Memorandum

URS

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To:	David Cline, P.E. (Tetra Tech)	**CC:**	Rod DenHerder, P.E. (URS)
From:	Martin McCabe, Ph.D., P.E. (URS) Suren Balendra, P.E. (URS)	**Date:**	December 15, 2009
RE:	**Addendum 1 to Fisher Slough Restoration Final Design Recommendations**		
Job No.	**33761856**		

1.0 INTRODUCTION

This Addendum 1 to the original URS "Technical Memorandum (TM) of Fisher Slough Restoration Final Design Recommendations "dated August 1, 2009 (URS Project No. 33760911) is to present the results of additional seepage and stability analyses that support a design configuration that has been slightly modified from earlier versions. The current design configuration for all new levees incorporates both an upstream clay seepage blanket (2-feet wide) on the face of the levee and an upstream cutoff trench (6-feet wide by 8-feet deep). This revised configuration, as reflected in Drawing C27 dated Nov 2009, was developed following a meeting at The Nature Conservancy (TNC) with Dike District # 3, engineering design review consultant Bob Boudinot, and other associated parties on September 17, 2009. TNC requested that an additional seepage and long term stability analyses to be performed for the configuration per scope identified in the URS contract amendments 4 and 5 dated November 11, 2009 and December 3, 2009, respectively. A transient component of the additional seepage analyses was included in the scope to address property owner concerns about the possible ponding or wet ground surface conditions from groundwater emerging on the downstream side of the levee during occasional episodes of high water that have been observed during early summer.

Unless noted otherwise, the conclusions and recommendations presented here as a result of the additional analyses shall supersede the previous conclusions and recommendations. However, all other existing recommendations and findings in the original technical memorandum remain applicable and valid.

2.0 BACK- ANALYSIS OF MEASURED SEEPAGE

In order to assure that the transient seepage analysis model used to represent the future levee configurations is as accurate as possible, an attempt was made to "calibrate" the model using a back-analysis of seepage conditions that were actually measured in the field by Tetra Tech. The back-analysis was performed by selecting the most appropriate variables such as soil permeability and moisture content versus pore water pressure relationship (referred to in this memo as "water content function"), and using the model to duplicate the measurements previously recorded in the field.

The seepage back analysis exercise was performed using the software SEEP/W at a location where ground water level monitoring data was collected on both sides of the levee, i.e. the "upstream" (Fisher Slough) side and the "downstream" (land) side. The cross-section for back analysis was selected through the pair of groundwater monitoring wells "ORIG GW1" (Fisher Slough side) and "ORIG GW2" (Land side). Figure 1 shows the groundwater monitoring well locations and Figure 2a shows groundwater monitoring data for a period from mid-July through early September 2006. The soil profile in the vicinity of these two wells is very similar to the profile through the proposed new north-south section of levee at URS Boring AB-2 along the Smith B property. That profile can be described as 13 to 15 feet of Stratum 1 or Stratum 2A silt overlying silty sand from Stratum 2B or Stratum 3. Based on information on the Figures 1 and 2a, the following assumptions were made:

- Minimum groundwater head drop from upstream to downstream is 4 feet for initial condition.
- The above observed downstream drop occurs at approximately 50 feet downstream from levee centerline, after which the ground water level further downstream matches the water level in Big Ditch.
- The slow decline in downstream groundwater level in ORIG GW2 is related to seasonal effects which cannot be modeled using SEEP/W, and will be ignored.

These assumptions were used as initial conditions in the analysis.

A preliminary analysis indicated that with soil permeability set at previously-used values for each soil layer, the water content function used to model unsaturated flow through Strata 1 and 2A had significant effect on the results. For the preliminary analysis, a typical water content function provided in GeoStudio (Geo-Slope, 2004 and 2007) was used to model unsaturated flow through Strata 1 and 2A. This typical water content function was selected from GeoStudio based on soil characteristics, and accordingly a function corresponding to "Silt" was selected at first for Strata 1 and 2A .

For the above case, initial steady-state and transient seepage analyses were performed. In the initial seepage analysis case, water table at the Fisher Slough side (upstream) was assumed to be at the ground surface (El. 7 feet.) and water table in the field side (downstream) was assumed to be at El. 3 feet at a distance of 50 ft away from levee centerline as shown in Figure 3

The seepage analyses were performed using the same properties as presented in the prior TM. The transient analysis was performed for a duration of 5 days. The total head boundary condition, as measured in the field and as shown in Figure 2b, was applied at the Fisher Slough side. This boundary condition is an expanded version of the ORIG GW1 data (Figure 2a). Initial transient runs using the water content functions provided in the GeoStudio guidance resulted in water level increases at downstream well ORIG GW2, and hence were considered inaccurate. The shape of the typical water content function for Silt was then modified, and the transient analysis repeated, until there was no significant (less than 1 feet) raise of water table at the downstream well compared to its initial condition. Figure 1.1 shows the predicted water table from this analysis. Figure 4 shows the modified water content function that was developed for Silt from the back-analysis process. This "calibrated" water content function was then used in transient analysis at the Smith B property as described below.

3.0 SEEPAGE ANALYSES OF SETBACK LEVEE

Seepage analyses were performed to evaluate potential seepage into the fields downstream from the levees. The objectives of the analyses were to estimate exit hydraulic gradients at the toe of the levee, assess whether groundwater may pond at the surface during the occasional unusual runoff events during the early summer, and obtain pore water pressures generated in the soil elements which will be used in the slope stability program SLOPE/W 2007 .

Four cross sections (locations) have been identified for seepage analyses. Selection of these cross sections is described in the prior TM. Selected locations for seepage analyses are as follows:

- parallel to Pioneer Highway near B-1 (Smith A, Station 10+00 to Station 16 + 00)
- parallel to Pioneer Highway near AB-1 (Smith A, Station 16 + 00 to Station 17 +50)
- along the abandoned railroad embankment near B-2 (Smith A, Station 17 +50 to Station 29 + 00)
- near east end of levee between GW-1 and B-4 (Smith B, Station 29 + 00 to Station 48+00)

Steady state seepage analyses were conducted for Smith A and B cross sections, and transient seepage analyses were conducted to represent the occasional Fisher Slough filling at Smith B during the early summer. The total head boundary conditions applied were as follows:

- **Long Term Conditions (Static) for Smith A and B:** Fisher Slough side of the new levee – water at El. 16.7 feet (maximum), Smith farm field side of the new levee – water at ground surface
- **Transient Analysis of Fisher Slough Side of New Levee for Smith B:** Analysis was performed for duration of 11 days in three steps as follows.
  - **Rapid Filling:** on Fisher Slough side of the new levee - water at El. 7, rising to El. 12 feet in three days; on Smith B field side of the new levee- water at EL. 2.1 feet in Big Ditch.
  - **Constant Head:** on Fisher Slough side of the new levee - water at El. 12 for four days; on Smith B field side of the new levee- water at EL. 2.1 feet in Big Ditch.
  - **Rapid Drawdown:** on Fisher Slough side of the new levee - water at El. 12, dropping to El. 7 feet in four days; on Smith B field side of the new levee- water at EL. 2.1 feet in Big Ditch.

The seepage analyses were performed using the same properties as presented in the prior TM. The following additional materials were introduced in this study:

- Clay Blanket–Blanket with permeability of 1 x 10^{-6} cm/sec
- Clay Cutoff–Cutoff with permeability of 1 x 10^{-6} cm/sec

Some preliminary analyses had suggested that an undesired condition of groundwater rising and ponding at the surface in the Smith B field could occur during the 11-day period when water could rise in Fisher Slough to the Ordinary High Water mark of Elevation 12. Therefore, the possibility of constructing a trench drain on the downstream side of the new levee was included in the transient analyses.

Transient seepage analyses for Smith B were conducted for the following cases:

- Case T-1 : Without clay upstream cutoff/blanket or downstream drain.
- Case T-2: With clay upstream cutoff/blanket but no downstream drain.
- Case T-3: With downstream drain (5 feet away from toe and 3 feet deep and 3 feet wide) but no clay upstream cutoff/blanket
- Case T-4: With both clay upstream cutoff/blanket and downstream drain (5 feet away from toe and 3 feet deep and 3 feet wide)

For each of these cases, initial steady-state and three transient (rapid filling, constant head, rapid drawdown) seepage analyses were performed. In the initial seepage analysis case, water table at the fisher slough side (upstream) was assumed to be at the ground surface (El. 7 feet.) and water table at Smith farm field side (downstream) was assumed to be at El. 3 feet at 50 ft away from setback levee toe as shown in Figure 5 These initial boundary conditions were developed based on the ground water monitoring data as described in section 2.

For levee underseepage conditions, the current USACE criterion for the *average vertical exit gradient* through a levee's landside blanket is that it should be less than or equal to 0.5 for the design floodwater level condition (see USACE, 2000 and USACE, 2005).

A total head contour output figure generated using SEEP/W for each steady state case is shown on Figures 1.2 to 1.9. The results of the steady state seepage analysis are summarized in Table 1. Based on the steady state seepage analysis for Smith A and B, the *average vertical exit hydraulic gradient* at the toe of the dike is estimated at less than or equal to 0.5. This analysis indicates that a 6 feet wide and 8 feet deep clay-filled cutoff trench with a 2-foot thick upstream face blanket configuration as shown in Drawing No. C27 dated November 2009 is adequate to meet USACE criterion.

The results of the transient seepage analysis are summarized in Table 2. A total head contour output figure was generated using SEEP/W for each case as shown on Figures 1.10 to 1.13 (without cutoff or drain, with cutoff, with drain, and with cutoff and drain, respectively). Analyses without a downstream drain indicates that the ground water may rise to the surface and cause localized ponding or wet surface conditions even if the clay blanket and cutoff are constructed. The presence of the cutoff/blanket will limit the possible ponding and wet surface conditions to an area roughly up to 60 feet downstream of the toe of the levee. The results indicate that a somewhat larger area of potential downstream ponding or wet surface conditions is created, possibly up to 80 feet downstream from the toe, if a clay cutoff and blanket are not used. Installation of a 3-feet wide by 3-feet deep trench drain along the levee toe at approximately 5 feet downstream is expected to prevent the possible ponding and wet surface conditions when the upstream clay cutoff trench and blanket are used. Although no other locations of trench drain were specifically examined during the modeling, the expectation is that if the trench drain is deeper, or wider, or multiple drains are installed in the area of ground water table rise, a greater level of confidence will be attained that ponding or wet surface conditions can be prevented. If a second drain is contemplated, the additional modeling suggests that it should be located approximately 50 feet downstream from the first drain, i.e. about 55 feet downstream of the levee toe.

4.0 STABILITY ANALYSES OF LEVEE

The same section locations and boundary conditions listed above in the seepage analysis section were used for the stability analysis. The stability analyses were performed using the same properties (friction angle, cohesion and unit weight) as presented in the prior TM. The assumed undrained shear strength of the compacted clay for the cutoff trench and the blanket was 2000 psf, which means it must be stiff to very stiff in character following compaction.

The results of the long term stability analyses are summarized in Table 3. The graphical outputs of the stability analyses results are presented in Attachment 2. The results of the long term stability analysis for Smith A and B indicate that the levee has an acceptable factor of safety according to guidelines presented in Table 3 of the prior TM.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Results of the additional seepage and stability analyses performed in support of a revised levee configuration that includes a clay cutoff trench and a clay blanket on the upstream side of the levee indicate the following:

- Seepage modeling should incorporate modifications to standard software guidance on unsaturated flow soil parameters, based on site-specific data, in order to accurately represent transient flow situations.

- The upstream clay cutoff trench and clay blanket result in acceptable seepage flow exit gradients at all selected cross sections under steady state seepage conditions.

- A trench drain is recommended in the Smith B field immediately downstream of the toe of the new north-south segment of the levee in order to prevent ponding or wet surface conditions during the occasional high water episodes observed in early summer.

- The proposed upstream compacted clay cutoff trench and blanket will not adversely affect stability of the levees, and factors of safety are acceptable.

6.0 LIMITATIONS

It should be noted that the results of seepage modeling methods and software employed during this design study are considered approximate, and actual ground water levels and flow quantities may vary. For transient seepage analyses, if the actual duration of water level rises is different from those described above, the extent of ponding and wet surface conditions will be different than represented here.

7.0 REFERENCES

USACE, US Army Corps of Engineers, *Design and Construction of Levees*, EM 1110-2-1913, April 2000

USACE, US Army Corps of Engineers, *Design Guidance for Levee Underseepage*, ETL 1110-2-569, 2005

ATTACHMENTS:

Table 1- Summary of Seepage Gradient at Toe

Table 2- Summary of Seepage Flow

Table 3- Summary of Long Term Condition Factor of Safety (FOS)

Figure 1- Groundwater Monitoring Locations

Figure 2- Groundwater Monitoring data

Figure 3- Initial Steady State Boundary Condition for Back Analysis

Figure 4- Modified Water Content Function for Silt from Back Analysis

Figure 5- Initial Steady State Boundary Condition for Smith B

Attachment 1 - Results of Seepage Analyses

Attachment 2 - Results of Stability Analyses

TABLES

Table 1: Summary of Seepage Gradient at Toe

Section	Water Level EL. (ft)		Maximum Exit Vertical Gradient (i_{max})	Average Exit Vertical Gradient (i_{avg})	Figure No
	Fisher Slough Side	Ditch/Smith Field Side			
parallel to Pioneer Highway near AB-1[a]	16.7	6	0.30	0.28	1.2 and 1.3
parallel to Pioneer Highway near B-1[a]	16.7	6	0.60	0.50	1.4 and 1.5
along the abandoned railroad embankment near B-2	16.7	6	0.30	0.25	1.6 and 1.7
near east end of levee between GW-1 and B-4	16.7	7	0.40	0.36	1.8 and 1.9

[a] with geogrid

Table 2: Summary of Seepage Flow

Analysis Case	Flow Rate ($ft^3/s/ft$)[b]	Figure No
without cutoff or drain	N/A	1.10
with cutoff	N/A	1.11
with drain[a]	$1.5x10^{-6}$	1.12
with cutoff and drain[a]	$1.3x10^{-6}$	1.13

[a] 5 feet away from toe and 3feet deep and 3 feet wide &

[b] End of 7th Day (End of Constant Head Run)

Table 3: Summary of Long Term Condition Factor of Safety (FOS)

Section	Water Level EL. (ft)		FOS		Figure No
	Fisher Slough Side	Ditch/Smith Field Side	Fisher Slough Side	Ditch/Smith Field Side	
parallel to Pioneer Highway near AB-1[a]	16.7	6	3.57	1.64	2.1 and 2.2
parallel to Pioneer Highway near B-1[a]	16.7	6	3.67	1.72	2.3 and 2.4
along the abandoned railroad embankment near B-2	16.7	6	3.55	1.58	2.5 and 2.6
near east end of levee between GW-1 and B-4	16.7	7	3.40	1.61	2.7 and 2.8

[a] with geogrid

FIGURES

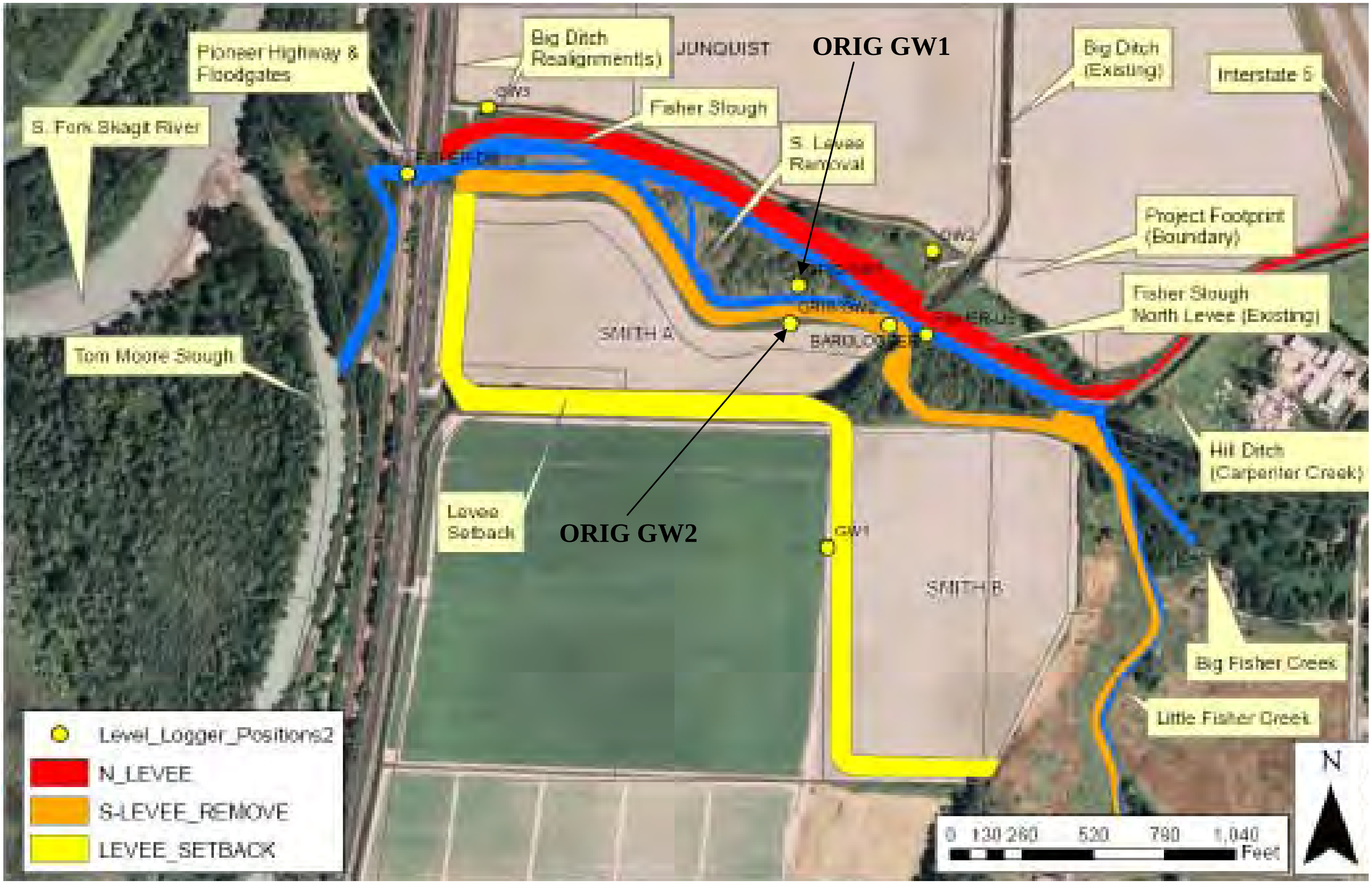

Figure 1

Job No. 33761856

Groundwater Monitoring Locations

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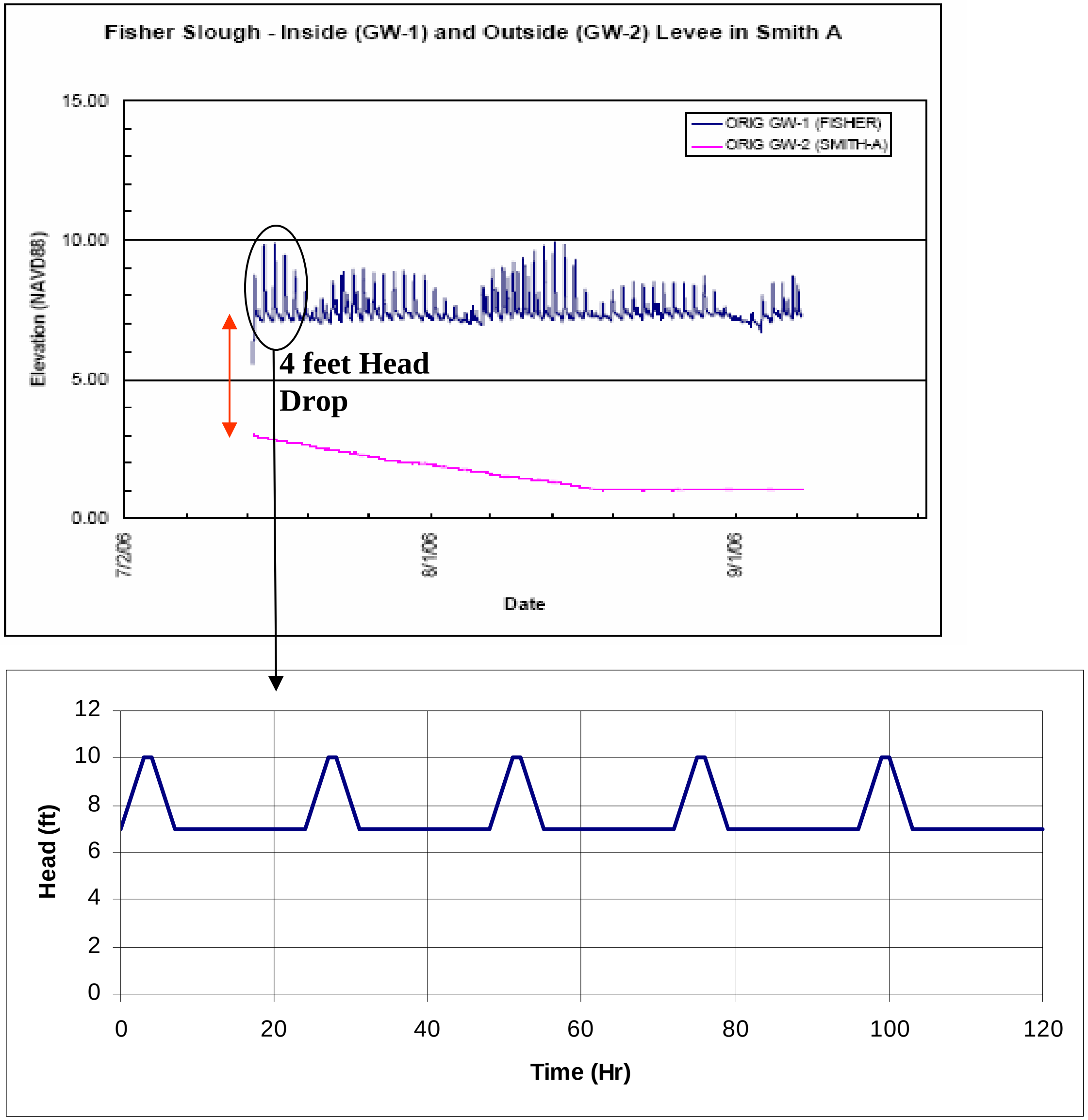
Fisher Slough Restoration Project
Skagit County, Washington



a. Groundwater Monitoring Well data

b. Idealized Head Function for 5 Days Duration

Figure 2

Groundwater Monitoring Data

Fisher Slough Restoration Project
Skagit County, Washington

Job No. 33761856

URS

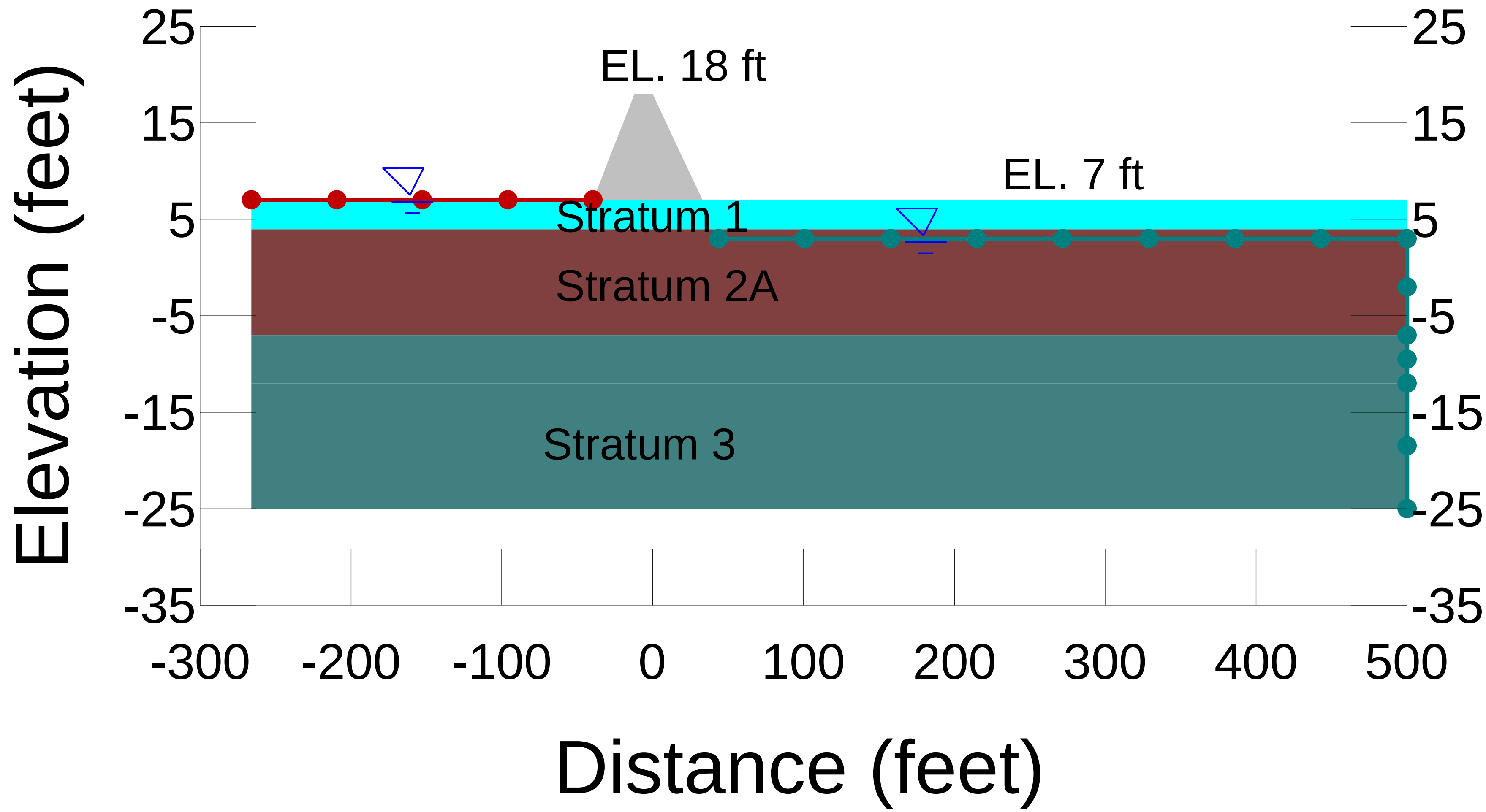


Figure 3

Initial Steady State Boundary Condition for Back Analysis

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URS

Fisher Slough Restoration Project
Skagit County, Washington

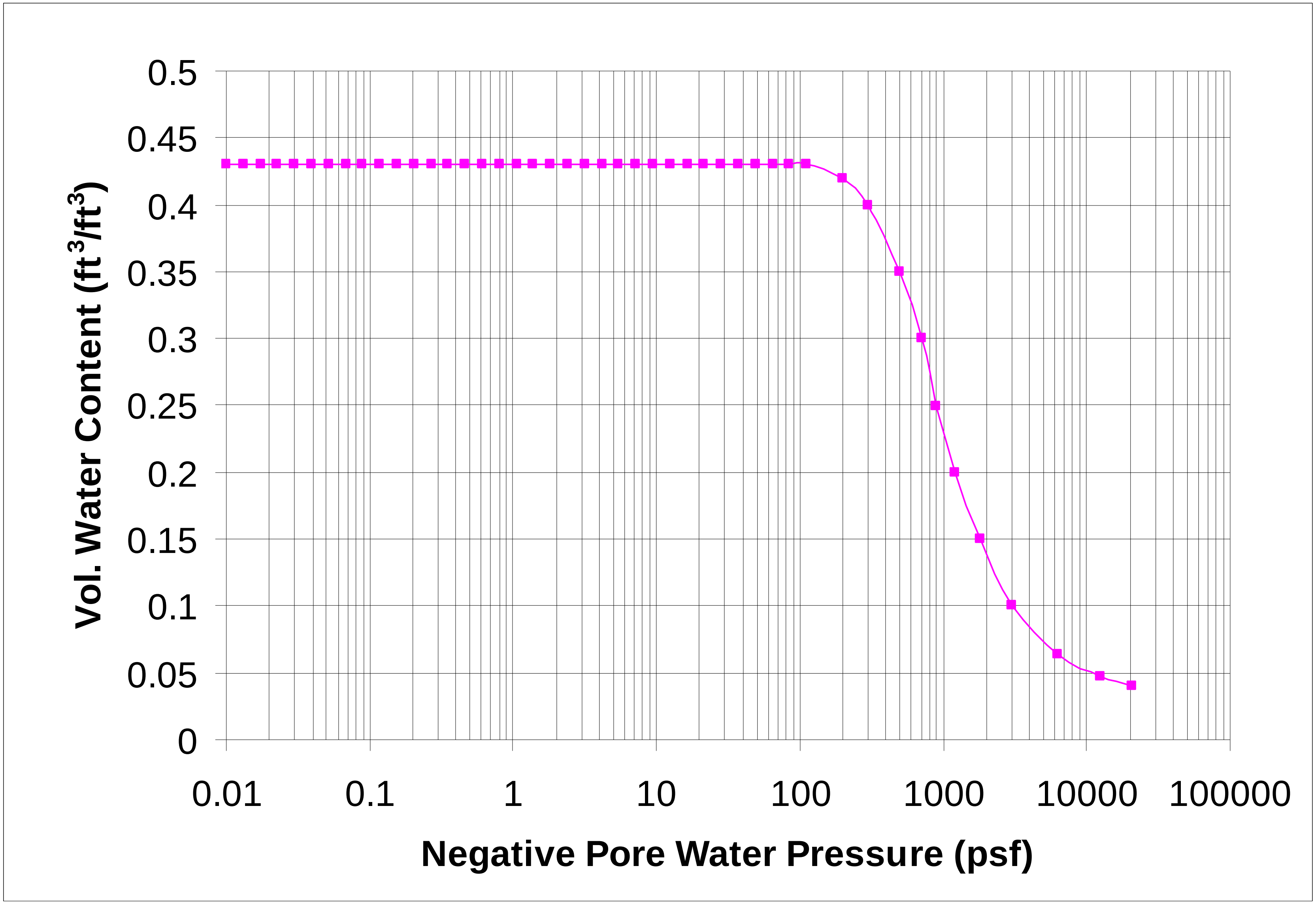

Figure 4

Job No. 33761856

Modified Water Content Function for Silt from Back Analysis

URS

Fisher Slough Restoration Project
Skagit County, Washington

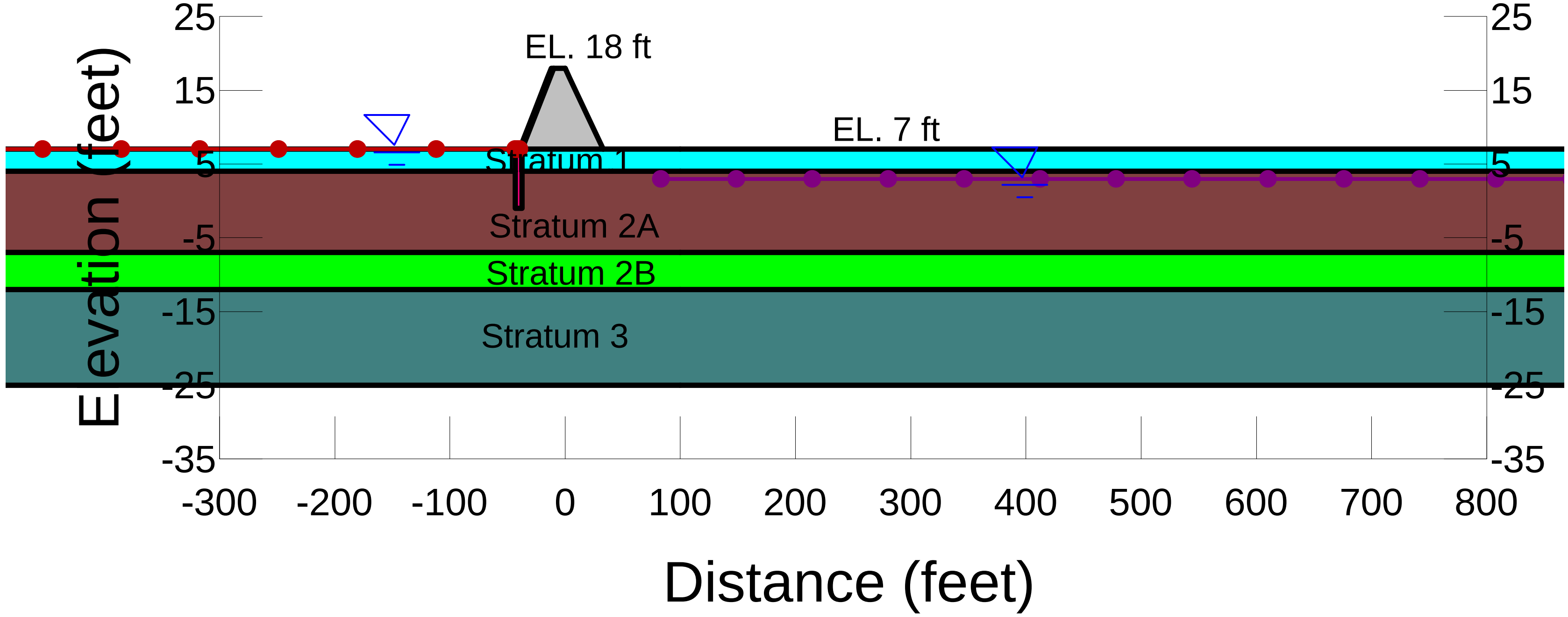

Figure 5

Job No. 33761856

Initial Steady State Boundary Condition for Smith B

URS

Fisher Slough Restoration Project
Skagit County, Washington

Attachment 1 - Results of Seepage Analyses

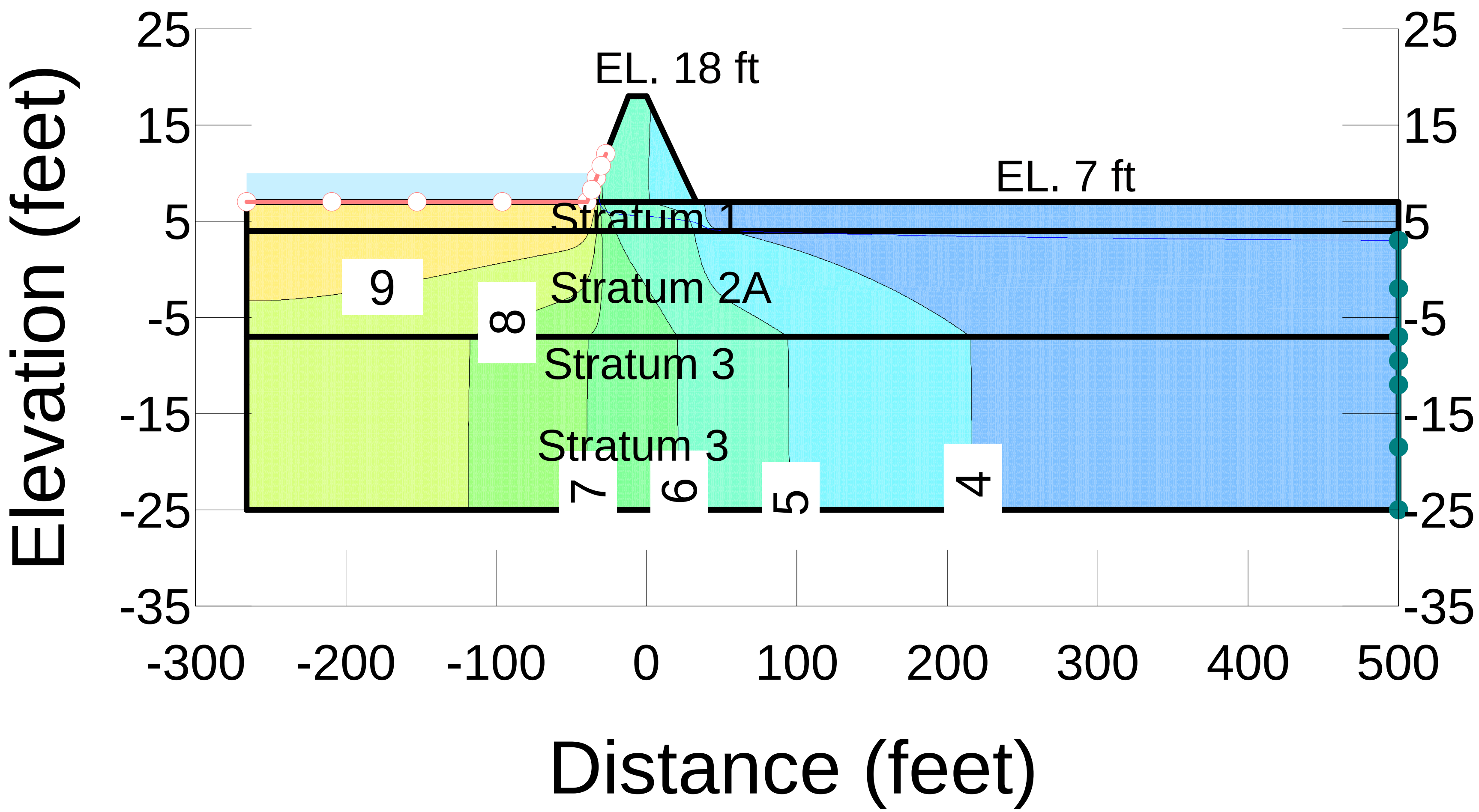

Figure 1.1

Total Head Contours for Back Analysis Case

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

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Name: Stratum 1 Model: Saturated Only K-Sat: 3.28084e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: Fill Model: Saturated / Unsaturated K-Function: New Fill Vol. WC. Function: Silty Sand K-Ratio: 1 K-Direction: 0
Name: Clay Cutoff Model: Saturated / Unsaturated K-Function: Clay Cutoff Vol. WC. Function: Clay Cutoff K-Ratio: 1 K-Direction: 0
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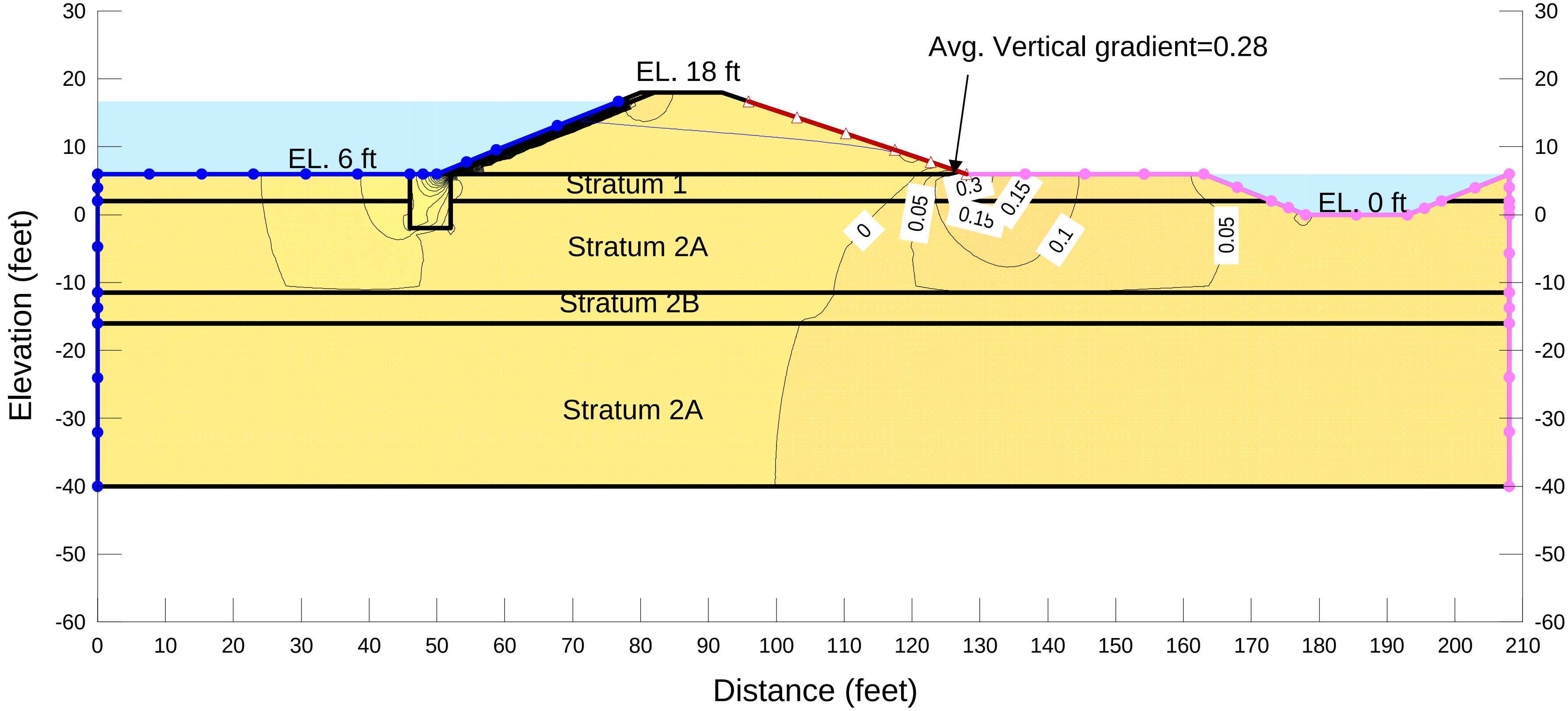

Figure 1.2

Job No. 33761856

Vertical Gradient Contours with Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

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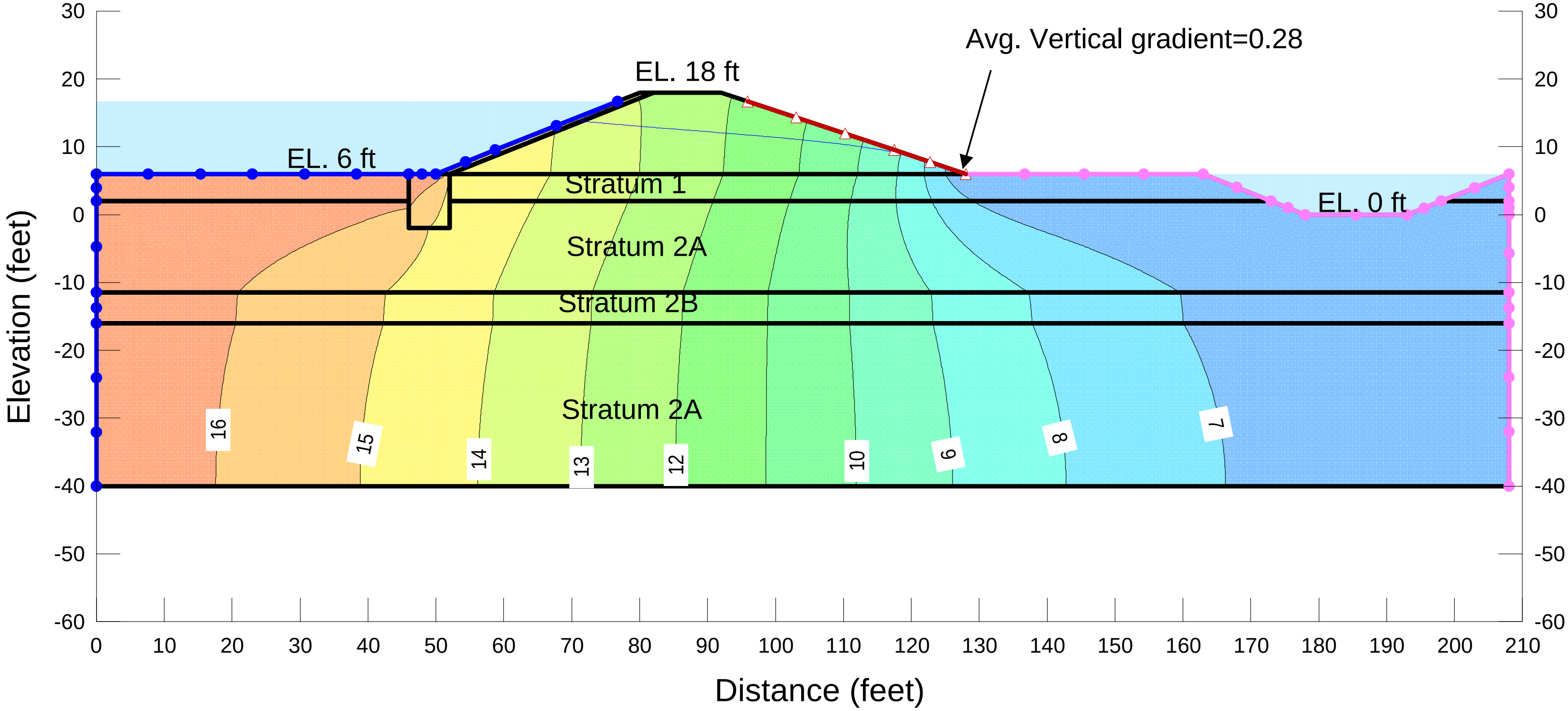

Figure 1.3

Total Head Contours with Clay Blanket and Clay Cutoff Case

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

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Name: Stratum 2A Model: Saturated Only K-Sat: 3.28084e-007 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
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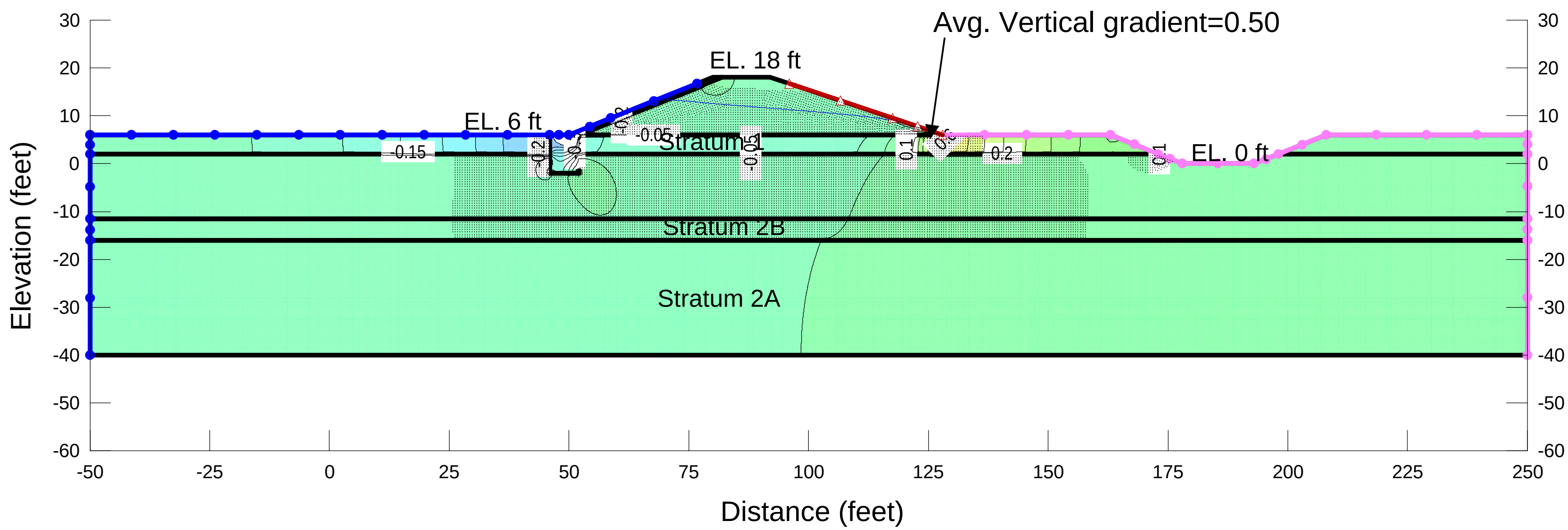

Figure 1.4

Job No. 33761856

Vertical Gradient Contours with Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

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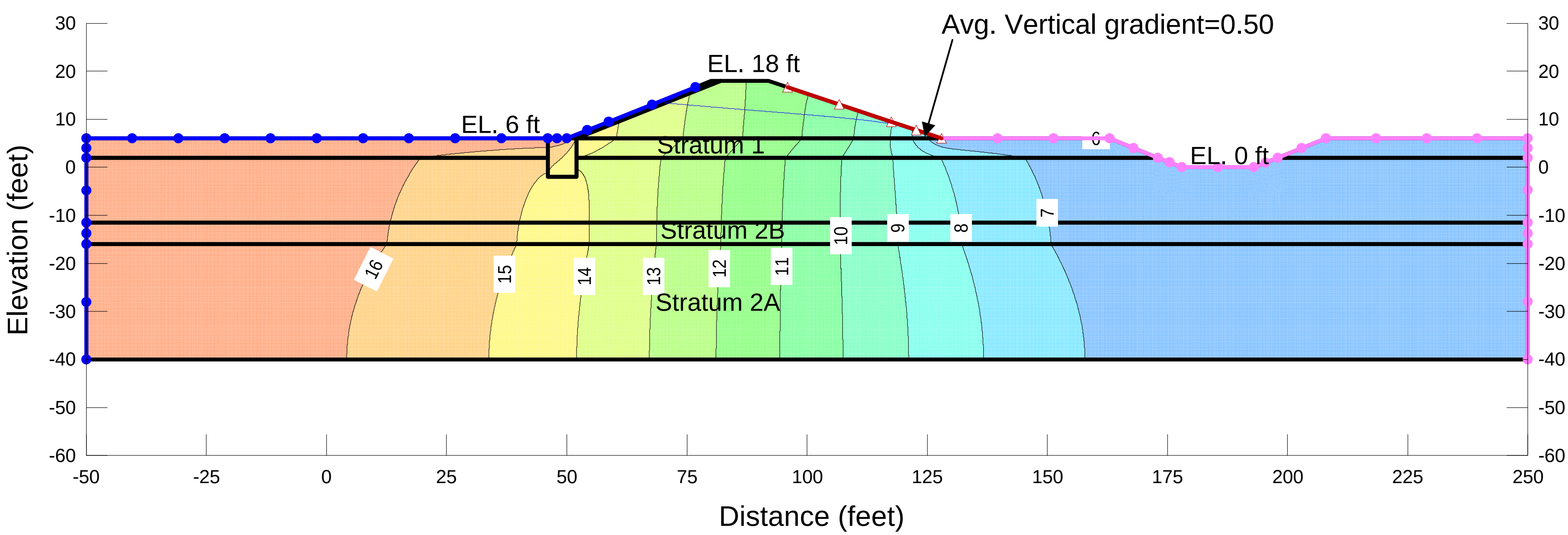

Figure 1.5

Total Head Contours with Clay Blanket and Clay Cutoff Case

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Fisher Slough Restoration Project
Skagit County, Washington

Station: 22+00

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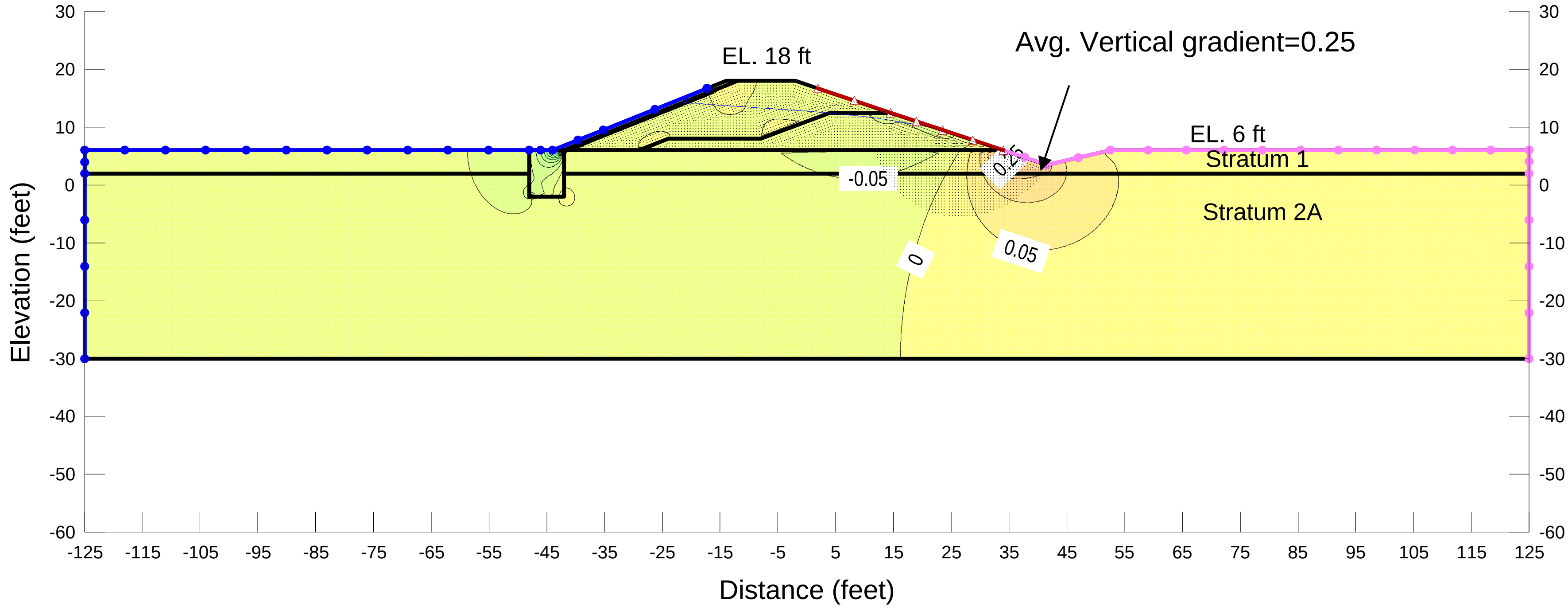

Figure 1.6

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Vertical Gradient Contours with Clay Blanket and Clay Cutoff Case

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Fisher Slough Restoration Project
Skagit County, Washington

Station: 22+00

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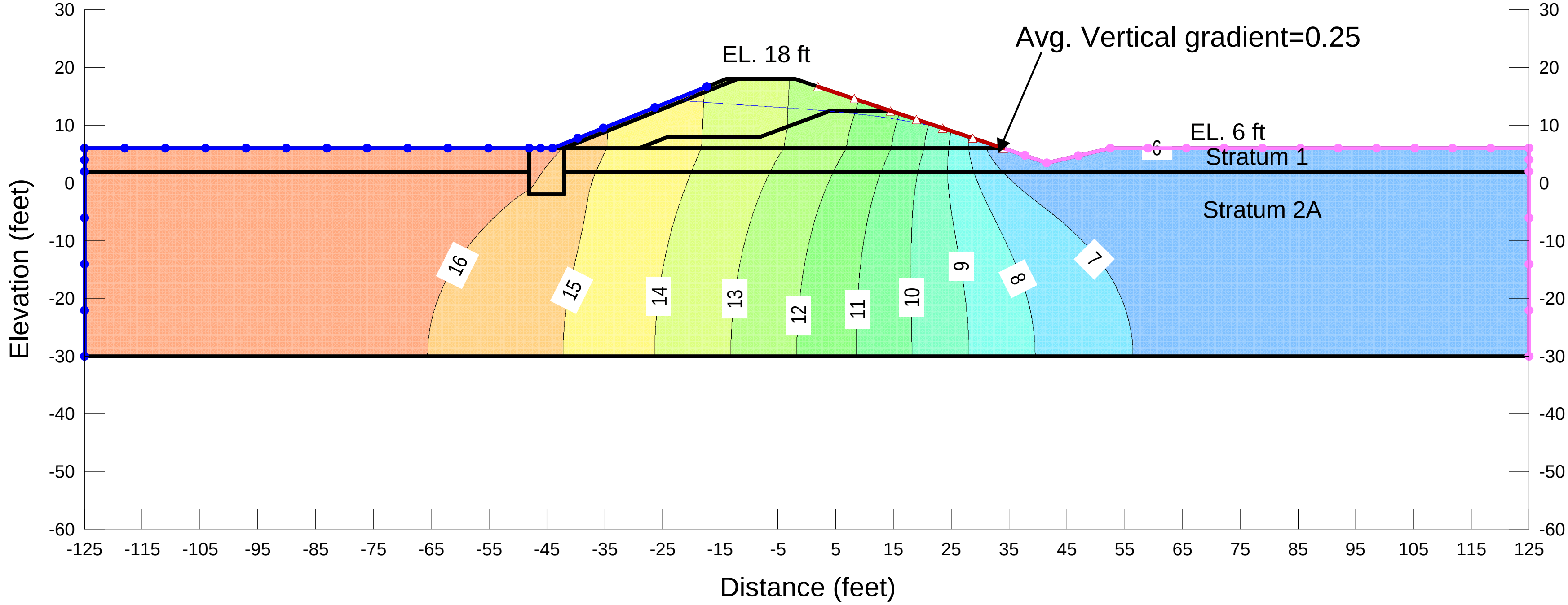

Figure 1.7

Job No. 33761856

Total Head Contours with Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 38+00

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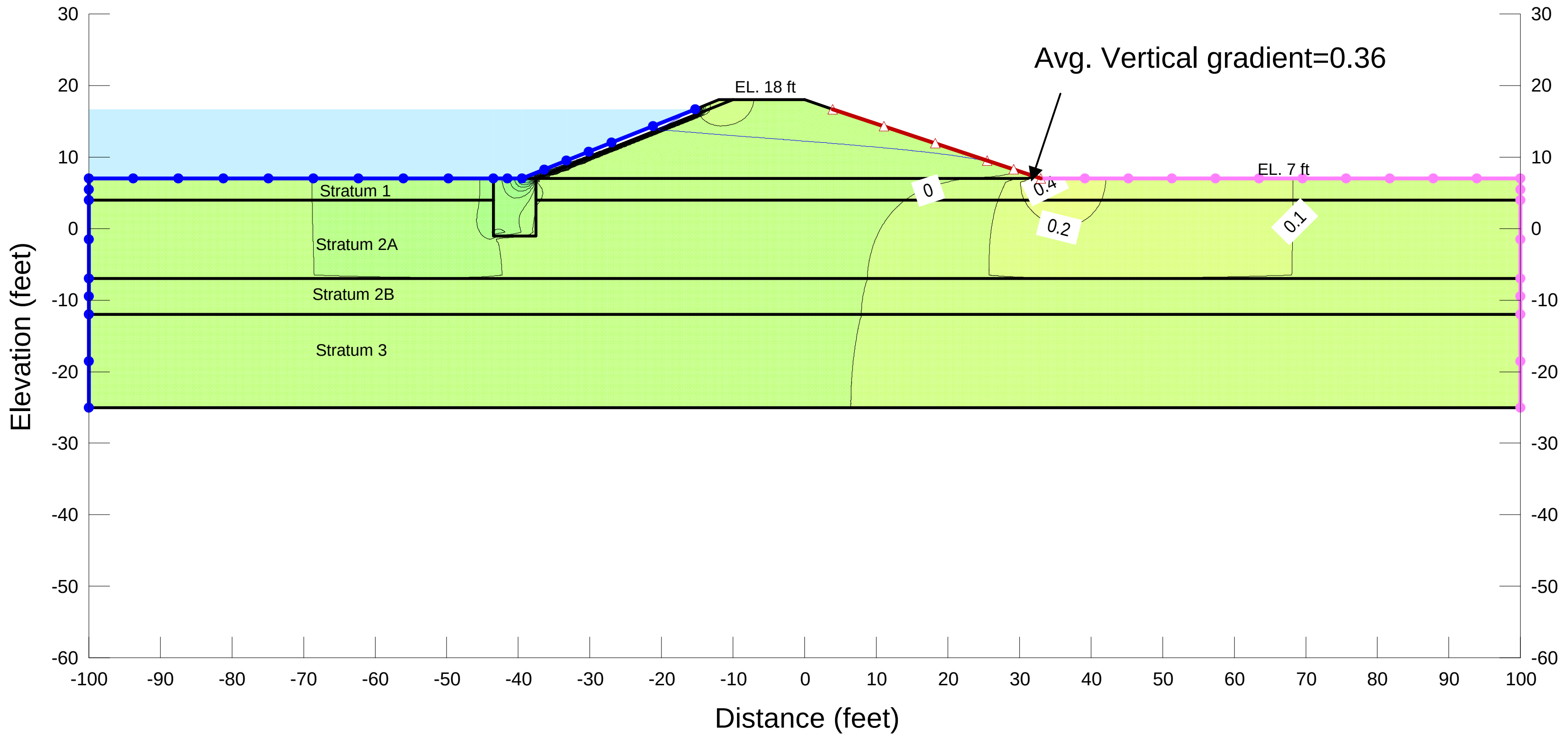

Figure 1.8

Job No. 33761856

Vertical Gradient Contours with Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 38+00

Name: Stratum 2B Model: Saturated Only K-Sat: 3.28084e-006 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
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Name: Stratum 1 Model: Saturated / Unsaturated K-Function: Stratum 1 Vol. WC. Function: Silt K-Ratio: 1 K-Direction: 0
Name: Fill Model: Saturated / Unsaturated K-Function: New Fill Vol. WC. Function: Silty Sand K-Ratio: 1 K-Direction: 0
Name: Stratum 3 Model: Saturated Only K-Sat: 3.28084e-005 Volumetric Water Content: 0 Mv: 0 K-Ratio: 1 K-Direction: 0
Name: Clay Blanket Model: Saturated / Unsaturated K-Function: Clay Blanket Vol. WC. Function: Clay Blanket K-Ratio: 1 K-Direction: 0
Name: Clay Cutoff Model: Saturated / Unsaturated K-Function: Clay Cutoff Vol. WC. Function: Clay Cutoff K-Ratio: 1 K-Direction: 0

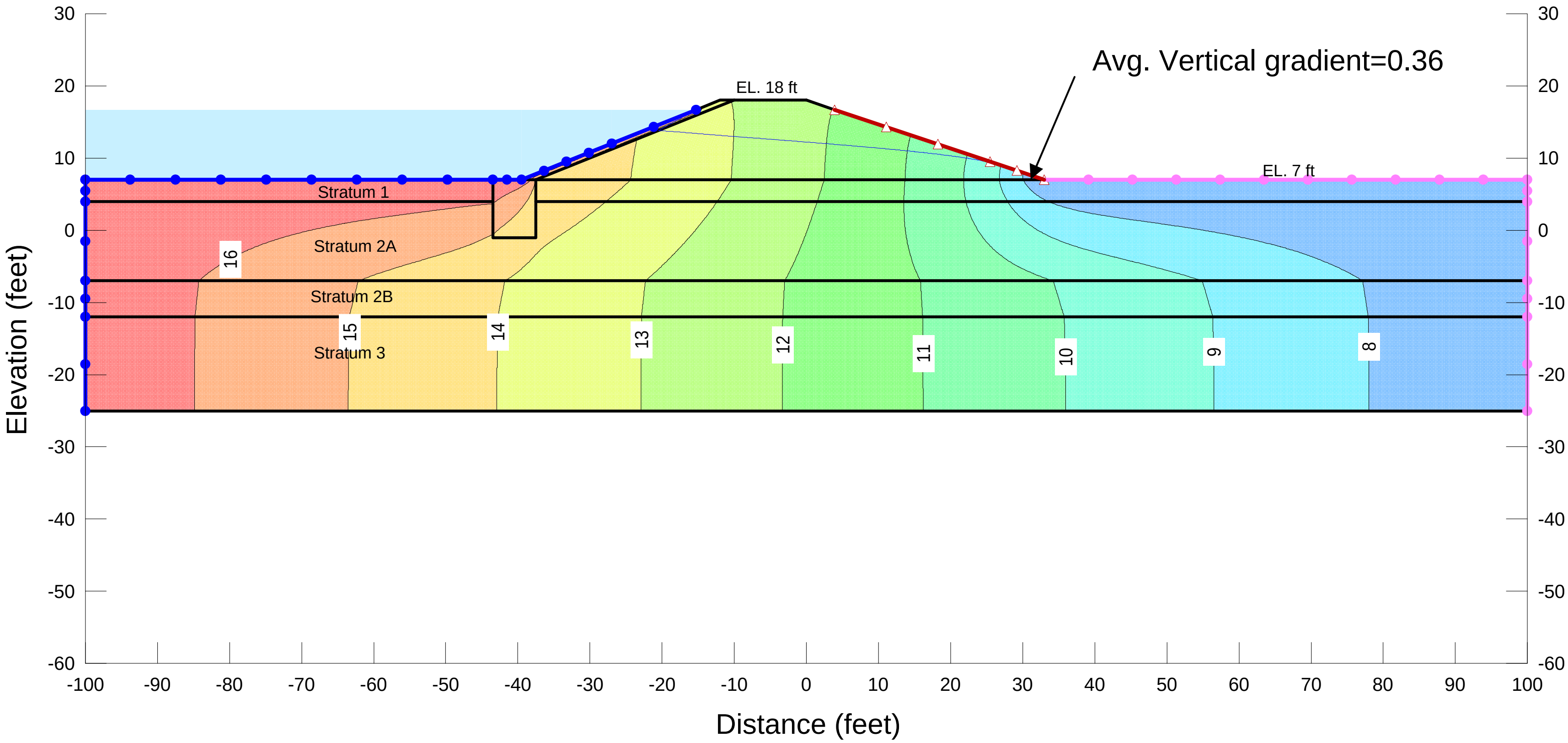

Figure 1.9

Total Head Contours with Clay Blanket and Clay Cutoff Case

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

End of 7[th] Day (End of Constant Head Run)

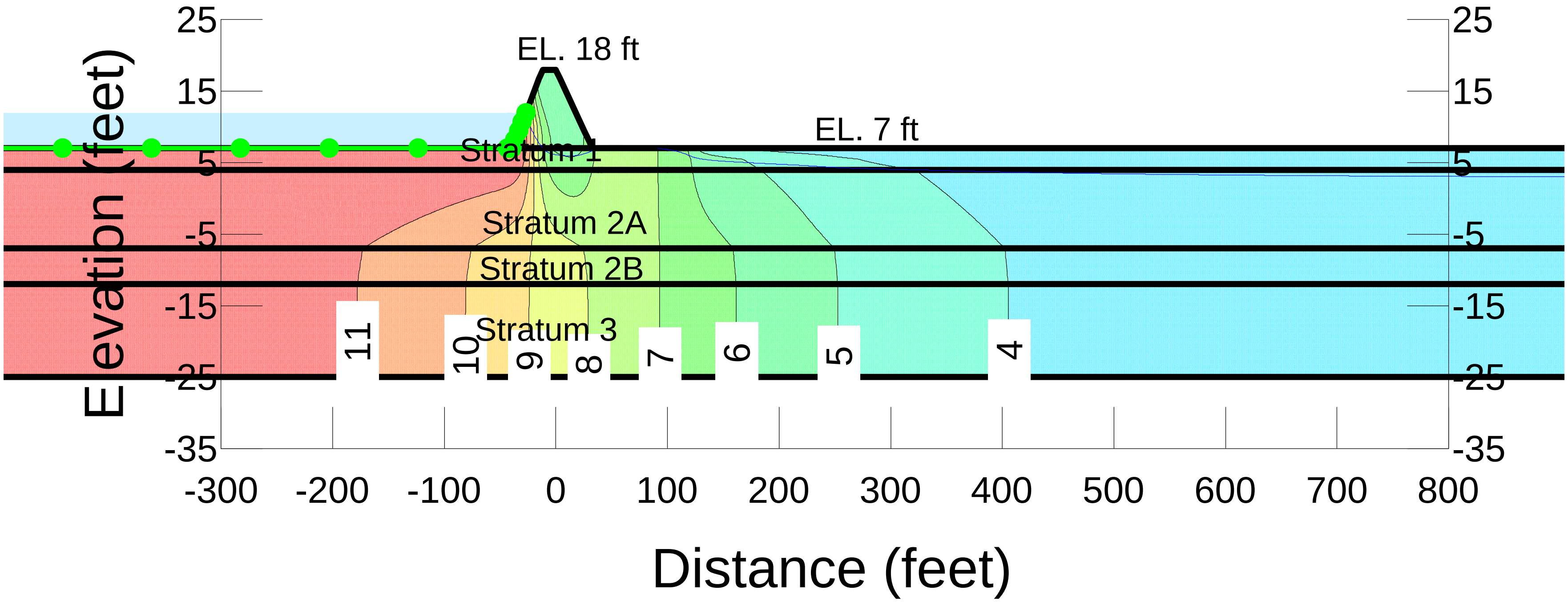

Figure 1.10

Job No. 33761856

Total Head Contours without Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

End of 7th Day (End of Constant Head Run)

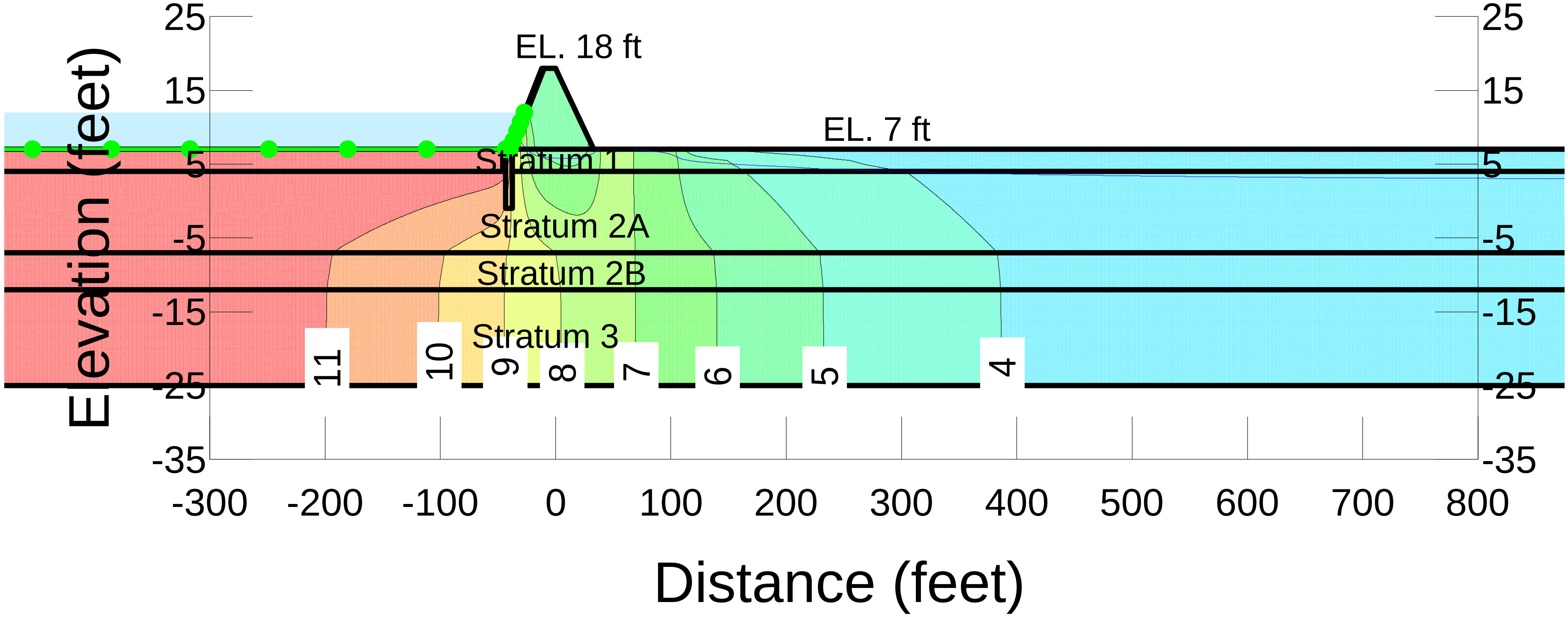

Figure 1.11

Job No. 33761856

Total Head Contours with Clay Blanket and Clay Cutoff Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

End of 7th Day (End of Constant Head Run)

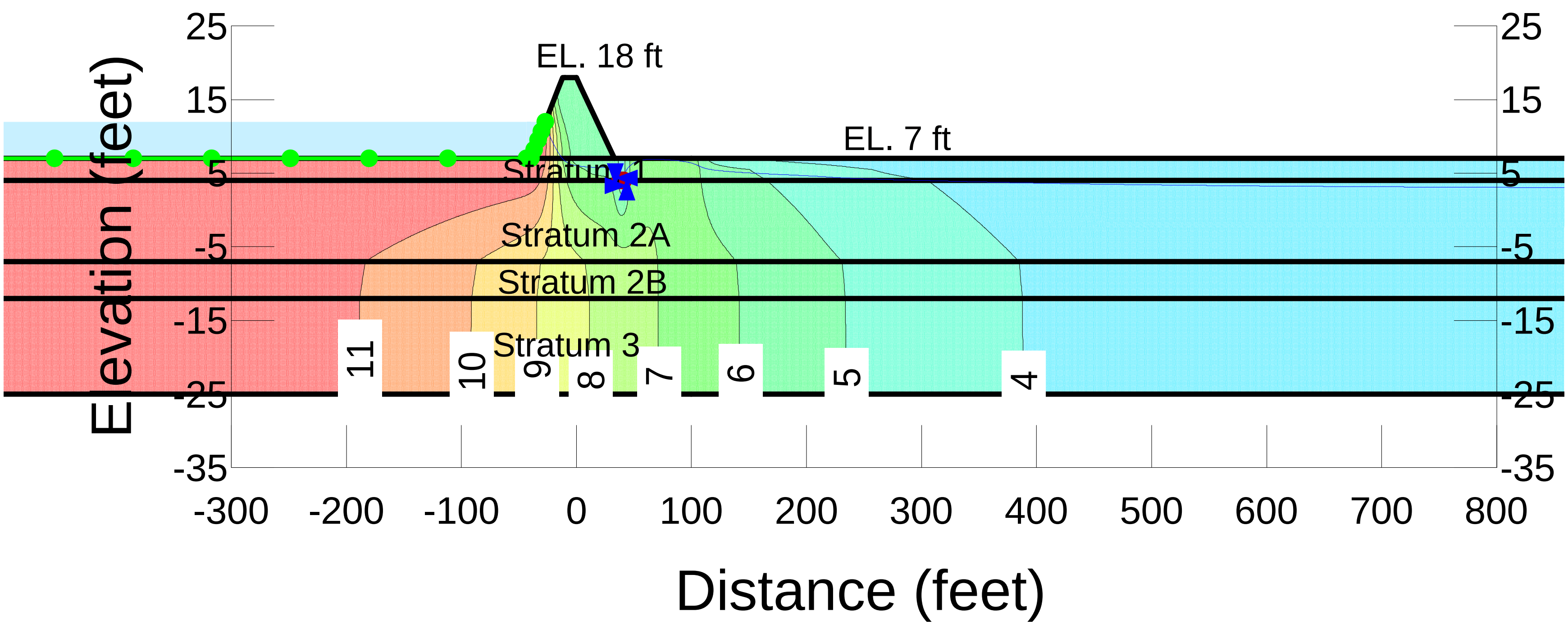

Figure 1.12

Job No. 33761856

Total Head Contours without Clay Blanket , Clay Cutoff and with Drain Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

End of 7th Day (End of Constant Head Run)

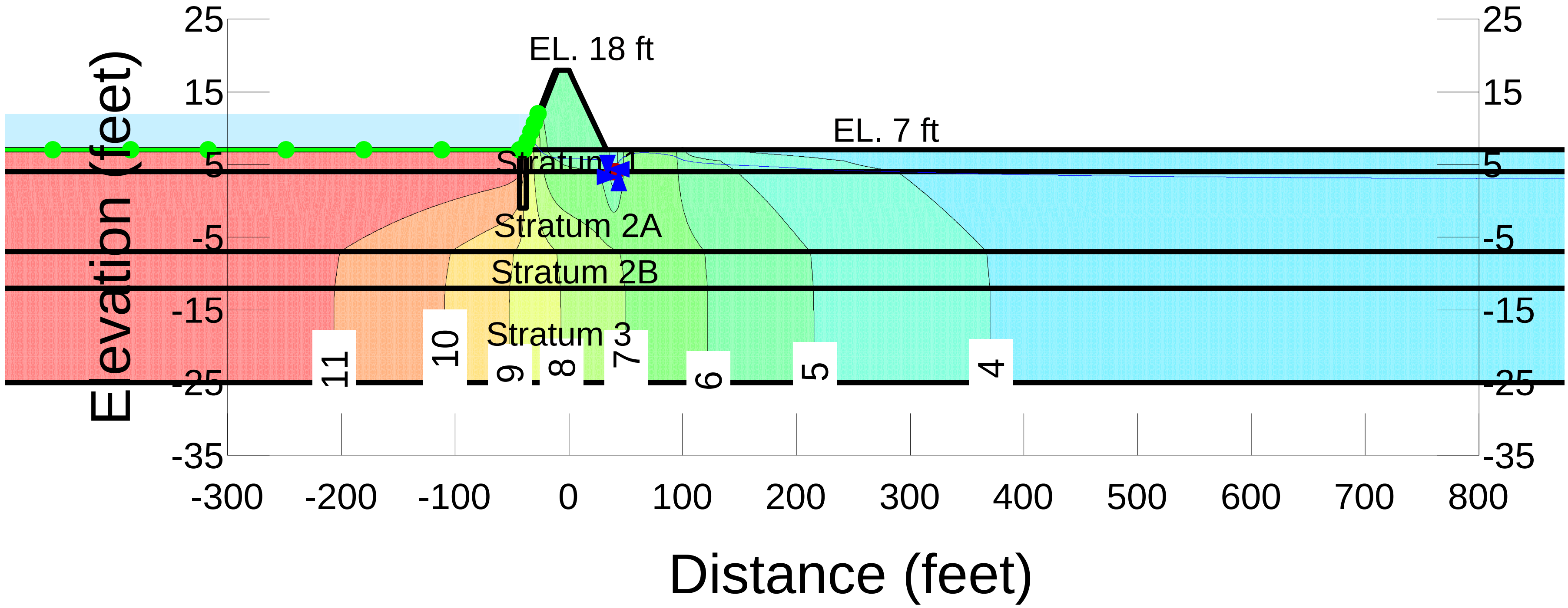

Figure 1.13

Job No. 33761856

Total Head Contours with Clay Blanket , Clay Cutoff and with Drain Case

URS

Fisher Slough Restoration Project
Skagit County, Washington

Attachment 2 - Selected Results of Stability Analyses

Name: Stratum 2B Model: S=f(overburden) Unit Weight: 100 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0

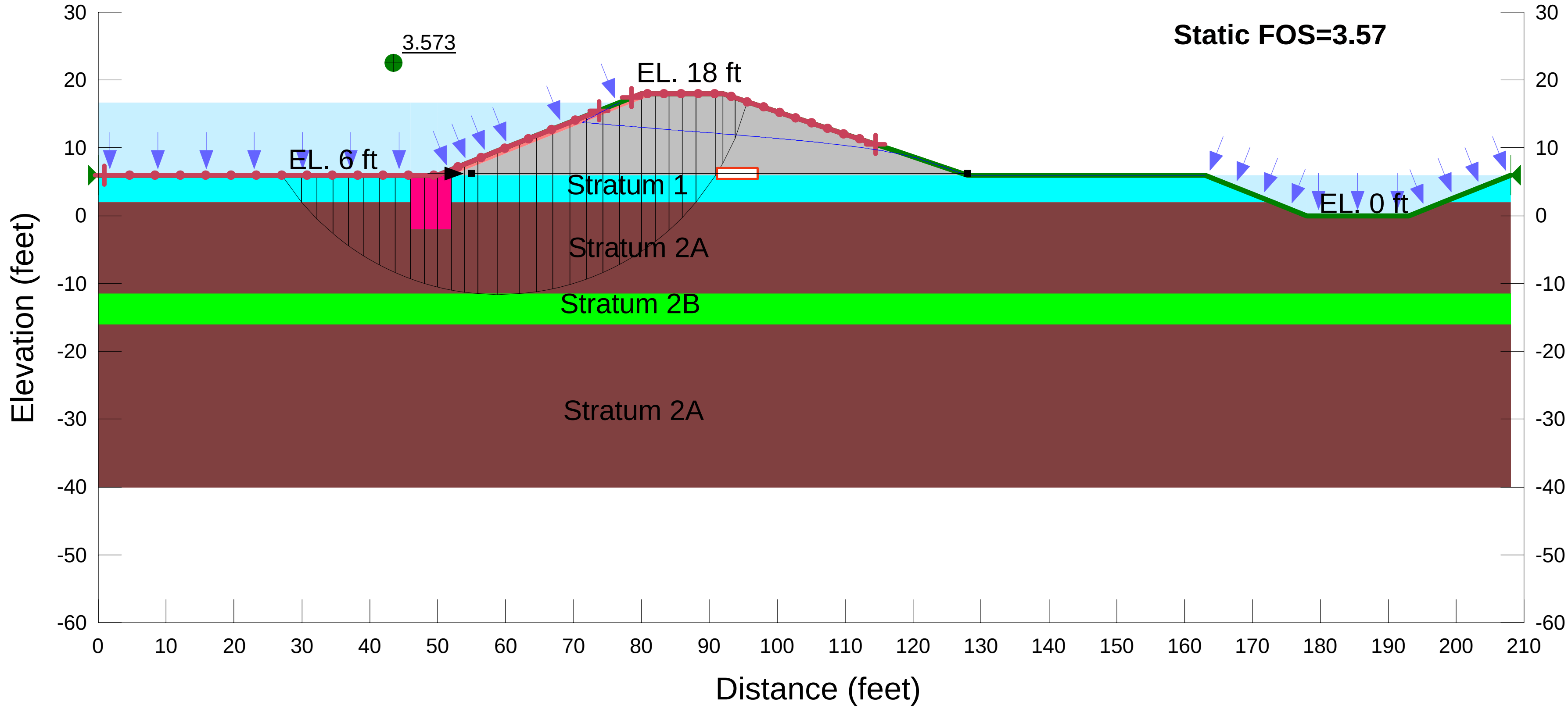

Figure 2.1

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Name: Stratum 2B Model: S=f(overburden) Unit Weight: 100 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0

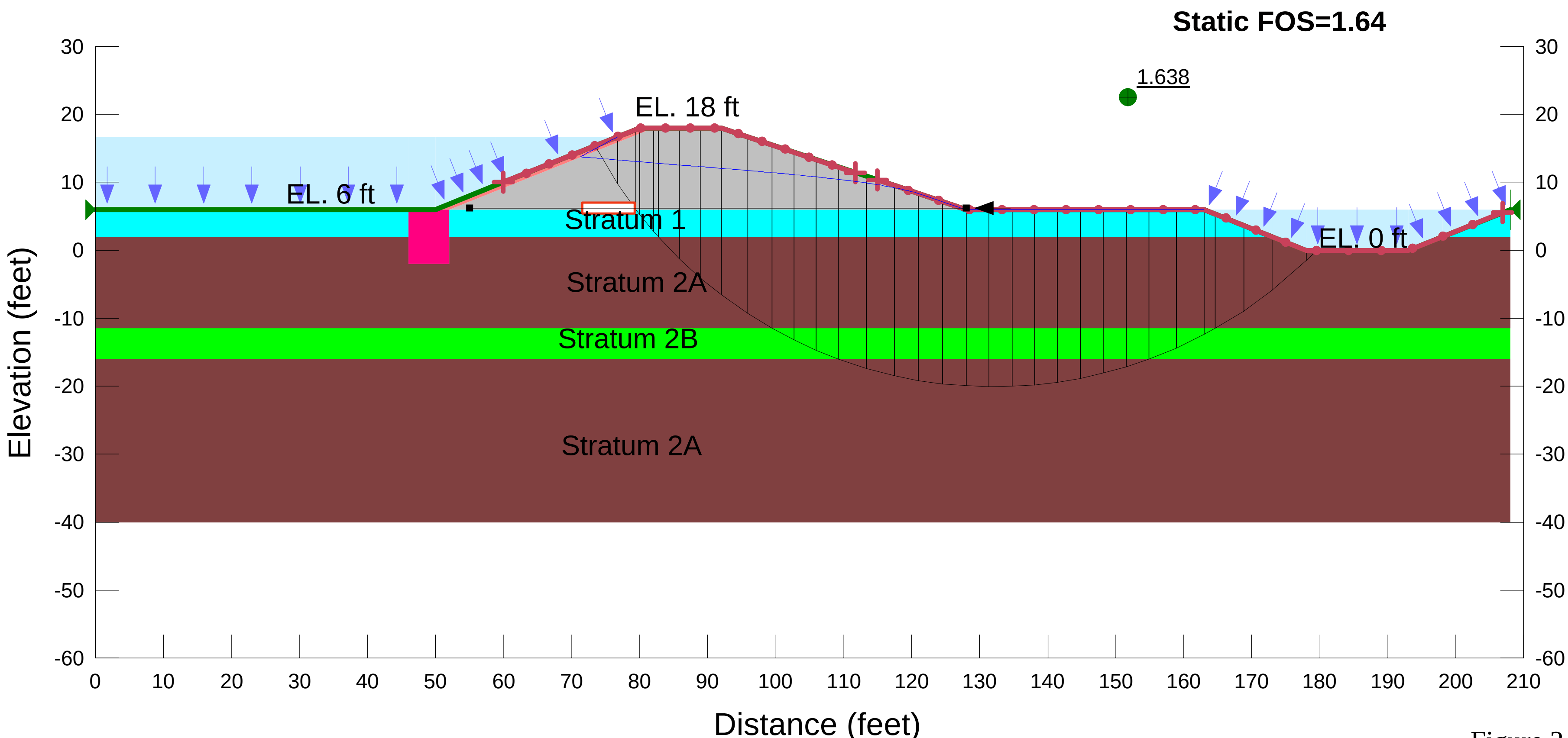

Figure 2.2

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Name: Stratum 2B Model: S=f(overburden) Unit Weight: 100 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0

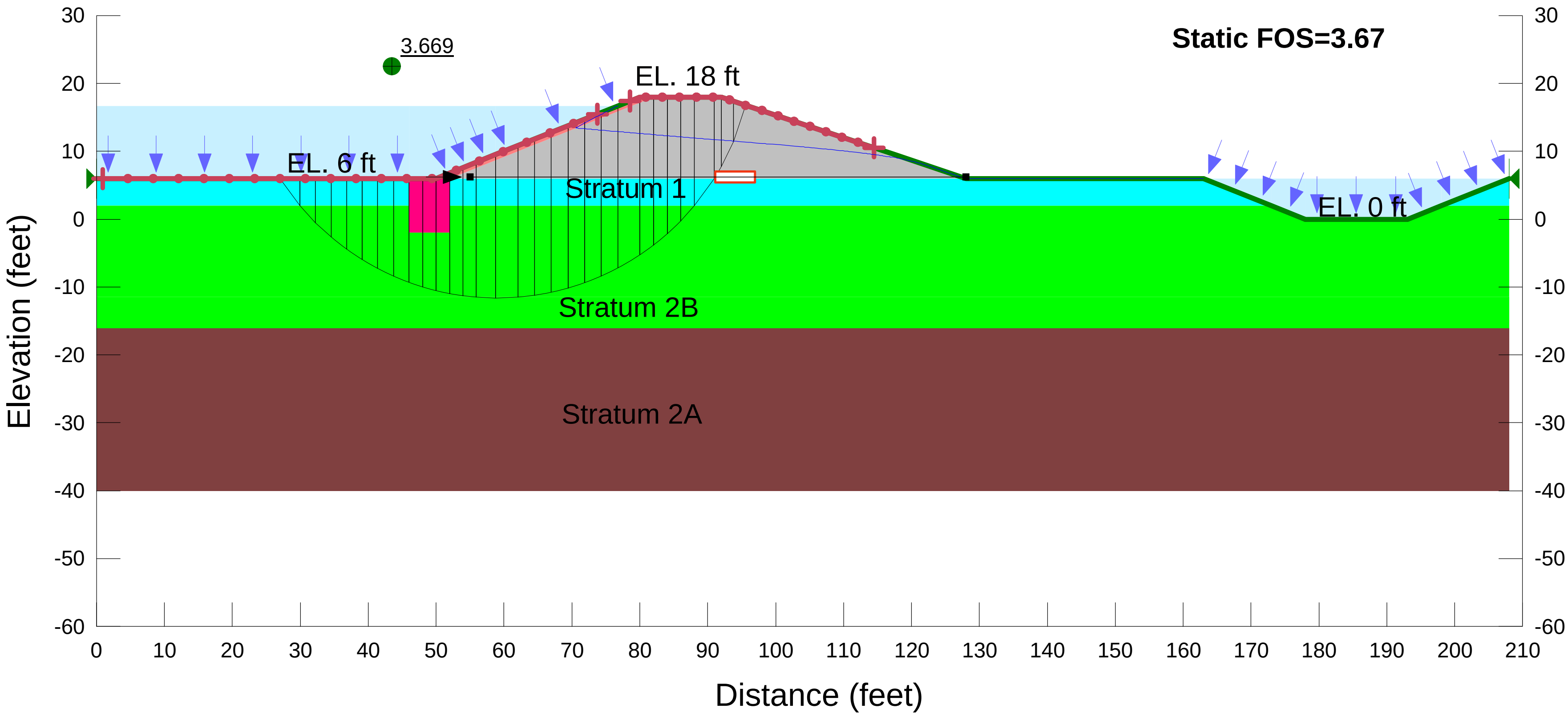

Figure 2.3

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Name: Stratum 2B   Model: S=f(overburden)   Unit Weight: 100   Tau/Sigma Ratio: 0.33   Minimum Strength: 250
Name: Stratum 2A   Model: S=f(overburden)   Unit Weight: 95   Tau/Sigma Ratio: 0.33   Minimum Strength: 250
Name: Stratum 1   Model: S=f(overburden)   Unit Weight: 110   Tau/Sigma Ratio: 0.33   Minimum Strength: 500
Name: Fill   Model: Mohr-Coulomb   Unit Weight: 120   Cohesion: 500   Phi: 36
Name: Clay Cutoff   Model: Mohr-Coulomb   Unit Weight: 115   Cohesion: 1000   Phi: 0
Name: Clay Blanket   Model: Mohr-Coulomb   Unit Weight: 115   Cohesion: 1000   Phi: 0

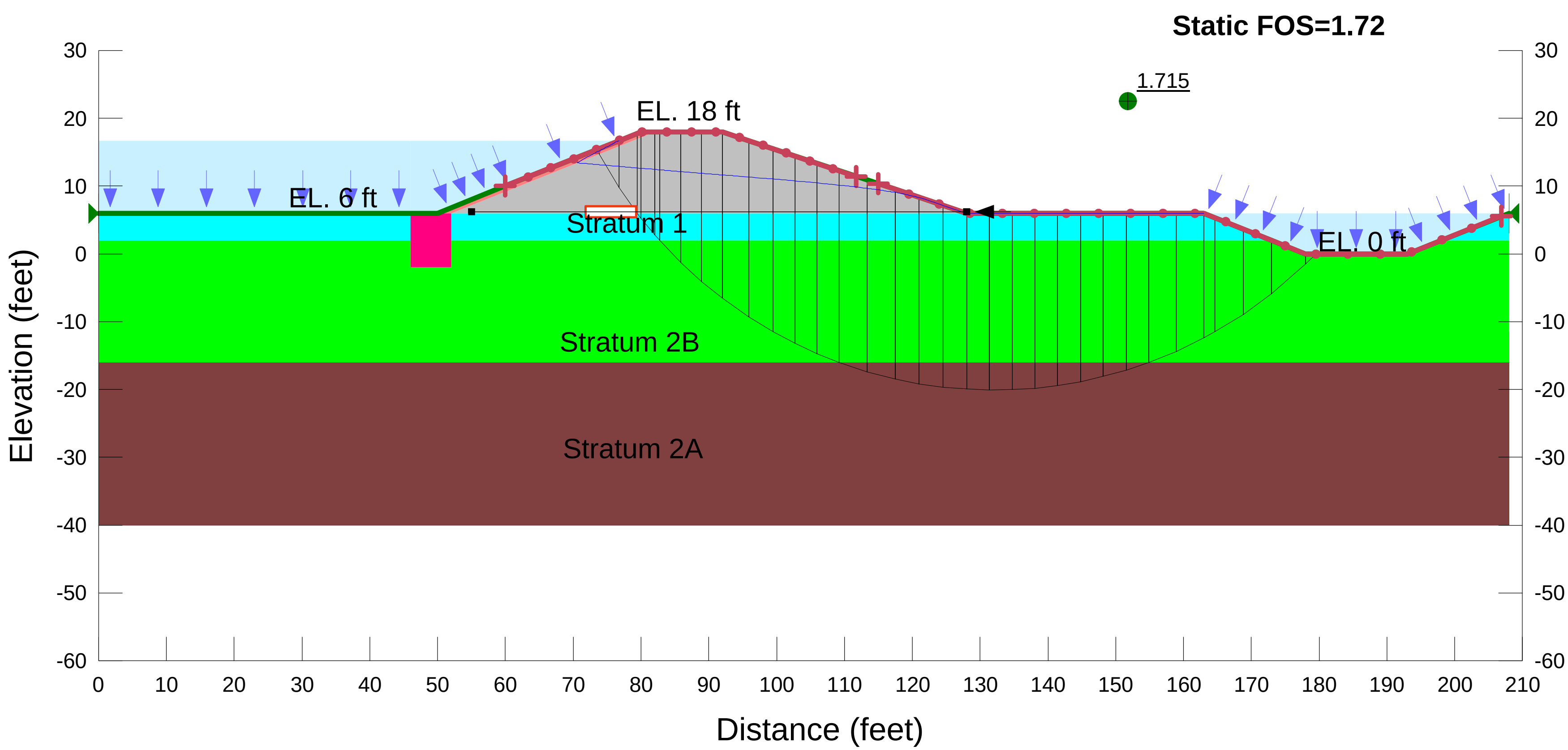

Figure 2.4

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 22+00

Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0

Static FOS=3.55

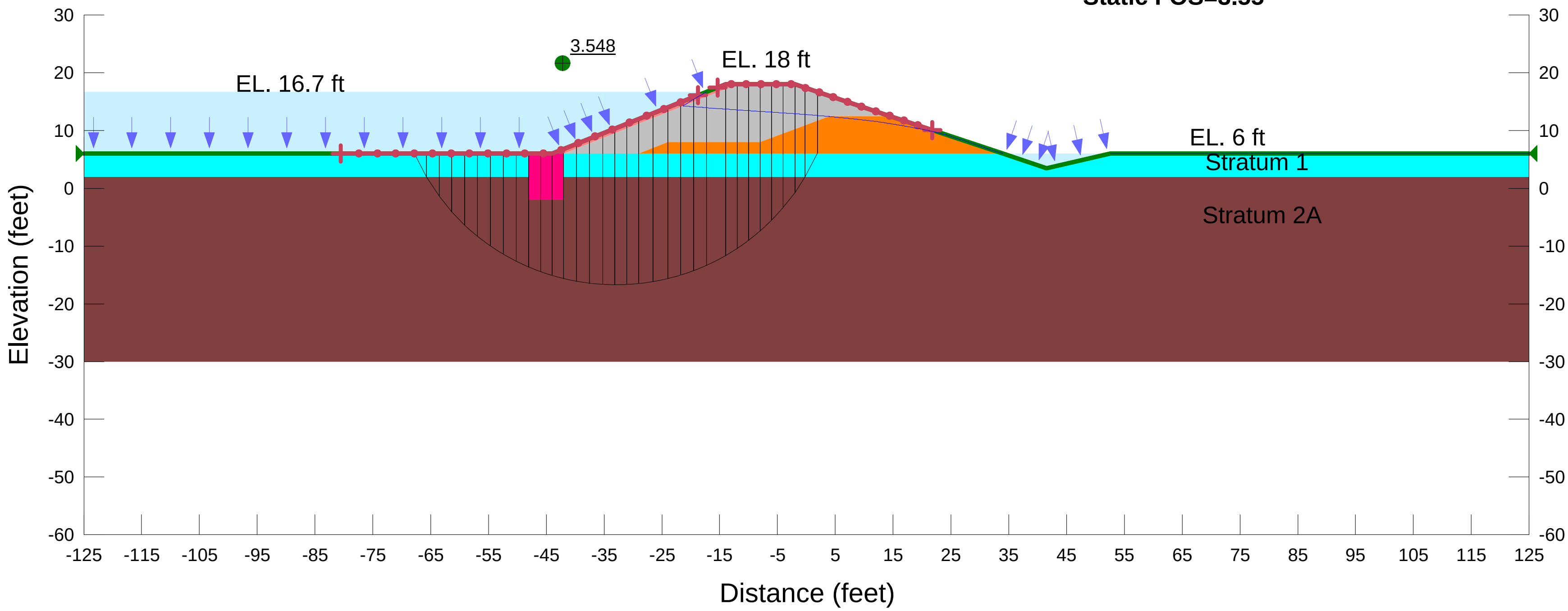

Figure 2.5

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 22+00

Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 115 Cohesion: 1000 Phi: 0

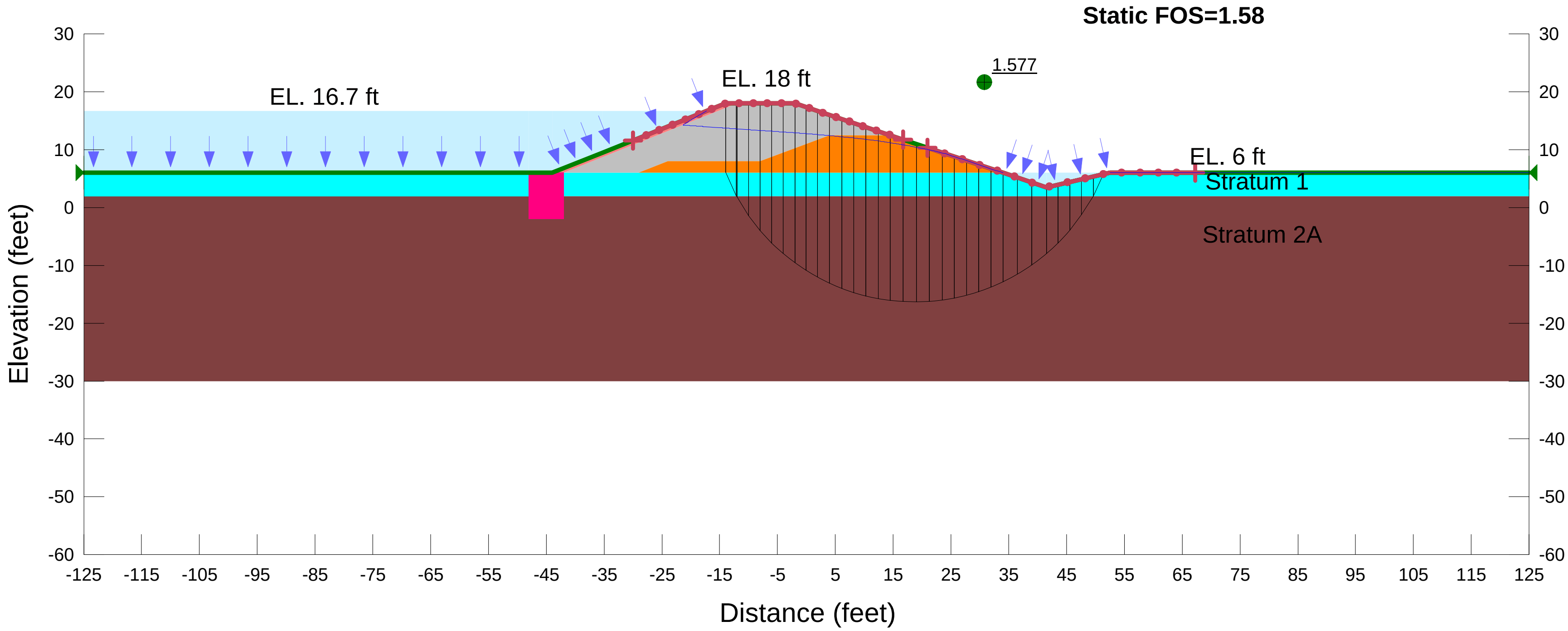

Figure 2.6

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 38+00

Name: Stratum 2B Model: S=f(overburden) Unit Weight: 100 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Stratum 3 Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 28
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0

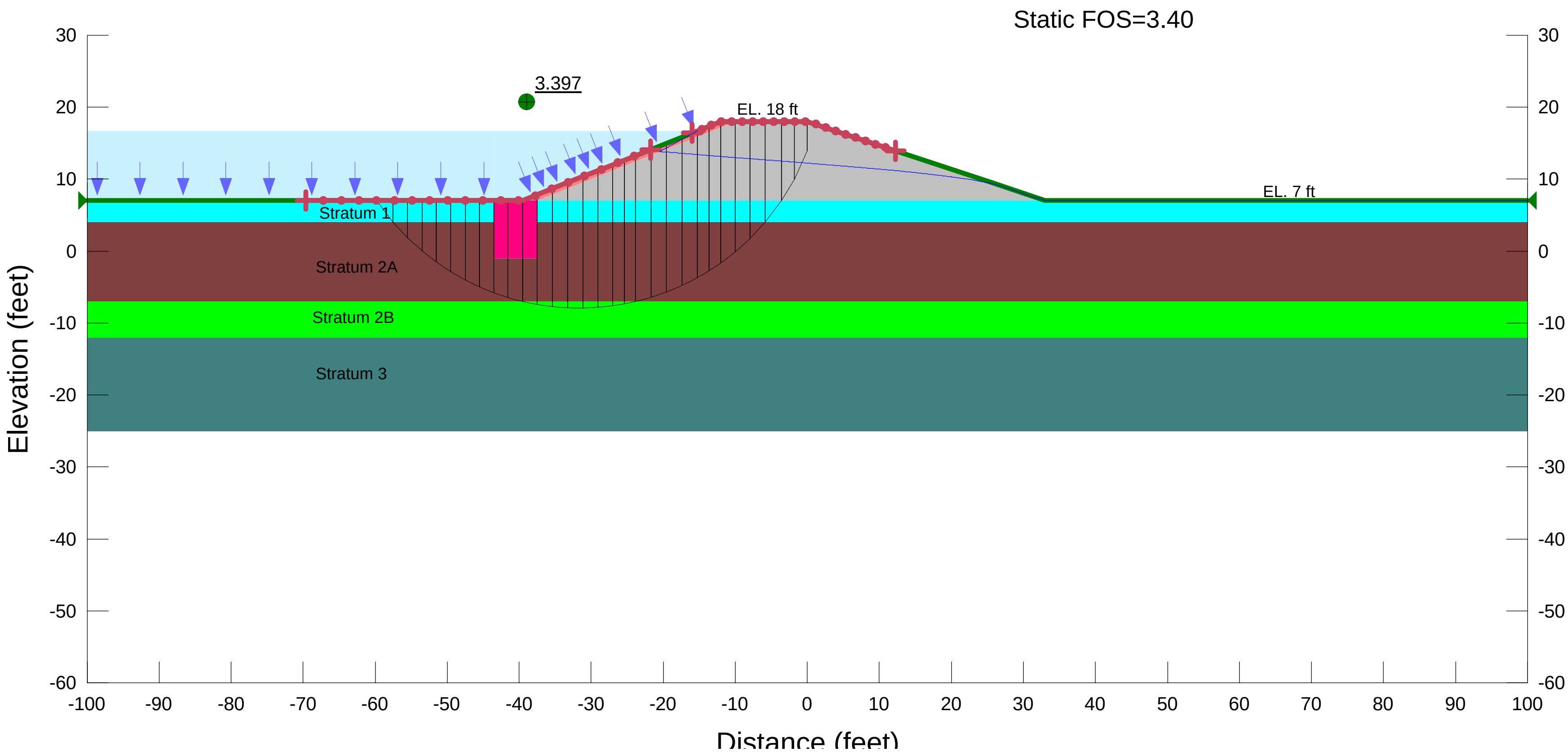

Figure 2.7

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington

Station: 38+00

Name: Stratum 2B Model: S=f(overburden) Unit Weight: 100 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 2A Model: S=f(overburden) Unit Weight: 95 Tau/Sigma Ratio: 0.33 Minimum Strength: 250
Name: Stratum 1 Model: S=f(overburden) Unit Weight: 110 Tau/Sigma Ratio: 0.33 Minimum Strength: 500
Name: Fill Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 500 Phi: 36
Name: Stratum 3 Model: Mohr-Coulomb Unit Weight: 110 Cohesion: 0 Phi: 28
Name: Clay Blanket Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0
Name: Clay Cutoff Model: Mohr-Coulomb Unit Weight: 120 Cohesion: 2000 Phi: 0

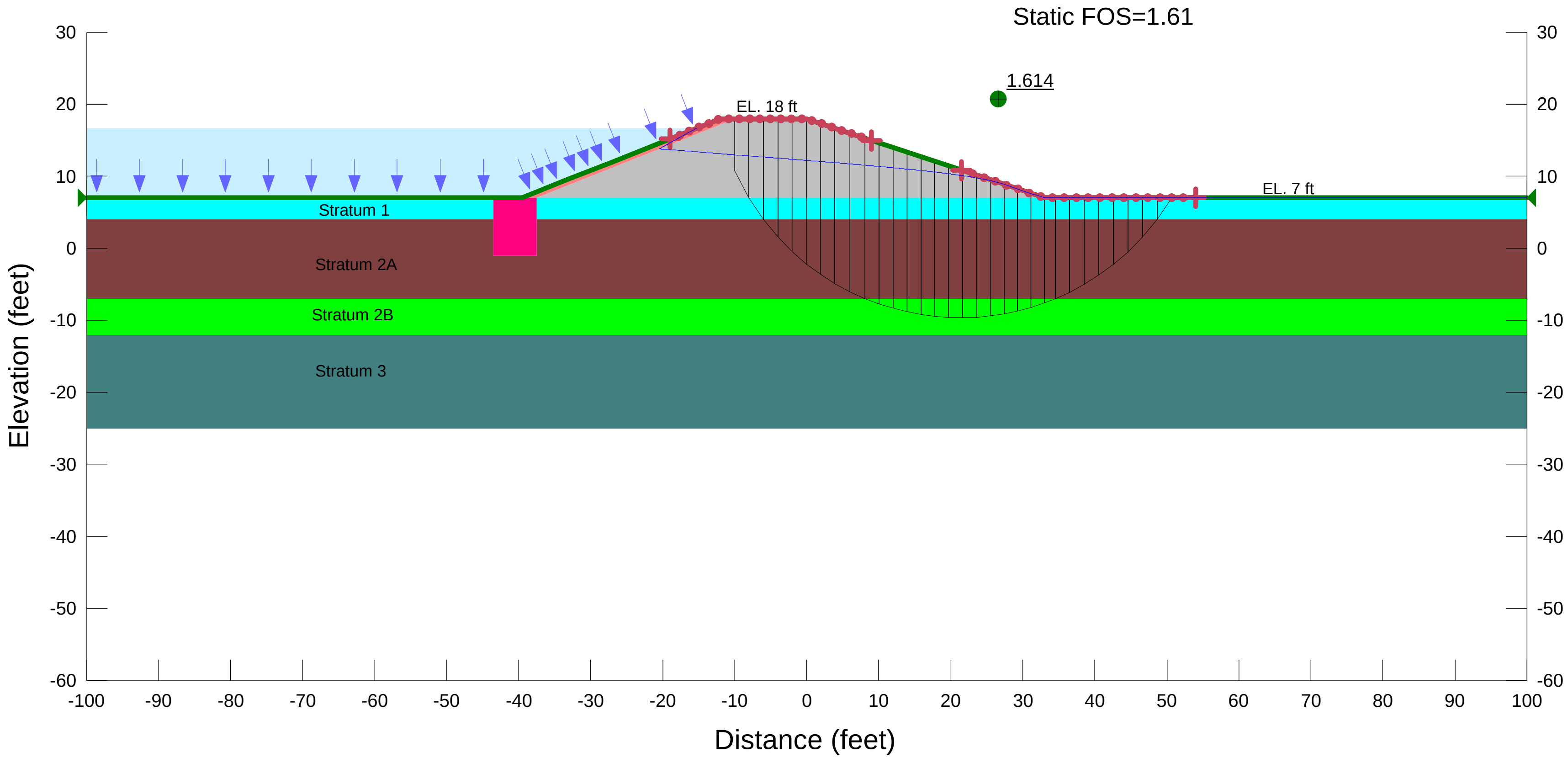

Figure 2.8

Job No. 33761856

URS

Fisher Slough Restoration Project
Skagit County, Washington