Attachment D-10:
Peer Review Comments

March 9, 2016

Plans and Specifications
Quality Control (QC) of Design Calculations

FMM Inlet Control Structure
St. Paul District
Fargo, North Dakota

The purpose of this sheet is to serve as the official QC sign off sheet for design calculations in electronic format. This sheet will be included in the front of the applicable calculation set. Signatures on this sheet certify that the described calculations were designed by and checked by the listed individuals.

Design Calculations File Location:

> **The design calculation for review are located in the following folder:**
> **\\mvd\mvp\PROJECTS\SA\SA_Fargo_Moorhead_Metro(PED)-370365\5_COE_Elements\Diversion_Inlet\03-Geotech\Peer_Review_of_Inlet_Structure_Documents**

Design Calculations Description:

A coupled seepage and slope stability Geostudio models were utilized to analyze the stability of the dam embankment, excavated material berms (EMB), and the levee embankment. The models were used to determine the required embankment and channel slopes. In addition, a Geostuido stability model was used to determine the potential for unbalanced loads on the piling for the T-wall.

Structural pile capacities were calculated for the Inlet Control Structure. The pile design methodology used for the Diversion Inlet Structure project is documented in the overall General FMM Project Geotech and Geology Appendix (Attachment 12 – Pile Load Test and Design Method) which was based on the pile load tests that was completed adjacent to the Red River. Given that there will be different pile lengths due to the sloped floodwall; a pile capacity vs. length of pile was created for the Inlet Structure to be used as design.

The upstream and downstream channel of the control structure was analyzed for the potential of rebound. Rebound calculations were completed using a excel spreadsheet to calculate 1-D expansion with the slope of the recompression index.

Purpose for Sign-off Sheet: This sheet was developed because there were multiple iterations for the design. The sign-offs for the excel spreadsheets, SLOPE/W and SEEP/W were done to document that these are the people who checked the actual calculations.

GeoStudio Model –SEEP/W & SLOPE/W Analysis for Downstream EMB, Levee, and Channel Slope (FMM_Inlet_Stability_Downstream_888.5_932_5.gsz)
GeoStudio Model –SEEP/W & SLOPE/W Analysis for Upstream EMB, Dam, and Channel Slope (FMM_Inlet_Stability_Upstream_Channel_899.2.gsz)
GeoStudio Model –SEEP/W & SLOPE/W Analysis for Tie-back Embankment Dam (FMM_Inlet_Stability_Tie-Back_Dam_899.2.gsz)
GeoStudio Model –SLOPE/W Analysis for Unbalanced Load on T-wall Piles at No Tailwater (FMM_Inlet_Stability_T-Wall_UBAL_Piezoline_50ft_Bench_Pool_922_No_TW.gsz)
GeoStudio Model –SLOPE/W Analysis for Unbalanced Load on T-wall Piles at Tailwater at 910 (FMM_Inlet_Stability_T-Wall_UBAL_Piezoline_50ft_Bench_Pool_926_TW_910.gsz)

Excel Spreadsheet – Upstream and Downstream Rebound (FMM_Inlet_Structure_Rebound_Calc_Spreadsheet.xlsx)
Excel Spreadsheet – Pile Capacities for Tip El. 880 (FMM_Inlet_Pile_Capacity_20150309_EL_880.xlsx)
Excel Spreadsheet – Pile Capacities for Tip El. 893 (FMM_Inlet_Pile_Capacity_20150309_EL_893.xlsx)
Excel Spreadsheet – Pile Capacities for Tip El. 902 (FMM_Inlet_Pile_Capacity_20150309_EL_902.xlsx)
Excel Spreadsheet – Pile Capacities for Tip El. 909 (FMM_Inlet_Pile_Capacity_20150309_EL_909.xlsx)
Excel Spreadsheet – Pile Capacities for Tip El. 913 (FMM_Inlet_Pile_Capacity_20150309_EL_913.xlsx)

Apile – 14x73 Pile Capacity Analysis for Tip El. 880 (FM_Inlet_Long_HP14x73_20150313_880.cpt)
Apile – 14x73 Pile Capacity Analysis for Tip El. 893 (FM_Inlet_Long_HP14x73_20150313_893.cpt)
Apile – 14x73 Pile Capacity Analysis for Tip El. 902 (FM_Inlet_Long_HP14x73_20150313_902.cpt)
Apile – 14x73 Pile Capacity Analysis for Tip El. 909 (FM_Inlet_Long_HP14x73_20150313_909.cpt)
Apile – 14x73 Pile Capacity Analysis for Tip El. 913 (FM_Inlet_Long_HP14x73_20150313_913.cpt)

This sign-off is for the person who checked the stability analyses, rebound analyses, and parameters for the design of the control structure for the FMM Diversion Inlet Structure. The reviewer checked the following:

Spreadsheet Rebound Computations

- Verify geologic stratigraphy, embankment geometry, soil unit weights, compressibility parameters (OCR, Cc, Cr, eo)

Spreadsheet Computations for Pile Capacities

- Verify pile capacities follow the outlined procedure in Attachment 12 of the General Geotech and Geology Report.

- Verify geologic stratigraphy, material properties, inputting the output for A-pile, and calculations for pile capacities.
- Verify inputs into the A-pile models are correct.

Slope Stability

- Verify inputs including: unit weights, material shear strengths (drained and undrained) accuracy of boundary conditions, soil stratigraphy, and pore water conditions. Verify outputs including: convergence of analyses, slip surface extents and shape, optimized critical slip surface is realistic, and appropriate tension crack line for undrained conditions (no tension in slices).

Review comments were provided to Mr. Schmidt in files:

1. FMM_Inlet_Structure_PeerReview_Pile_Capacity.docx
2. FMM_Inlet_Structure_PeerReview_Rebound.docx
3. FMM_Inlet_Structure_PeerReview_Stability_Models.docx
4. FMM_Inlet_Structure_PeerReview_Unbalanced_Loads.docx

Designed By: Luke Schmidt, PE
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Checked By: Jason Foss, PE
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US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Pile_Capacity_LLS_Responses_JRF20160309.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Pile Capacity		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

Folder: " Pile_Loads_&_Capacity"

Subfolder: Capacities-APile_Inlet

- FM_Inlet_Long_HP14x73_20150313_880.cpt
- FM_Inlet_Long_HP14x73_20150313_893.cpt
- FM_Inlet_Long_HP14x73_20150313_EL_902.cpt
- FM_Inlet_Long_HP14x73_20150313_EL_909.cpt
- FM_Inlet_Long_HP14x73_20150313_EL_913.cpt

- File 880.cpt shows Bottom of Layer 4 at 50 feet. Spreadsheet calculation shows this layer having a bottom elevation of 835, thus 880-835 = 45 feet. Double check this input value.
  This was done due to A-pile calculations requiring the bottom layer to go beyond the pile tip. Having the pile and the stratigraphy at the same elevation was causing the program to not complete the calculations. Therefore, the bottom layer was extend another 5-10ft down. This extension doesn't affect the calculations or comparison between the two methods it was only required to have a soil formation below the bottom of the pile.
- File 893.cpt shows Bottom of Layer 4 at 65 feet. Spreadsheet calculation shows this layer having a bottom elevation of 835, thus 893-835 = 58 feet. Double check this input value.
  Same reason as above.
- File 902.cpt shows Bottom of Layer 5 at 75 feet. Spreadsheet calculation shows this layer having a bottom elevation of 835, thus 902-835 = 67 feet. Double check this input value.
  Same reason as above.
- File 909.cpt shows Bottom of Layer 6 at 80 feet. Spreadsheet calculation shows this layer having a bottom elevation of 835, thus 909-835 = 74 feet. Double check this input value.
  Same reason as above.
- File 909.cpt shows Bottom of Layer 2 as 13 feet. This is assigned with Sherack Formation Parameters; however, the calculated thickness of the Sherack in the spreadsheet is 16 feet. Double check this input value.
  The Sherack formation was inputted for some reason as two layers instead of one. With both layers adding up to a thickness of 17ft. The layer input was revised to delete one of the Sherack layers and change to the correct thickness of 16ft.
- File 913.cpt shows Bottom of Layer 6 at 85 feet. Spreadsheet calculation shows this layer having a bottom elevation of 835, thus 913-835 = 78 feet. Double check this input value.
  Same reason as explained above.
- File 913.cpt shows Bottom of Layer 2 as 17 feet. This is assigned with Sherack Formation Parameters; however, the calculated thickness of the Sherack in the spreadsheet is 20 feet. Double check this input value.
  The stratigraphy was revised to the correct layer thickness of 20ft and calculations performed on the new stratigraphy elevations. Results were updated into the summary spreadsheet.
- All files appear to use effective stress soil parameters; however, models for soil layers using total stress parameters were not provided.
  All the methods except for the beta method are for the total stress condition. The effective stress design capacities are difficult to determine and not considered to govern.

Folder: " Pile_Loads_&_Capacity"

Subfolder: Final_Pile_Capacity_Calcs

- FMM_Inlet_Pile_Capacity_20150309_EL_880.xslx
- FMM_Inlet_Pile_Capacity_20150309_EL_893.xslx
- FMM_Inlet_Pile_Capacity_20150309_EL_902.xlsx
- FMM_Inlet_Pile_Capacity_20150309_EL_909.xlsx
- FMM_Inlet_Pile_Capacity_20150309_EL_913.xlsx

- (All files) Stratigraphy seems off based on the average contact elevations from 15-231M, 15-232M, and 15-233M.
  - I came up with the following averages based on these borings:
    Sherack 914 to 895; Brenna 895 to 865; Argusville 865 to 844; Weathered Till 844 to 839, Till below that.
    The stratigraphy elevations were selected based on conservative elevations rather than an average

elevation for the contacts.

- (All files) Groundwater elevations seem to have been entered correctly.
  Yes.
- (All files) Saturated unit weights used in the spreadsheets for each formation do not match those of Table D-2.
  Agreed. Unit weights were updated in the spreadsheet for each formation and the spreadsheet was recalculated.
- (All files) Ultimate Total Stress Shear Strengths for Brenna and Argusville formations do not match those of Table D-2. It is also not clear where the values for peak and ultimate strengths were derived for the Unit A Till formation. How were the strength factors chosen?
  The Ultimate Total Stress Shear Strengths for the Brenna and Argusville formations were updated to reflect the correct values. Some testing was completed on the weathered till to be able to estimate strengths. The Unit A Till was not able to be tested to very high blow counts. The strength factors were based on the pile load test completed adjacent to the river. See Attachment D-12 of the main geotechnical appendix for determination of parameters.
- (All Files) Be sure to include units for symbols used in the alpha and beta methods to avoid confusion. For example, see q_s in column L of worksheet Long 14x89A. See other worksheets used as well, like "Su (peak)" in Column L of "Stress" worksheet.
  Attempts in the future will be to better label the headings of the spreadsheet.
- (All Files) Beta Method: Why do you use an average in-situ effective overburden stress in the calculation for f_s in column L? See for example "Long 14x89 B" and "Long 14 x 73B" worksheets.
  Taking the overburden stress at the highest would result in overestimating the skin friction for the entire layer. Therefore, the average is taken.
- (All Files) Beta Method: Where does the calculation for β in column K come from? Why do you use this value in calculations rather than the values estimated from Table 9-4 and Figure 9.20 of the FHWA reference?
  The calculated values are based on site specific data which should be closer approximation then the FHWA reference. The equation that was used is the following:

β = Bjerrum-Burland beta coefficient = $K_s \tan \delta$.
$\bar{p}_o$ = Average effective overburden pressure along the pile shaft, (kPa).
K_s = Earth pressure coefficient.
δ = Friction angle between pile and soil.

Report:

- "Draft_DDR_FMM_Diversion_Inlet_Appendix_D_Geo_FTR_ATR_Sponsor_with_Attachments.pdf"
- "FMM_Pile_Load_Test_20150115_CB review comment.docx"

- The design methodology for the pile load test uses 10 feet of weathered till thickness, yet the input used in the spreadsheet calculations uses a 5 foot thickness. Does this have an effect on the calculations/assumptions?
  A 5ft weathered till thickness was selected based on the site specific borings at the site. A bullet was added to the DDR to state that a 5ft weathered till thickness was used for the design.
- It is difficult to understand how the design methodology described in the Pile Load Test document is used within the DDR. There are differences in stratigraphy (borings used, contact elevations, weathered zone depth) and design parameters (friction angle, undrained shear strengths) that ought to be presented and explained. Perhaps the addition of a table of design parameters and would be beneficial.
  The main design methodology is described in the Attachment D-12 of Main Geotechnical Appendix. Therefore, instead of repeating this information in Control structure report only the main differences were presented in the DDR and reference the design methodology.

03-09-2016:

All comment responses made by LLS were checked; however, the updated models were not re-reviewed for changes made. Instead, JRF held discussions with LLS about changes and updated results (which had changed minimally). JRF trusts that changes were made as noted. Work will ultimately be rechecked during the DQC phase of this project.

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Rebound.docx
PROJECT:	**FMM Inlet Structure**	Geotechnical Designer: Luke Schmidt, P.E.
PHASE:	**P&S Quality Control**	Geotechnical Reviewer: Jason Foss, P.E.
PRODUCT:	Design Calculations: Rebound	

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
Folder: "Rebound" File: FMM_Inlet_Structure_Rebound_Calc_Spreadsheet.xlsx						
SETTLEMENT ANALYSIS (EM 1110-2-1904)						
1	If soil conditions and project requirements warrant, have settlement issues been addressed?	Not a part of this review.	☐	☐	☒	JRF 12-21-2015
2	Have consolidation properties of the foundation soils been determined?	▪ Average values were used as defined in Table D-1 of the DDR. -Good. ▪ Stratigraphy information for layer contacts in "FMM_Inlet_Connecting_Channel" disagree with the boring log contacts shown for 15-232M. -Elevations of the contacts were either rounded up or down to complete calculations with whole numbers. That is the reason the numbers are little off from what is presented on the boring logs.	☐	☒	☐	JRF 12-21-2015 JRF 3-9-2016 LLS Response OK
	▪ laboratory consolidation tests	▪ Tests for 14-210M were provided, but tests for 15-232M were not. -No testing was completed on boring 15-232M. ▪ Hand calculations for OCR, Cr and Cc were not provided for 15-232M. -No testing was completed on boring 15-232M, therefore hand calculations were not completed. ▪ Hand calculations check for 14-210M on sample 1 reveal a higher OCR than reported/used for calculations. -Agreed. The correct values were calculated and revised in the table.	☒	☐	☐	JRF 12-21-2015 JRF 3-9-2016 LLS Response OK

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
		▪ Where there is site specific data, why do you use overall project averages? -Basing the analysis on a couple of tests could significantly alter the quantity of settlement if the sample was disturbed or there was an inaccurate reading to cause the sample to report either an either higher or lower consolidation parameter. Therefore, with the consistency of the Red River Valley formations, the average consolidation values were used.				
	▪ empirical correlations with moisture content and Atterberg values	N/A	☐	☐	☒	JRF 12-21-2015
	▪ other	N/A	☐	☐	☒	JRF 12-21-2015
3	Have calculations been performed to estimate the total expected embankment settlement and the time of consolidation?	Ok. But change in stratigraphy contact elevations may alter these numbers. Time rate of consolidation calculations were not provided. -The stratigraphy contact elevations were not changed.	☒	☐	☐	JRF 12-21-2015 JRF 3-9-2016 LLS Response OK
	▪ CASE software or equivalent	N/A	☐	☐	☒	JRF 12-21-2015
	▪ Hand calculations	N/A	☐	☐	☒	JRF 12-21-2015
4	If differing foundation soil and/or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate consolidation at locations representative of the most critical conditions?	I would discuss in the write-up: ▪ Decision to use average values for OCR, Cr, and Cc for this work in lieu of site specific data. -Some additional discussion was added to the consolidation parameters paragraph to outline why the overall average values were used. ▪ Decision for contact elevations. -The contact elevations were	☐	☒	☐	JRF 12-21-2015 JRF 3-9-2016 LLS Response OK

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
		rounded up to facilitate the calculations.				
5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?	N/A	☐	☐	☒	JRF 12-21-2015
6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?	N/A	☐	☐	☒	JRF 12-21-2015
7	Has the effect of any foundation soil consolidation (including differential settlement) been evaluated with regard to adjacent structures (e.g., bridges, buildings, culverts, utilities) which will also undergo settlement and be subject to stresses induced by the consolidation of the surrounding soil?	N/A	☐	☐	☒	JRF 12-21-2015
8	Has unstable foundation soil been identified?	N/A	☐	☐	☒	JRF 12-21-2015
	▪ Heaving of expansive clays	N/A	☐	☐	☒	JRF 12-21-2015
	▪ Collapse of silty sands, sandy silts, and clayey sands	N/A	☐	☐	☒	JRF 12-21-2015
9	Has a method been chosen as a solution to the settlement issues? Check Method used:	N/A	☐	☐	☒	JRF 12-21-2015
	▪ waiting periods with monitoring	N/A	☐	☐	☒	JRF 12-21-2015
	▪ drainage blanket and wick drains	N/A	☐	☐	☒	JRF 12-21-2015
	▪ surcharge (preloading)	N/A	☐	☐	☒	JRF 12-21-2015
	▪ removal and replacement of weak soil	N/A	☐	☐	☒	JRF 12-21-2015
	▪ lowering proposed grade / change alignment	N/A	☐	☐	☒	JRF 12-21-2015
	▪ grade / change alignment _ lightweight fill	N/A	☐	☐	☒	JRF 12-21-2015
	▪ other	N/A	☐	☐	☒	JRF 12-21-2015

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Stability_Models_LLS_Responses.docx
PROJECT:	**FMM Inlet Structure**	Geotechnical Designer: Luke Schmidt, P.E.
PHASE:	**P&S Quality Control**	Geotechnical Reviewer: Jason Foss, P.E.
PRODUCT:	Design Calculations: Geostudio stability models	

See User Notes at end of document.

ITEM NO.	REVIEW ITEM	COMMENTS	CONFORMANCE Y	CONFORMANCE N	CONFORMANCE N/A	REVIEWER'S INITIALS & DATE

Folder: "Final_Stability"

Geostudio models (to be referred to as M1, M2, and M3):

M1. FMM_Inlet_Stability_Upstream_Channel_899.2.gsz
M2. FMM_Inlet_Stability_Downstream_888.5_932_5.gsz
M3. FMM_Inlet_Stability_Tie-Back_Dam_899.2.gsz – Many of these items don't apply to this model as it is atypical relative to the other two models. See end notes for this model.

MODEL SETUP IN GEOSTUDIO

ITEM NO.	REVIEW ITEM	COMMENTS	Y	N	N/A	REVIEWER'S INITIALS & DATE
1	EMB/Levee Fill Model Setup: • 95 foot offset from top of diversion channel to toe of EMB? • Minimum diversion side EMB slope = 1V:4H? • Minimum landward side EMB slope = 1V:4H? • Right side EMB length ≥ 250 ft? • 2% slope on any EMB flat surface? • Minimum levee top elevation of 923.5 ft? • EMB maximum top elevation 932.5 ft?	• Flat surfaces of EMB were NOT sloped to 2%. The designer kept the EMB as a flat slope as a more conservative design approach. The designer considers this to be a more robust design. • Models M1 and M2 did not have offsets of 95 feet. Offset in M1 was 46 feet. Offset in M2 was 86.5 feet. M1 was revised to offset the toe to the correct 50ft. M2 was revised to offset the toe to the correct 95ft.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
2	Dam Model Setup: • 1V:4H side slopes (min.)? • 15 foot top width? • 50 foot offset from top of diversion channel to toe of dam? • Top elevation 932.5?	• Model M3: Landward side slope is 1V:4.06H The designer considers 1V:4.06 adequate for the design. • There is no offset or channel. The model is just for the dam embankment and not for the offset or channel slopes.	☒	☐	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
3	Inlet Structure - Channel Invert Elevations: • Upstream elevation: 899.2 • Downstream elevation: 888.5	• Model M2 has channel invert of 883.5 Agreed. The reason for the lower elevation was due to the control structure concrete slab and required excavation to place the downstream riprap and bedding layer.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate

See User Notes at end of document.

ITEM NO.	REVIEW ITEM	COMMENTS	CONFORMANCE Y	CONFORMANCE N	CONFORMANCE N/A	REVIEWER'S INITIALS & DATE
4	Geometric Cases: Do the models meet the criteria of MFR-002, Diversion Channel and Low-Flow Design?	*See notes below*	☐	☒	☐	JRF 12-17-2015
a	• Case 1 – centered channel, width = 300ft	• Case 1 was analyzed in Models M1 and M2, but in both cases the models are labeled as Case 2. This is a little confusing as there is not a low flow channel in this reach. Removed the reference "Case" in the model labels. • Model M2 has a diversion channel width of 230 feet. Should be 300 feet. Agreed. The channel bottom width was increased from 115ft to 150ft.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
b	• Case 2	Case 2 was not analyzed.	☐	☐	☒	JRF 12-17-2015
c	• Case 5	Case 5 was not analyzed.	☐	☐	☒	JRF 12-17-2015
SEEPAGE ANALYSIS USING SEEP/W						
5	Do hydraulic design parameters match Table D-3 of the Draft DDR for the FMM Diversion Inlet, dated October 28, 2015?	Model parameters match Table D-3. Only comment is that the Table does not include any note or explanation for the parameters used for the Levee Fill/EMB/ Embankment Dam. It makes sense that you would choose Alluvium/Sherack hydraulic properties, but perhaps it would be good to document that in the table. Agreed. A row was added with the selected permeability parameters for the embankment dam, levee, and EMB.	☒	☐	☐	JRF 12-14-2015 JRF 02-25-2016 LLS response is adequate
6	Model size: Do the models meet the following criteria?	*See notes below*	☐	☒	☐	JRF 12-17-2015
a	• Half-space models used appropriately?	Model M2 technically does not model half-space appropriately,	☐	☒	☐	JRF 12-17-2015

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
		as its channel bottom width ought to be 300 feet but is currently at 230 feet Agreed. The model was extended to 150ft (300ft channel bottom width)				JRF 02-25-2016 LLS response is adequate
b	• Model extends laterally 2,000 feet from offset of centerline of diversion	Ok.	☒	☐	☐	JRF 12-17-2015
c	• Unit "A" till thickness at the base of the model is 50 feet.	Model M2 has a Unit "A" till thickness at the base of the model of 51 feet. Unit "A" till thickness changed from 51ft to 50ft.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
7	Meshing: Do the models meet the following criteria?	*Additional note: Meshing regions need to incorporate the levee fill, which may overlap two different regions (i.e., multiple mesh sizes may exist within the levee fill geometry)*	☐	☒	☐	JRF 12-17-2015
a	• Meshing Region 1: All foundation materials above the till at a distance extending 100 feet from top of excavated slope.	M1: Region 1 extends 107 feet from top of excavated slope. Revised to 100ft from the top of excavated slope. M2: Region 1 extends 26.5 feet from top of excavated slope. Revised to extend 100ft from the top of the excavated slope.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
b	• Meshing Region 1: Mesh size 2 feet	Ok, but see extent issue in previous bullet point. Extent issue has now been resolved.	☒	☐	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
c	• Meshing Region 2: All foundation materials at a distance extending 100 feet from top of excavated slope to 250 beyond top of excavated slope.	M1: Region extends from a length of 145 feet from x = -367 to -512 The region has now been revised to extend to correct distance of 150 from region 1.	☐	☒	☐	JRF 12-17-2015

See User Notes at end of document.

ITEM NO.	REVIEW ITEM	COMMENTS	CONFORMANCE Y	CONFORMANCE N	CONFORMANCE N/A	REVIEWER'S INITIALS & DATE
		M2: Region extent is 150 feet, but is not at the correct extents since meshing region 1 is incorrect. Extents of region 1 has been corrected.				JRF 02-25-2016 LLS response is adequate
d	• Meshing Region 2: Mesh size 4 feet	Ok, but see extent issue in previous bullet point. Extents issues has been corrected.	☒	☐	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
e	• Meshing Region 3: All foundation materials extending further than 250 beyond top of excavated slope.	M1 and M2 both require fixing the incorrect Meshing Region 1 for Meshing Region 3 to be correct. Meshing regions have been corrected.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
f	• Meshing Region 3: Mesh size 6 feet	Ok, but see extent issue in previous bullet point. Extents issue has been corrected.	☒	☐	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
8	Boundary Conditions: Do the models meet the following criteria?	*See notes below*	☐	☒	☐	JRF 12-17-2015
a	• Total Head Boundary conditions along the vertical edge of the model 2,000 feet from the centerline. Value = 10 feet below ground surface.	Model M1 has a total head boundary condition at X=-2000 feet of 5 feet below ground surface. Total head for M1 has been corrected to now 10 feet below ground surface.	☐	☒	☐	JRF 12-17-2015 JRF 02-25-2016 LLS response is adequate
b	• Potential seepage boundary conditions used along the face of the excavated slope for review of the piezometric surface.	Ok.	☒	☐	☐	JRF 12-17-2015

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Stability_Models_LLS_Responses.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Geostudio stability models		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
SLOPE STABILITY ANALYSIS USING SLOPE/W						
1	Do strength design parameters match Table D-2 of the Draft DDR for the FMM Diversion Inlet, dated October 28, 2015?	1. Curvilinear envelopes were not used for Brenna or Argusville formations as shown in Table D-2. Instead the Bilinear curves were chosen. I'm not sure which is correct, or if the table just needs to be updated. Table D-2 was mislabeled. The table was corrected to indicate that Brenna and Argusville use a bi-linear effective stress curve. 2. When using "Levee Fill" or "Embankment Dam" unit weights are set at 125 pcf, whereas Table D-2 says it should be 120 pcf (check Models M1, M2, and M3, both effective and total stress parameters). All the models were updated to the correct unit weight of 120pcf. 3. Argusville Undrained C-Maximum set at 850 psf, whereas Table D-2 says it should be 825 psf (check Model M1 and Model M3) The Table contained the incorrect value. Table revised to 850 psf.	☐	☒	☐	JRF 12-14-2015 JRF 02-25-2016 LLS response is adequate
2	Was the Spencer's method used in this analysis?	Ok.	☒	☐	☐	JRF 12-14-2015
3	Minimum number of slices ≥ 30?	Ok.	☒	☐	☐	JRF 12-14-2015
4	Are failure slip surfaces optimized?	Ok.	☒	☐	☐	JRF 12-14-2015
5	Slip Surface Search: Do the models meet the criteria of MFR-002, Diversion Channel and Low-Flow Design?	*See notes below*	☐	☒	☐	JRF 12-18-2015

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Stability_Models_LLS_Responses.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Geostudio stability models		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
a	• Global Long-Term Stability Entry/Exits	Models M1 and M2 have entry/exit extents that are inconsistent with criteria of MFR-002 The extents have been change to match criteria of MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
b	• EMB on Global Stability Entry/Exits	Models M1 and M2 have entry/exit extents that are inconsistent with criteria of MFR-002 The extents have been change to match criteria of MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
c	• Lower Slope Long-Term Stability Entry/Exits	Models M1 and M2 have entry/exit extents that are inconsistent with criteria of MFR-002 The extents have been change to match criteria of MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
d	• Localized Slope Long-Term Stability Entry/Exits	Models M1 and M2 have entry/exit extents that are inconsistent with criteria of MFR-002 The extents have been change to match criteria of MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
e	• End of Construction Stability Entry/Exits	Models M1 and M2 have entry/exit extents that are inconsistent with criteria of MFR-002 The extents have been change to match criteria of MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
6	Were the results of the analysis verified with a different computer program?	That information was not provided. Rocscience Slide 6.0 was used as a 2nd stability program to verify stability results of the geostudio models. Only the downstream	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
		EMB and Channel was modeled (M2). Both programs correlated very well with no significant differences in FS.				response is adequate
7	Do the results of the analysis meet USACE criteria for all cases analyzed, per MFR-002, Diversion Channel and Low-Flow Design?	Factors of Safety will likely change once the extents are corrected to be consistent with criteria of MFR-002 Revisions were made to the models and factor of safety for design are still above the minimum requirements.	☒	☐	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
a	• Global Long-Term Stability – Case 2 → FS ≥ 1.4	Ok. But recheck after entry/exit extents are altered. Reanalyzed and still above 1.4	☒	☐	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
b	• EMB on Global Stability – Case 2 → FS ≥ 1.4	Ok. But recheck after entry/exit extents are altered. Reanalyzed and still above 1.4	☒	☐	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
c	• Lower Slope Long-Term Stability – Case 2 → FS ≥ 1.2	Ok. But recheck after entry/exit extents are altered. Reanalyzed and still above 1.2	☒	☐	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
d	• Localized Slope Long-Term Stability – Case 2 → FS ≥ 1.2	Ok. But recheck after entry/exit extents are altered. Reanalyzed and still above 1.2	☒	☐	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
e	• End of Construction Stability –	Ok. But recheck after entry/exit	☒	☐	☐	JRF

See User Notes at end of document.

ITEM NO.	REVIEW ITEM	COMMENTS	CONFORMANCE Y	CONFORMANCE N	CONFORMANCE N/A	REVIEWER'S INITIALS & DATE
	Case 2 → FS ≥ 1.3	extents are altered. Reanalyzed and still above 1.3				12-18-2015 JRF 02-25-2016 LLS response is adequate
8	Was a crack included in the analysis? (Cohesive materials, minimum 2 feet and filled with water.)	M1 tension crack does not cover the entirety of the entry slip surface extent in Undrained Analysis Tension crack limits were increased to include the entire entry slip surface extents in the undrained analysis. M2 tension crack does not cover the entirety of the entry slip surface extent in Undrained Analysis. Tension crack limits were increased to include the entire entry slip surface extents in the undrained analysis. M2 tension crack depth varies in undrained analysis. Tension crack depth revised to a constant depth. M2 tension crack extent does not align with slip surface extent in the 1b Global Entry Check Analysis. Tension crack revised to align with slip surface extent.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate
9	Were both circular and non-circular shear surfaces analyzed?	Ok.	☒	☐	☐	JRF 12-18-2015
10	Was a sensitivity analysis for potential range in material shear strength values and water levels done?	N/A	☐	☐	☒	JRF 12-18-2015
11	Are results presented in a chart or graph to demonstrate the variation in FS with different water levels?	N/A	☐	☐	☒	JRF 12-18-2015
12	Does the analysis agree with past performance and a back analysis done to see if results seem to agree with past observations?	N/A	☐	☐	☒	JRF 12-18-2015

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Stability_Models_LLS_Responses.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Geostudio stability models		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
13	Did the model geometry use critical shear surface and material zones?	N/A	☐	☐	☒	JRF 12-18-2015
14	Are the material properties used tabulated and presented?	Ok.	☒	☐	☐	JRF 12-18-2015
15	Are both the circular and noncircular critical shear surfaces plotted on the same figure?	N/A	☐	☐	☒	JRF 12-18-2015
16	Are the shear strengths actually used in the analyses for the various materials shown in a tabular form on the same figure as the shear surface plots?	N/A	☐	☐	☒	JRF 12-18-2015
17	Are several potential shear surfaces shown that may be significant for other reasons such as passing through the crest or stability berms or passing through weak foundation layers.	Model M1 Lower and Localized have slip surfaces passing through the node of the entry/exit extents. The extents were revised to match what is presented in MFR-002. Model M2 Global, Lower, and Localized have slip surfaces passing through the node of entry/exit extents. The extents were revised to match what is presented in MFR-002.	☐	☒	☐	JRF 12-18-2015 JRF 02-25-2016 LLS response is adequate

SETTLEMENT ANALYSIS (EM 1110-2-1904) – NOT APPLICABLE

FILTER DESIGN (EM 1110-2-1913 APPENDIX D) – NOT APPLICABLE

UTILITIES (Pipelines, drainage lines, culverts, outlet structures) – NOT APPLICABLE

EROSION PROTECTION (EM 1110-2-2300) – NOT APPLICABLE

Notes for Model M3: FMM_Inlet_Stability_Tie-Back_Dam_899.2.gsz

1) When using "Embankment Dam" unit weight is set at 125 pcf, whereas Table D-2 says it should be 120 pcf (check both effective and total stress parameters).

   The Dam/Levee material was updated to model the correct unit weight of the material.

   - **JRF 02-25-2016 Response: LLS response is adequate.**

2) Argusville Undrained C-Maximum set at 850 psf, whereas Table D-2 says it should be 825 psf.

   Table D-2 was incorrect and changed to present the correct C-maximum value of 850 psf.

   - **JRF 02-25-2016 Response: LLS response is adequate.**

3) Undrained analyses have a variable tension crack depth and do not follow the entire slip surface entry extent.

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Tension crack depth and extents were revised to a constant depth and now extend to include the entire slip surface entry extents.

- **JRF 02-25-2016 Response: LLS response is adequate.**

4) The Localized slip surface entry/exit extents do not follow the MFR-002, Diversion Channel and Low-Flow Design.

   The slip surface entry/exits extents were revised to closely follow MFR-002.

   - **JRF 02-25-2016 Response: LLS response is adequate.**

5) Top of the embankment dam does not slope at 2%.

   The embankment dam top 2% slopes was excluded for simplicity and some conservatism.

   - **JRF 02-25-2016 Response: LLS response is adequate.**

6) Inspection trench was not modeled (not that this should be much of a factor).

   Inspection trenches were included in all the models.

   - **JRF 02-25-2016 Response: LLS response is adequate.**

7) The main point for this review is that there doesn't seem to be enough information written about the methodology for this analysis. I've inferred and assumed some things about the design, and I don't disagree with the approach. However, it would be good to have a write-up that explains the methodology.

   The methodology is outlined in MFR-002 and was copied into the geotechnical write-up. Is there specific items that you should think need to be included.

   - **JRF 02-25-2016 Response: LLS response is adequate. I think what you have included into the write-up is general enough to encompass the work that was completed on the Tie-Back Dam.**

02-25-2016:

All comment responses made by LLS were checked; however, the updated models were not re-reviewed for changes made. JRF called LLS on 2/25/2016 to discuss changes that were made. JRF trusts that changes were made as noted. Work will ultimately be rechecked during the DQC phase of this project.

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Unbalanced_Loads-JRF20160302.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Unbalanced Loads		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE

Folder: "T-Wall_Unbalanced_Loads"

Geostudio models (to be referred to as UL1 and UL2):

UL1. FMM_Inlet_Stability_T-Wall_UBAL_Piezoline_50ft_Bench_Pool_922_No_TW.gsz

UL2. FMM_Inlet_Stability_T-Wall_UBAL_Piezoline_50ft_Bench_Pool_926_TW_910.gsz

MODEL SETUP IN GEOSTUDIO

1	Does Geometry match that as shown in project drawings?	• UL1 and UL2: Bottom of slab is at Elev. 894, should be 894.7? The designer felt that using an elevation of 894 simplified the model and was slightly more conservative. • UL1 and UL2: Downstream top of slab and 50 foot bench is at Elev. 900, should be 899.7? The designer felt that using an elevation of 900 simplified the model and not significantly affect the design. • UL1 and UL2: Downstream slope is annotated as "1V:7H"; however, calculation shows 1V:5.9H. Detail 2 on CS402 indicates slope should be 8.5% (1V:11.7H). The design assumed a minimum slope of 1V:7H downstream of the T-wall which is more conservative than the proposed 8.5%. Therefore, the design is more robust and conservative.	☐	☒	☐	JRF 12-18-2015 JRF 3-2-2016 Responses are adequate, but see the follow up comment within this document.
2	Stratigraphy	Include labels on appropriate stratigraphic layers. Label IDs are now included on the geostudio models.	☐	☒	☐	JRF 12-18-2015 JRF 3-2-2016 LLS response is adequate.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
3	Modeling Methodology	The DDR does not include a lot on the methodology other than to say it is "similar to settlement induced bending moments on T-wall located in New Orleans." While that may be true, their methods were for total stress analyses. It seems important to document your design decisions, assumptions, and differences between the two methods. Agreed. The section in the DDR was revised to provide further documentation on the procedure used for developing the unbalanced loads.	☐	☒	☐	JRF 12-18-2015 JRF 3-2-2016 See additional notes within the updated Appendix D.
SEEPAGE ANALYSIS USING SEEP/W – Piezometric Line Used In Lieu of SEEP/W Model						
SLOPE STABILITY ANALYSIS USING SLOPE/W						
1	Do strength design parameters match Table D-2 of the Draft DDR for the FMM Diversion Inlet, dated October 28, 2015?	1. Curvilinear envelopes were not used for Brenna or Argusville formations as shown in Table D-2. Instead the Bilinear curves were chosen. I'm not sure which is correct, or if the table just needs to be updated. The table was outdated and now has been updated to represent the correct values and parameters. 2. Undrained parameters did not match Table D-2; however, the undrained analyses were apparently not a part of the effort. The undrained analysis wasn't completed and therefore the parameters were not updated.	☐	☒	☐	JRF 12-21-2015 JRF 3-2-2016 LLS response is adequate.
2	Was the Spencer's method used in this analysis?	Ok.	☒	☐	☐	JRF 12-18-2015

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
3	Minimum number of slices ≥ 30?	Ok.	☒	☐	☐	JRF 12-18-2015
4	Are failure slip surfaces optimized?	Optimized not used for block-specified methods. I recommend that further explanation/reasoning be provided. Agreed. Some discussion was added to outline the rational for excluding the optimized slip surface.	☐	☐	☒	JRF 12-21-2015 JRF 3-2-2016 LLS response is adequate.
5	Were the results of the analysis verified with a different computer program?	How do the FLAC results compare for unbalanced loads produced in the LEM models? The results are from two separate types of analyses and it's difficult to compare the results. Overall, the FLAC results appeared to match the structural pile design with unbalanced loading included.	☐	☒	☐	JRF 12-21-2015 JRF 3-2-2016 See the follow-up comment in this document.
6	Do the results of the analysis meet USACE criteria for all cases analyzed, per MFR-002, Diversion Channel and Low-Flow Design?	This doesn't really apply, but I do have the following notes: 1. Effective stress analyses were not performed for conditions without flood load (i.e., GW 5 ft BGS elevation, with potential seepage face review on downstream slope. The case above is not considered to be the critical case and therefore was not analyzed. 2. Total stress analyses were not performed. Total stress analysis were not performed as the controlling case would be the drained condition. 3. Methodology for these different conditions needs to be defined if it is	☐	☒	☐	JRF 12-21-2015 JRF 3-2-2016 LLS response is considered adequate although once might anticipate additional comments on this during DQC.

See User Notes at end of document.

ITEM NO.	REVIEW ITEM	COMMENTS	CONFORMANCE Y	CONFORMANCE N	CONFORMANCE N/A	REVIEWER'S INITIALS & DATE
		different than the other FMM diversion stability models. The methodology for the unbalanced load analysis does not follow the criteria outlined in MFR-002. The methodology was developed specifically for the Inlet Structure which was based on the T-wall procedure developed for New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS).				
7	Was a crack included in the analysis? (Cohesive materials, minimum 2 feet and filled with water.)	Models did not require tension cracks.	☐	☐	☒	JRF 12-21-2015
8	Were both circular and non-circular shear surfaces analyzed?	Block specified was used.	☐	☐	☒	JRF 12-21-2015
9	Was a sensitivity analysis for potential range in material shear strength values and water levels done?	N/A	☐	☐	☒	JRF 12-18-2015
10	Are results presented in a chart or graph to demonstrate the variation in FS with different water levels?	Ok.	☒	☐	☐	JRF 12-21-2015
11	Does the analysis agree with past performance and a back analysis done to see if results seem to agree with past observations?	If using block specified failure surface: • Would you expect failure entry and exit angles follow failure surfaces described by lateral earth pressure theory (i.e., Rankine, Coulomb)? The entry exit angles were based on engineering judgment and sensitivity analysis to meet kinematically slip surfaces. • What made you decide on a right block exit angle of 35 degrees? Is there some sensitivity to this? The entry exit angles were based on engineering judgment	☐	☒	☐	JRF 12-21-2015 JRF 3-2-2016 LLS response is considered adequate although once might anticipate additional comments on this during DQC.

US Army Corps of Engineers St. Paul District	PEER REVIEW EC-G TECHNICAL CHECKLIST FOR DESIGN GEOTECHNICAL	FILE: FMM_Inlet_Structure_PeerReview_Unbalanced_Loads-JRF20160302.docx
PROJECT: **FMM Inlet Structure** PHASE: **P&S Quality Control** PRODUCT: Design Calculations: Unbalanced Loads		Geotechnical Designer: Luke Schmidt, P.E. Geotechnical Reviewer: Jason Foss, P.E.

ITEM NO.	*See User Notes at end of document.* REVIEW ITEM	COMMENTS	CONFORMANCE Y	N	N/A	REVIEWER'S INITIALS & DATE
		and sensitivity analysis to meet kinematically slip surfaces.				
12	Did the model geometry use critical shear surface and material zones?	N/A	☐	☐	☒	JRF 12-18-2015
13	Are the material properties used tabulated and presented?	Ok.	☒	☐	☐	JRF 12-18-2015
14	Are both the circular and noncircular critical shear surfaces plotted on the same figure?	N/A	☐	☐	☒	JRF 12-18-2015
15	Are the shear strengths actually used in the analyses for the various materials shown in a tabular form on the same figure as the shear surface plots?	N/A	☐	☐	☒	JRF 12-18-2015
16	Are several potential shear surfaces shown that may be significant for other reasons such as passing through the crest or stability berms or passing through weak foundation layers.	See notes under number 6 above.	☐	☒	☐	JRF 12-21-2015
SETTLEMENT ANALYSIS (EM 1110-2-1904) – NOT APPLICABLE						
FILTER DESIGN (EM 1110-2-1913 APPENDIX D) – NOT APPLICABLE						
UTILITIES (Pipelines, drainage lines, culverts, outlet structures) – NOT APPLICABLE						
EROSION PROTECTION (EM 1110-2-2300) – NOT APPLICABLE						

Other Notes:

1. *The FLAC model shows a layer of weathered till that is excluded from the GEO-SLOPE models.*
   Agreed. The weathered till was left out of the geostudio model as the layer wouldn't affect the stability analysis.
   - **JRF 03-02-2016 Response: LLS response is adequate.**
2. *Appendix D, Attachment D-6 states that the tip elevation of the piles was at elevation 836. GEO-SLOPE models have it at 842. This is a minor comment that I mention only in case you wanted to make things more consistent between the two methods.*
   The pile elevation was lowered to 836 in the geostudio models.
   - **JRF 03-02-2016 Response: LLS response is adequate.**

03-02-2016:

All comment responses made by LLS were checked; however, the updated models were not re-reviewed for changes made. Instead, LLS had provided screenshot PDFs of the unbalanced load stability analyses. JRF trusts that changes were made as noted. Work will ultimately be rechecked during the DQC phase of this project.