conditions are applied at the horizontal extents of the model as low groundwater table (GWT) elevation for Seepage Case 1 or the Flood Water Surface Elevation (WSE) for Seepage Case 2.
6. Kv/Kh is the anisotropy ratio of vertical to horizontal hydraulic conductivity.
7. Average Vertical Exit Gradients (i_ave) are presented on the following seepage figures at the appropriate locations.

NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS

STATION: **130+00**

SEEPAGE PARAMETERS AND RESULTS

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

MID-BARATARIA SEDIMENT DIVERSION

GEOTECHNICAL ENGINEERING REPORT

STATE PROJECT NUMBER: BA-153

FEDERAL PROJECT NUMBER: BA-153

DATE: JULY 2014

DRAWN BY:

DESIGNED BY:

APPROVED BY:

FIGURE: A-8.1

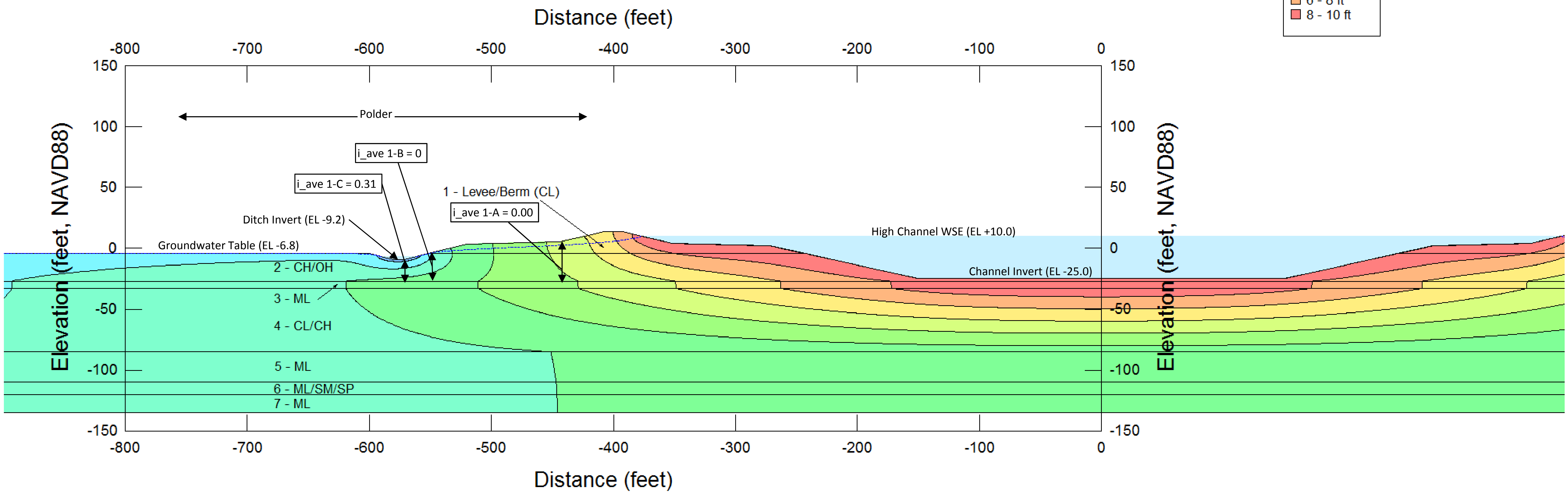
Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 130+00_30% Levee.gsz
Analysis: SEEP Case 1: (In: 10 ft / Out: GWT)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH -4.5 to -27 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - ML -27 to -33 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CL/CH -33 to -85 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - ML -85 to -110 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - ML/SM/SP -110 to -120 (Kv=6x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - ML -120 to -135 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head

- -8 - -6 ft
- -6 - -4 ft
- -4 - -2 ft
- -2 - 0 ft
- 0 - 2 ft
- 2 - 4 ft
- 4 - 6 ft
- 6 - 8 ft
- 8 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **130+00**
SEEPAGE CASE: **1**
WSE In Channel: +**10 feet**
WSE Outside Channel: **-6.8 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

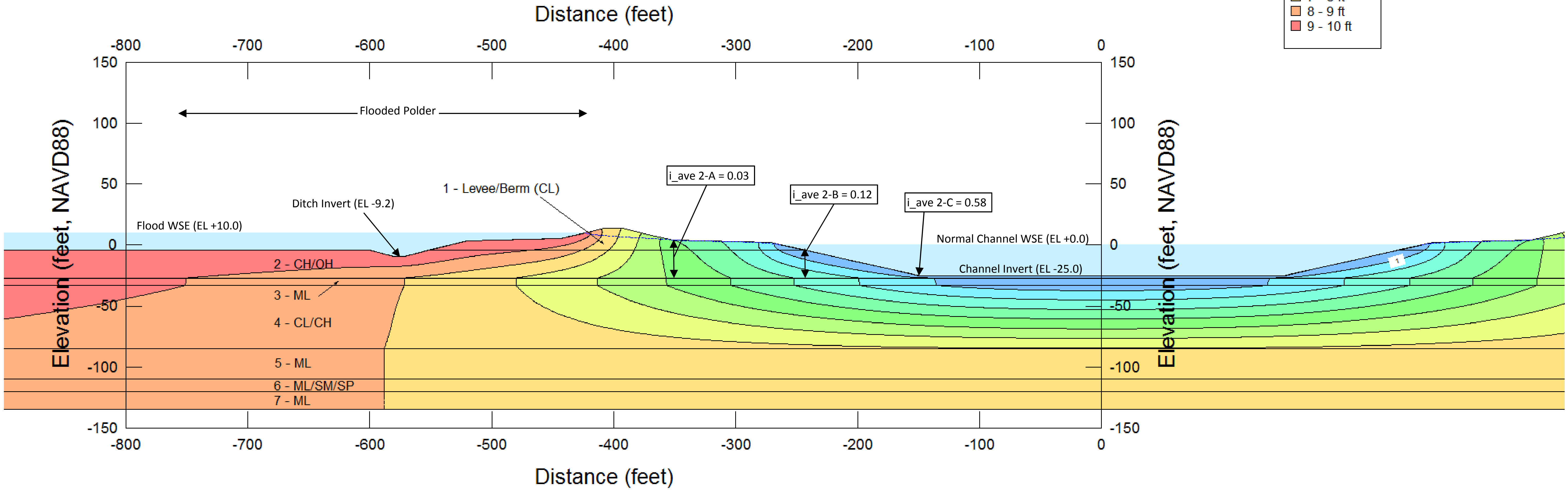
DRAWN BY:	DESIGNED BY:	MID-BARATARIA SEDIMENT DIVERSION	GEOTECHNICAL ENGINEERING REPORT
		STATE PROJECT NUMBER: BA-153	
		FEDERAL PROJECT NUMBER: BA-153	DATE: JULY 2014
		APPROVED BY:	FIGURE: A-8.2

Created By: Crosariol, Victor
Date: 11/18/2013
File Name: 02_Station 130+00_30% Levee.gsz
Analysis: SEEP Case 2: (Out: 10 ft / In: 0 ft)

MATERIALS

1 - Levee/Berm (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
2 - CH/OH -4.5 to -27 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated / Unsaturated K-Function: Clay Vol. WC. Function: Clay
3 - ML -27 to -33 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
4 - CL/CH -33 to -85 (Kv=5x10-7 cm/sec, Kv/Kh=0.25) Model: Saturated Only
5 - ML -85 to -110 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
6 - ML/SM/SP -110 to -120 (Kv=6x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only
7 - ML -120 to -135 (Kv=4x10-5 cm/sec, Kv/Kh=0.25) Model: Saturated Only

Total Head
- 0 - 1 ft
- 1 - 2 ft
- 2 - 3 ft
- 3 - 4 ft
- 4 - 5 ft
- 5 - 6 ft
- 6 - 7 ft
- 7 - 8 ft
- 8 - 9 ft
- 9 - 10 ft



NOT TO SCALE

STEADY-STATE SEEPAGE ANALYSIS
STATION: **130+00**
SEEPAGE CASE: **2**
WSE In Channel: **+0.0 feet**
WSE Outside Channel: **+10.0 feet**

30 PERCENT DESIGN

REV.	DATE	DESCRIPTION	BY

COASTAL PROTECTION & RESTORATION AUTHORITY
ENGINEERING DIVISION
450 LAUREL STREET
BATON ROUGE, LOUISIANA 70801

DRAWN BY: DESIGNED BY:

MID-BARATARIA SEDIMENT DIVERSION
STATE PROJECT NUMBER: BA-153
FEDERAL PROJECT NUMBER: BA-153
APPROVED BY:

GEOTECHNICAL ENGINEERING REPORT
DATE: JULY 2014
FIGURE: A-8.3