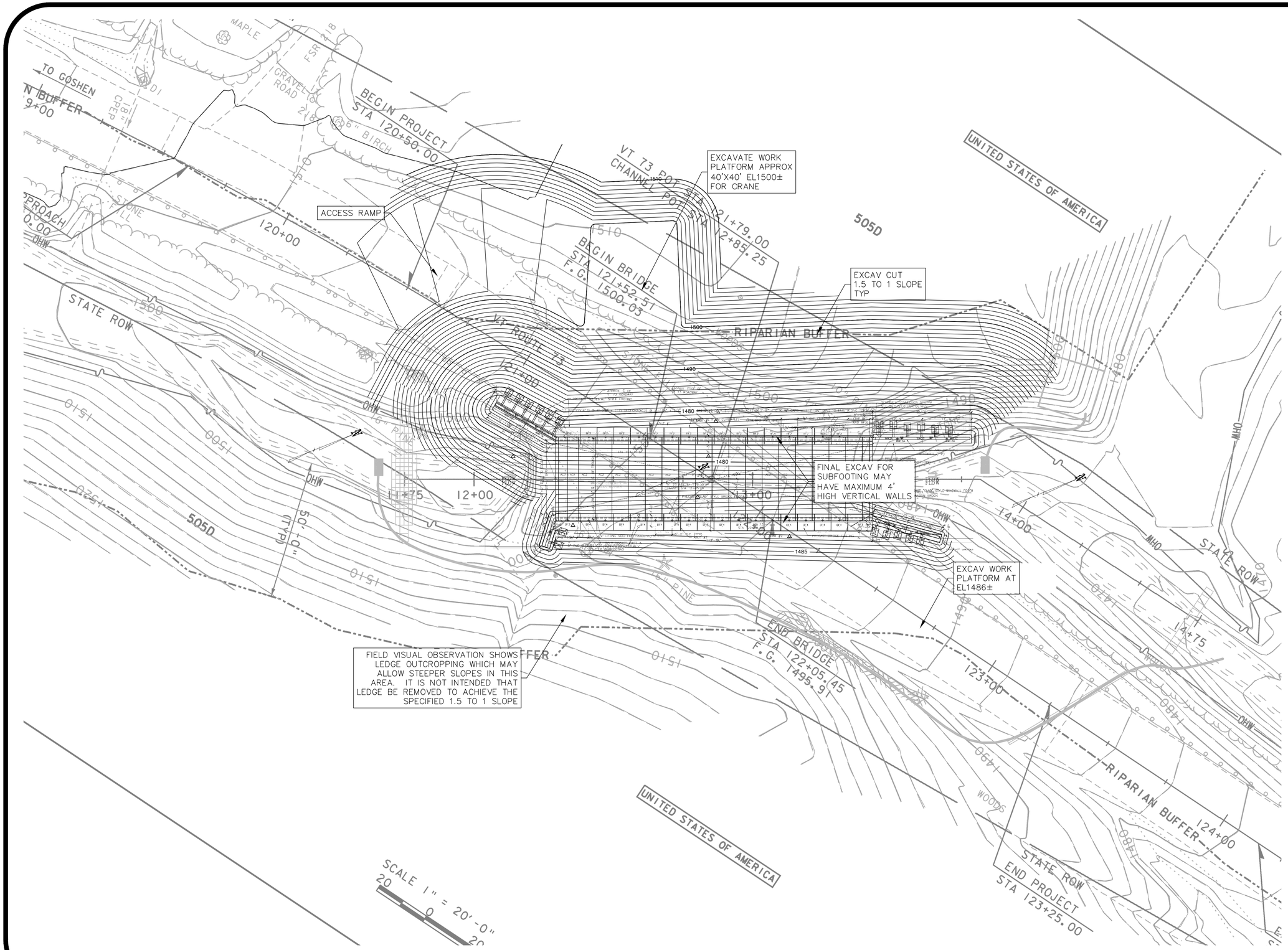


PLAN VIEW

$\frac{1}{8}$" = 1'

General Notes

Excavation:

1. Design is based on OSHA Soil Type C
2. Maximum allowable slope of excavation is 1.5 to 1 unless otherwise noted
3. Excavator is to be positioned such that track pressure is a minimum 3' back from top of slope

STATE OF VERMONT
TERRY WAITE
LICENSED
PROFESSIONAL ENGINEER

September 9, 2014

No.	Revision/Issue	Date

Firm Name and Address

TAW Associates
Waterville Valley, NH
603-236-4247 www.TAWAssociates.net

Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 - Rochester, VT Vtrans ER BRF 0162(19), (16), (17) & (18)

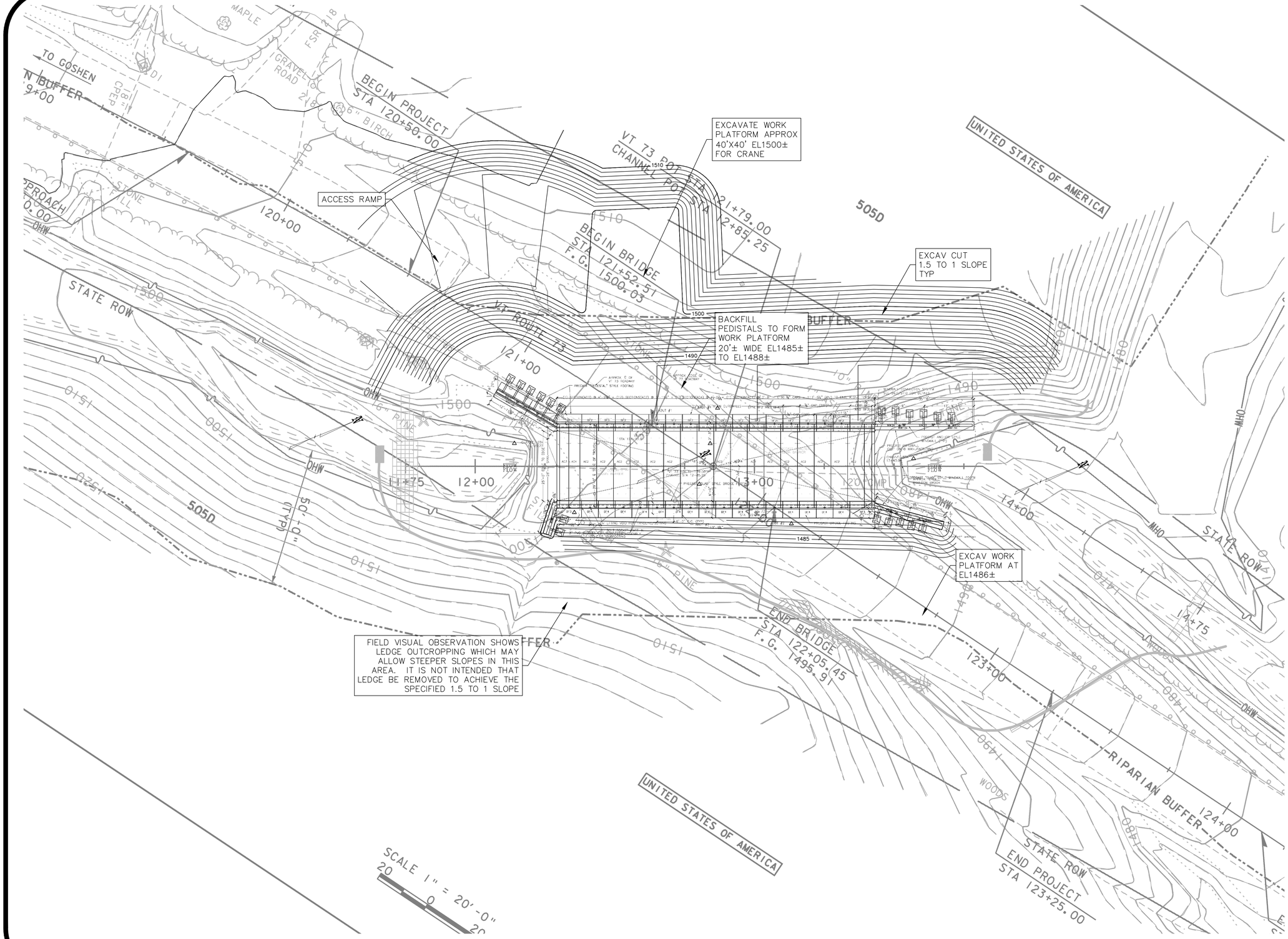
Project Name and Address

Partial Erection Bridge 13

EXCAVATION PLAN FOR FOOTINGS

Project 140404A	Sheet EX01
Date September 9, 2014	
Scale noted	

SCHULTZ CONSTRUCTION, INC.



PLAN VIEW

$\frac{1}{8}$" = 1'

General Notes

Excavation:

1. Design is based on OSHA Soil Type C
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Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 - Rochester, VT Vtrans ER BRF 0162(19), (16), (17) & (18)

Project Name and Address

Partial Erection Bridge 13

EXCAVATION PLAN FOR ARCHES

Project 140404A	Sheet EX02
Date September 9, 2014	
Scale noted	

SCHULTZ CONSTRUCTION, INC.

DOCUMENT: 140404A

Bridge 13
Precast Erection
Excavation Plan

-

For The Project:
Proposed Improvement Bridge Project Bridge No. 13, 15, 16 & 19 – Rochester, VT
Vtrans ER BRF 0162(19), (16), (17) & (18)

-

for

SCHULTZ CONSTRUCTION, INC.

by

TAW ASSOCIATES

September 9, 2014

TABLE OF CONTENTS

TABLE OF CONTENTS *2*
SCOPE *3*
EXISTING CONDITIONS *3*
PROCEDURE *3*
Excavation: **3**
SUPPORTING COMPUTATIONS: *3*
SLOPE STABILITY ANALYSIS **3**

SCOPE

Provide plan for the excavation for the erection of the precast segments for Bridge 13 for the Project.

EXISTING CONDITIONS

Existing conditions as used in this design are those taken from Contract Documents.

PROCEDURE

This document is supplemented by drawings of the same number. Refer to drawings for details.

Excavation:
1. Design is based on OSHA Soil Type C
2. Maximum allowable slope of excavation is 1.5 to 1 unless otherwise noted
3. Excavator is to be positioned such that track pressure is a minimum 3' back from top of slope

SUPPORTING COMPUTATIONS:

SLOPE STABILITY ANALYSIS

OSHA Soil Type classification is based on the following:

where,

"Granular soil" means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Type B means:
a. Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or
b. Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
c. Previously disturbed soils except those which would otherwise be classed as Type C soil.
d. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
e. Dry rock that is not stable; or

f. Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:
a. Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or
b. Granular soils including gravel, sand, and loamy sand; or
c. Submerged soil or soil from which water is freely seeping; or
d. Submerged rock that is not stable, or
e. Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

with,

(d) Acceptable visual and manual tests. - **(1) Visual tests**. Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as
samples from excavated material.
(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. ***Soil composed primarily of coarse-grained sand or gravel is granular material.***
(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. ***Soil that breaks up easily and does not stay in clumps is granular***.
(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.
(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.
(v) Observed the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.
(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.
(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.
(2) Manual tests. Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.
(i) Plasticity. Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) Dry strength. ***If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular*** (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not
break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.
(iii) Thumb penetration. The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488 - "Standard Recommended Practice for Description of Soils (Visual - Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. ***Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure.*** This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.
(iv) Other strength tests. Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.
(v) Drying test. The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:
(A) If the sample develops cracks as it dries, significant fissures are indicated.
(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as an unfissured cohesive material and the unconfined compressive strength should be determined.
(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. ***If they pulverize easily into very small fragments, the material is granular.***

OSHA Standards allow for maximum slopes of,

Type B Soil

Type B soil refers to cohesive soil that has a compressive strength between 0.5 tons per square feet and 1.5 tons per square feet. Examples of Type B soil include crushed rock, silt or dry rock that is not stable. Type B soil has a maximum allowable slope of a 45 degree angle.

Type C Soil

Gravel, sand and unstable submerged rock are examples of Type C soil. Type C soil has a compressive strength of 0.5 tons per square feet or less. Excavations in Type C soil are permitted a maximum allowable slope of 34 degrees.

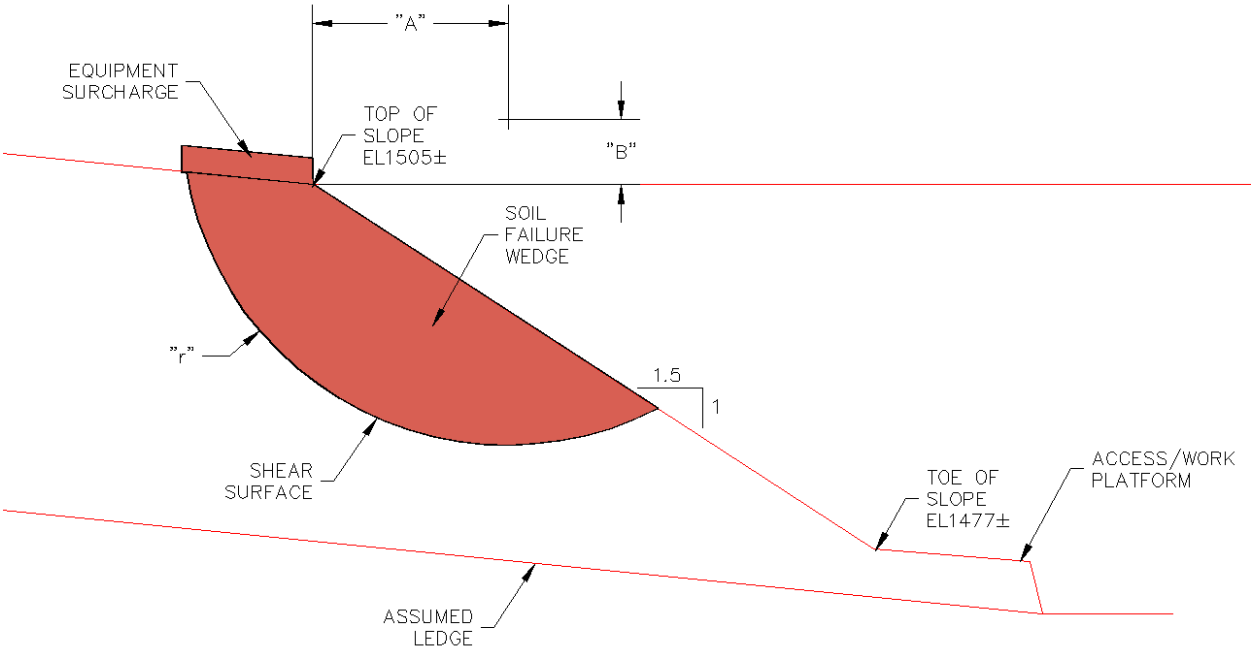
Based on field observation and review of boring logs in the area provided in the Contract Documents, the following assumptions are made for the slope soil,

OSHA Soil Classification = Type C
Material = sand-gravel, medium density
γ_s' = 0.125kcf
N = 20bpf
ϕ = 34°

An equipment surcharge is applied at the top of slope,

s_{equip} = 0.250ksf

applied as a soil surcharge 10' wide and 2' deep (where 2 * γ_s' = 0.250ksf).



A soil failure wedge is sought through trial and error to find the lowest factor of safety against shear failure along the shear surface by taking the moment about the center of the shear surface radius.

TRIAL:	A =	0		B =	0		r =	25	
Element					Density kcf	Weight k		Moment About 0.0	
1	Area:			832.5216	0.125	104.07	k	(420)	ft-k
	Perimeter:			116.6017					
	Bounding box:	X:		-25					
		Y:		-25.000					
	Centroid:	X:		-4.036					
		Y:		-11.468					
		Z:		0.5					
2	Area:			20	0.125	2.50	k	(13)	ft-k
	Perimeter:			24.0998					
	Bounding box:	X:		-10					
				0.0000 --					
		Y:		3.0000					
	Centroid:	X:		-5.000					
		Y:		1.500					
		Z:		0.5					
						107	k	(433)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	71.88	k	Weight*tanϕ/arc length
r =	25.00	ft	radius of shear surface

Resisting Moment = shear * r = 1,797 ft-k

FS = 4.15

TRIAL:	A =	0	B =	0		**r =**	**20**	
Element				Density kcf	Weight k		**Moment About 0.0**	
1	Area:		532.8138	0.125	66.60	**k**	**(215)**	ft-k
	Perimeter:		93.2814					
	Bounding	X:	-20					

	box:							
		Y:	-20.000					
	Centroid:	X:	-3.229					
		Y:	-9.174					
		Z:	0.5					
2	Area:		20	0.125	2.50	**k**	**(13)**	ft-k
	Perimeter:		24.0998					
	Bounding box:	X:	-10 0.0000 --					
		Y:	3.0000					
	Centroid:	X:	-5.000					
		Y:	1.500					
		Z:	0.5					
					69	**k**	**(228)**	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	46.61	k	Weight*tanϕ/arc length
r =	20.00	ft	radius of shear surface

Resisting Moment = shear * r = 932 ft-k

FS = 4.10

TRIAL:	A =	0	B =	0		**r =**	**15**	
Element				Density kcf	Weight k		**Moment About 0.0**	
1	Area:		299.7078	0.125	37.46	**k**	**(91)**	ft-k
	Perimeter:		69.961					
	Bounding box:	X:	-15					
		Y:	-15.000					
	Centroid:	X:	-2.422					
		Y:	-6.881					
		Z:	0.5					
2	Area:		20			**k**		ft-k

			0.125	2.50		**(13)**	
Perimeter:		24.0998					
Bounding box:	X:	-10					
		0.0000 --					
	Y:	3.0000					
Centroid:	X:	-5.000					
	Y:	1.500					
	Z:	0.5					

			40	**k**	**(103)**	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	26.96	k	Weight*tanϕ/arc length
r =	15.00	ft	radius of shear surface

Resisting Moment = shear * r = 404 ft-k

FS = 3.92

TRIAL: A = 0 B = 0 r = 10

Element				Density kcf	Weight k		Moment About 0.0	
1	Area:		133.2035	0.125	16.65	k	(27)	ft-k
	Perimeter:		46.6407					
	Bounding box:	X:	-10					
		Y:	-10.000					
	Centroid:	X:	-1.615					
		Y:	-4.587					
		Z:	0.5					
2	Area:		20	0.125	2.50	k	(13)	ft-k
	Perimeter:		24.0998					
	Bounding box:	X:	-10					
			0.0000 --					
		Y:	3.0000					

Centroid:	X:	-5.000					
	Y:	1.500					
	Z:		0.5				
				19	k	(39)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	12.92	k	Weight*tanϕ/arc length
r =	10.00	ft	radius of shear surface

Resisting Moment = shear * r = 129 ft-k

FS = 3.28

TRIAL: A = 0 B = 0 r = 5

Element				Density kcf	Weight k		Moment About 0.0	
1	Area:		33.3009	0.125	4.16	k	(3)	ft-k
	Perimeter:		23.3203					
	Bounding box:	X:	-5					
		Y:	-5.000					
	Centroid:	X:	-0.807					
		Y:	-2.294					
		Z:	0.5					
2	Area:		9.483	0.125	1.19	k	(3)	ft-k
	Perimeter:		13.4346					
	Bounding box:	X:	-4.9752					
		Y:	0.000					
	Centroid:	X:	-2.374					
		Y:	1.216					
		Z:	0.5					
					5	k	(6)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient

shear =	3.61	k	Weight*tanϕ/arc length
r =	5.00	ft	radius of shear surface

Resisting Moment = shear * r = 18 ft-k

FS = 2.92

TRIAL: A = -5 B = 0 r = 5

Element				Density kcf	Weight k		Moment About 0.0	
1	Area:		44.2369	0.125	5.53	k	(1)	ft-k
	Perimeter:		26.655					
	Bounding box:	X:	-5					
		Y:	-5.000					
	Centroid:	X:	-0.185					
		Y:	-1.847					
		Z:	0.5					
2	Area:		20	0.125	2.50	k	-	ft-k
	Perimeter:		24.0998					
	Bounding box:	X:	-5					
		Y:	0.000					
	Centroid:	X:	0.000					
		Y:	1.500					
		Z:	0.5					
					8	k	(1)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	5.42	k	Weight*tanϕ/arc length
r =	5.00	ft	radius of shear surface

Resisting Moment = shear * r = 27 ft-k

FS = 26.51

TRIAL:	A =	5	B =	0		r =	5	
				Density	Weight		**Moment**	
Element				kcf	k		**About 0.0**	
1	Area:		13.4083	0.125	1.68	**k**	**(3)**	ft-k
	Perimeter:		18.316					
	Bounding box:	X:	-5					
		Y:	-5.000					
	Centroid:	X:	-1.996					
		Y:	-3.065					
		Z:	0.5					
2	Area:		0	0.125	-	**k**	**-**	ft-k
	Perimeter:		0					
	Bounding box:	X:	0					
		Y:	0.000					
	Centroid:	X:	0.000					
		Y:	0.000					
		Z:	0					
					2	**k**	**(3)**	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	1.13	k	Weight*tanϕ/arc length
r =	5.00	ft	radius of shear surface

Resisting Moment = shear * r = 6 ft-k

FS = 1.69

TRIAL:	A =	5	B =	0		r =	10	
				Density	Weight		Moment	
Element				kcf	k		About 0.0	
1	Area:		96.8108	0.125	12.10	k	(34)	ft-k
	Perimeter:		42.2026					
	Bounding box:	X:	-10					
		Y:	-10.000					

	Centroid:	X:	-2.804					
		Y:	-5.215					
		Z:	0.5					
2	Area:		9.678	0.125	1.21	k	(9)	ft-k
	Perimeter:		13.7188					
	Bounding box:	X:	-9.9876					
		Y:	0.000					
	Centroid:	X:	-7.420					
		Y:	1.232					
		Z:	0					
					13	k	(43)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	8.98	k	Weight*tanϕ/arc length
r =	10.00	ft	radius of shear surface

Resisting Moment = shear * r = 90 ft-k

FS = 2.09

TRIAL: A = 5 B = 5 r = 10

Element				Density kcf	Weight k		Moment About 0.0	
1	Area:		25.3643	0.125	3.17	k	(12)	ft-k
	Perimeter:		25.7835					
	Bounding box:	X:	-8.8726					
		Y:	-10.000					
	Centroid:	X:	-3.718					
		Y:	-7.489					
		Z:	0.5					
2	Area:		8.5466	0.125	1.07	k	(8)	ft-k
	Perimeter:		12.8184					
	Bounding box:	X:	-9.674					
		Y:	-5.000					

Centroid:	X:	-7.143				
	Y:	-3.755				
	Z:	0				
			4	k	(19)	ft-k

Slip Plane Resistance

ϕ =	34	°	soil friction angle
tanϕ =	0.6745085		soil friction coefficient
shear =	2.86	k	Weight*tanϕ/arc length
r =	10.00	ft	radius of shear surface

Resisting Moment = shear * r =	29	ft-k
FS =	**1.47**	

At a 1.5 to 1 slope, the slope is stable. The underlying ledge provides rigid resistance in the larger shear surface radii, while the lower factors of safety in the smaller ranges of radii are highly affected by the equipment surcharge. For that reason, though a factor of safety of approximately 1.5 holds with the surcharge at the top of slope, it is recommended that the equipment be kept such that the nearest track pressure occurs no closer than 3’ back from top of slope.