Gannett Fleming

Excellence Delivered ***As Promised***

August 31, 2016

Mr. Robert Thiry
Engineering and Construction Division
Port Authority of Allegheny County
345 6th Avenue
Pittsburgh, PA 15222-2527

Re: Port Authority of Allegheny County
East Busway Rock Slope Stabilization Study
Geotechnical Engineering Report

Dear Mr. Thiry:

This report summarizes the geotechnical investigation, findings, and preliminary recommendations for mitigation of the rock slopes located adjacent to the Martin Luther King East Busway (Busway) between Pitt Tower and 26th Street access ramp (Busway Stations 218+00 to 247+50).

INTRODUCTION

The East Busway carries the Port Authority of Allegheny County's (PAAC) bus traffic between the Downtown Pittsburgh and the easternmost neighborhoods of Allegheny County. The East Busway begins at Grant Street in downtown Pittsburgh and extends east terminating in Swissvale (Figure 1).

Work Order No. 20 of Gannett Fleming, Inc.'s (GF) General Architectural and Engineering Consulting Services Contract (No. R13-09-A), was initiated by PAAC for the investigation and evaluation of alternatives to mitigate the rockfall and landslides affecting the Busway. Tasks performed for the completion of this Work Order include:

- Background Review of Project Site and Geologic Setting
- Slope Surveying and Field Reconnaissance
- Evaluation of Slope Failure Mechanisms
- Evaluation of Potential Stabilization Alternatives
- Preparation of a Report Summarizing Findings and Recommendations

Gannett Fleming, Inc.

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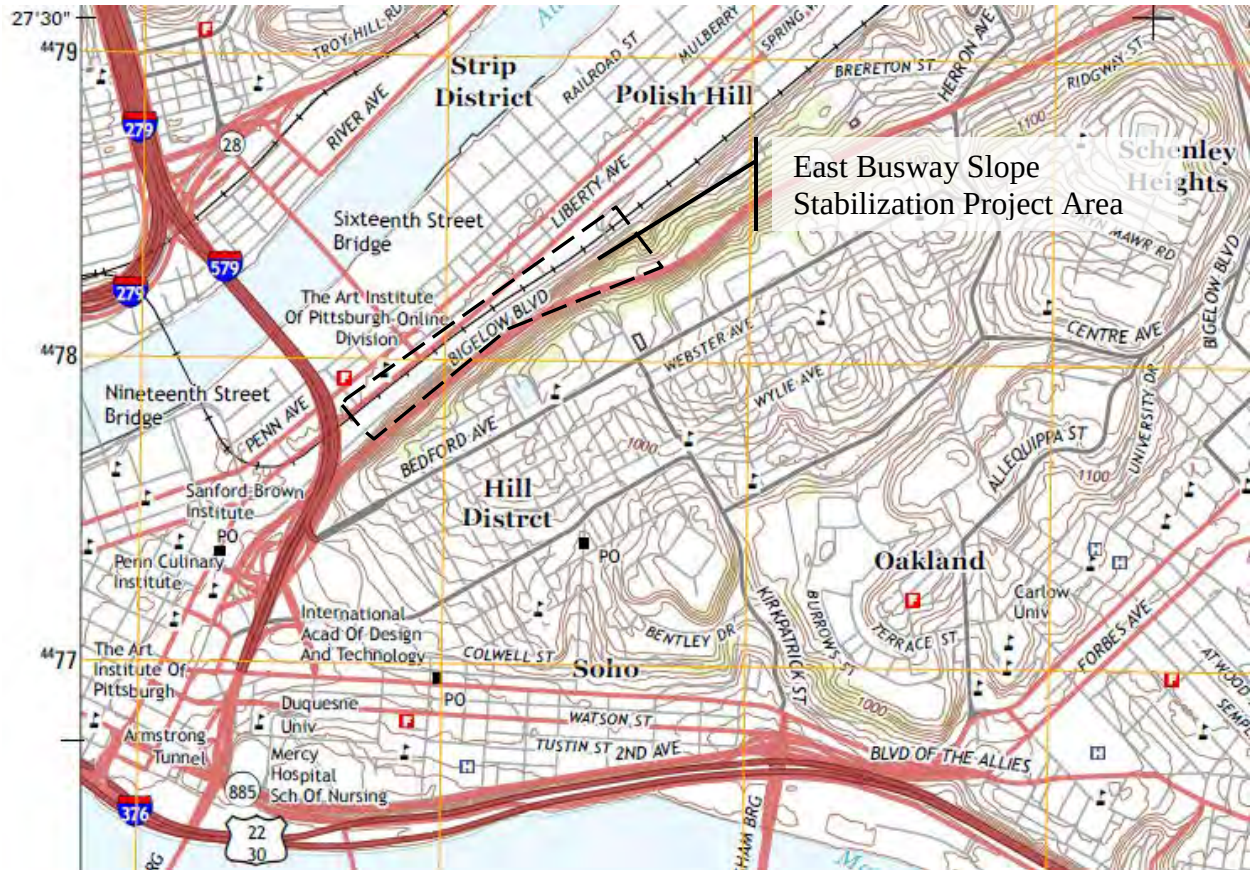


Figure 1: General project location map showing project limits.

SITE DEVELOPMENT HISTORY

The history of the site was gathered from record drawings made available by PAAC. These included:

- East Busway Construction Drawings, Dated March 10, 1980.
- East Busway Construction As-Built Drawings, Dated July 12, 1982.

The East Busway (Busway) was constructed between 1980 and 1982 at the toe of the steep rock slope supporting Bigelow Boulevard. The Busway was generally situated in the flat area beneath the rock slope from Pitt Tower through Station 238+00, where the alignment cut into the existing slope, offset right. The Busway alignment continued in cut through the intersection with the 26th Street ramp to Station 249+00. Throughout this half mile stretch there have been numerous rockfall and landslide events within the slope between the Busway and Bigelow Boulevard.

To alleviate the potential for rockfall and landslide debris from reaching the Busway two rockfall barriers have been constructed from Stations 221+25 to 225+00 (Rockfall Fence No. 1) and 237+90 to 247+22 (Rockfall Fence No. 2). Common barrier construction at this time included embedding steel posts into rock and using cables and chain link fence to contain rockfall. Advances in design and construction of flexible barriers with corrosion resistant hardware have since made these barriers obsolete. It is assumed that the original design engineers determined that the area at the toe of the slope between the barriers had a wide enough catchment area to contain future rockfall and debris.

PHYSIOGRAPHIC AND GEOLOGIC SETTING

The site is located within the Appalachian Plateaus Province in the Appalachian Highlands. The Appalachian Plateaus consists of gently folded, relatively flat lying rock units dipping regionally to the southwest at a rate of approximately 1 foot per 100 feet (M.E. Johnson, 1928.) The topography within the region consists of steep hillsides and deep river and stream valleys with magnitudes of vertical relief typically ranging between 200 and 400 feet. Specifically, the 150 foot vertical relief of the slope adjacent to the Busway was formed as the result of long term erosion processes of the Allegheny River and the accompanying valley wall stress relief (H.F. Ferguson, 1967, H.F. Ferguson and J.V. Hamel, 1981).

Stratigraphically, the slope reveals exposures of rock units within the Conemaugh Group of the Pennsylvanian system with geologic units in the lower Casselman and upper Glenshaw Formations (Figure 2). The main lithologic types are shale, claystone, marine and freshwater limestone, sandstone, siltstone, and coal. The strata composing the slope are characteristic of the late Pennsylvanian deltaic depositional environment. Definitive contacts can be observed between the stratigraphic units exposed on the slope with the apparent dip from east to west. The following subsections discuss the stratigraphic units exposed on the bluff.

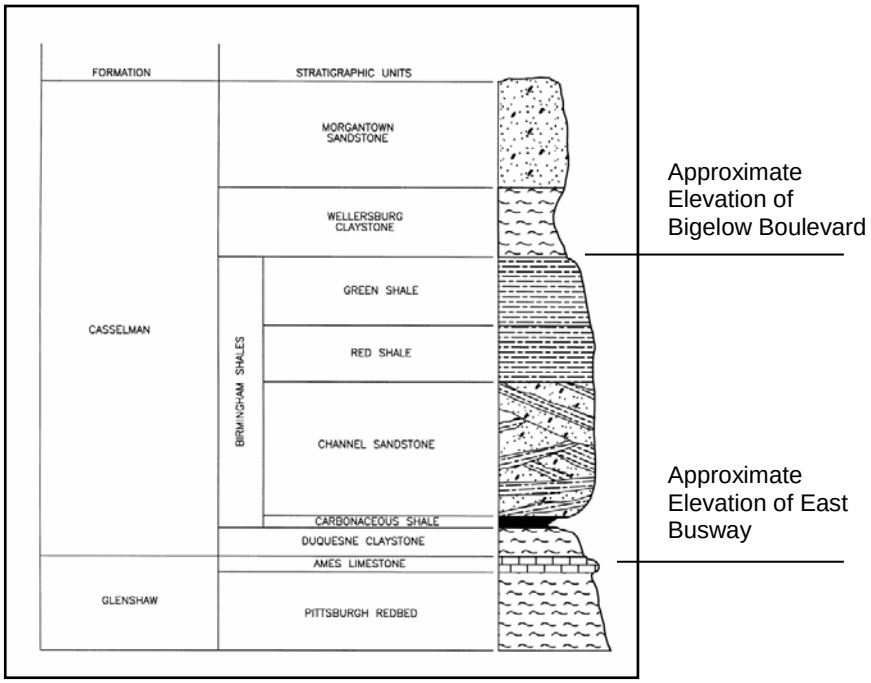


Figure 2: Generalized Stratigraphic Column of the Stratigraphic Units Comprising the Slope Adjacent to the East Busway.

The Birmingham shale. The Birmingham shale unit is the most predominant exposure visible on the slope and ranges in thickness from 45 to 70 feet in exposure. Within the Birmingham are several subunits including the green shale, the red shale and the channel sandstone. The green shale is located in the upper portion of the Birmingham unit and is generally not visible in exposure. The red shale underlies the green shale and is observed throughout the slope. The red shale is poorly fissile and highly jointed. Channel sandstone is also visible and represents the exposure of a traverse cross section of a meandering stream and flanking floodplain deposits (M.L. Price, 1970). Investigators of this stratigraphic unit have concluded that

the color variations within the shale have been the result of environments of deposition transgressing from freshwater to brackish. Marine fossils have been identified in the Birmingham shale, suggesting that this is the highest stratigraphic unit in western Pennsylvania to contain such fossils. Recent field investigations have indicated that the red and green shale are somewhat susceptible to weathering, but more resistant than the Wellersburg claystone present directly above. The lowest subunit within the Birmingham shale is a 2-foot thick, highly weatherable basal, black carbonaceous shale.

The Duquesne claystone. The Duquesne claystone is generally obscured by talus and vegetation and is situated on the slope beneath the near vertical Birmingham shale. The claystone is a very weatherable unit and, along with the basal black shale, has led to serious overhanging conditions of the Birmingham shale unit.

In addition to the alternating sequences of durable and less durable rock units along the slope, jointing is readily observed on the slope face and has been instrumental in the development of current slope conditions and instabilities. Many of the joints exposed on the slope are observed to be closed; however, several joints are open, as much as 6 inches. Primary jointing types, including tectonic and valley stress relief, have resulted in the formation of rock wedges and the potential for rock fall conditions. Tectonic joints, formed by the lateral compressive deformation of the earth's crust, are found to be systematically perpendicular and intersect the slope face at angles ranging between 30 and 60 degrees. Stress relief joints are also present along the slope face and have formed by the relief of stresses with the valley down cutting by the Allegheny River (H.F. Ferguson, 1967, H.F. Ferguson and J.V. Hamel, 1981). These joints are curvilinear but generally parallel to the slope face and have been measured at 15 degrees, plus or minus, of due east. Jointing conditions, as described, have promoted slope instabilities leading to wedge and toppling failures. It is anticipated that geomorphic processes including root pry and frost wedging may have initiated these failures. Additionally, seepage can be observed within the Birmingham shale and Duquesne claystone units.

SITE INVESTIGATION SUMMARY

Gannett Fleming geotechnical personnel performed multiple field visits of the project area over the past two years to view drainage and slope stability issues. During the course of these investigations the following observations regarding the slope stability concerns were made. Photographs of the areas of slope stability concern are included on the annotated As-Built Drawings included as Attachment 1.

At the time that the existing rockfall fences were constructed, the barriers met the common standard of practice, however more recent developments in rockfall modeling and barrier design have advanced the standard of practice to a point where the current barriers are functionally obsolete. While the current barriers still have some service capacity, as evidenced by their ability to contain rockfall, it is very difficult to determine their remaining life as the materials comprising the barriers (beams, bolts, wire cables) are severely corroded and in many areas entirely deteriorated. The observations summarized below are qualitative in nature and subsequent conclusions and recommendations are intended to bring the rockfall protection up to current standards.

- The rockfall barrier between Stations 221+25 and 225+00 is still functioning to contain debris, with the exception of a 50 foot section between Stations 222+62 and 223+12. This posts and barrier facing in this area have been impacted by rockfall debris, damaging the posts and barrier beyond repair. The rockfall debris behind this entire barrier should be removed and the 50' section of barrier noted should be replaced to provide for additional rockfall to be contained in the area behind the barrier.

- Significant rockfall debris and talus have accumulated on the slope and within the catchment area between Stations 230+00 and 237+00. In general the debris has not impacted the busway, and is contained behind the guiderail. While the catchment area in this section is adequate to contain rockfall, the debris should be removed to allow for future rockfall material to accumulate.

- The drainage inlets adjacent to the busway throughout the study area appear to be generally clear and functioning as intended.

- The rock slope contains many discontinuities (bedding planes and joints) that intersect, forming the blocks that detach from the face and ultimately fall to the slope below. The primary failure method is rockfall created when the underlying rock weathers. It is also anticipated that hydrostatic pressure builds up in the joints during the winter months when the slope face freezes, preventing the seepage of water from the slope face. When these forces build up, the rock blocks slide or topple from the slope.

- Significant rockfall debris and talus have accumulated behind the rockfall barrier between Stations 238+00 and 247+00. The barrier posts, cables, and facing are in very poor condition with failures of the wire cables and connections throughout the length of the barrier. In addition to the barrier being functionally obsolete due to the condition of the barrier hardware, the barrier is not functioning as intended due to the accumulation of debris, eliminating the desired catchment volume. Removal of the debris from behind the barrier is necessary for the barrier to have any service capacity in the short term and complete replacement will be required for long term rockfall protection.

- The stone retaining wall that supports Bigelow Boulevard at the top of the slope appears to be in good condition, with no visible failures or distress.

- Several large blocks of rock, which appear to be detached, are situated within the upper portion of the slope below Bigelow Boulevard. These blocks pose a potential rockfall threat to the Busway and should be removed as part of the mitigation program.

<u>Observations Made Outside of the PAAC Right-of-Way</u>

- Surface drainage from the sidewalk adjacent to Bigelow Boulevard is draining over the wall and down the rock slope. This drainage is intended to drain towards the roadway through weepholes in the curb, however the weepholes are plugged by sediment build up on the sidewalk.

- Scarp traces are present between Stations 247+00 and 250+00, at the top of the slope within the Frank Curto Park property. These scarp traces are indicative of a large landslide or rock slump within the slope above the East Busway. It is anticipated that the slide is moving very slowly and that slide debris has been transported to the toe of the slope and removed by PAAC maintenance forces over the years as the material accumulated.

To supplement the field reconnaissance and existing project mapping, 3D LiDAR scanning of the slope was completed by McKim and Creed (MKC). This survey data was merged with the LiDAR data provided by Pennsylvania Spatial Data Access (PASDA). Due to the lack of existing survey controls, MKC established survey control based on the Pennsylvania State Plane Coordinate System. This survey provides detail of the slope face and structure that is not obtainable through traditional survey methods. For the purposes of this investigation the Busway construction baseline has been approximated on the plans using

common topographic features (inlets/barriers/structures). Additional survey will be required in the future to tie the original construction baseline into the PA State Plane Coordinate System.

CONCLUSIONS

Based upon the review of the record reports, record drawings, and field reconnaissance data, the following conclusions have been made regarding the failure modes present at the site:

- The primary failure method is rockfall created when the underlying rock weathers into the slope removing the underlying support.

- A secondary likely failure mode involves the buildup of hydrostatic pressure in the joints within the slope. During the winter months the slope face freezes, preventing the seepage of water from the slope face. When these forces build up, the rock blocks slide or topple from the slope.

- The size of the rock block failures is controlled by the discontinuities (joints & bedding planes) in the rock mass. The valley stress relief joints serve as the failure plane parallel to the slope face and the tectonic joints form the lateral boundaries of the rock blocks. Given these geometries the maximum block thickness is approximately eight feet.

- Should the rock face continue to fail and weather back, the stability of the stone wall at the top of the slope may be compromised. It is understood that this wall is outside of the PAAC right-of-way and coordination with the adjacent property owners will likely be required to develop a design that is acceptable to all stakeholders.

- While portions of Rockfall Fence No. 1 are in serviceable condition and may contain rockfall in the short term, it is recommended that long term mitigation plans include the replacement of all rockfall barriers within the project area to meet current design standards. The new barriers would be appropriately sized based on rockfall simulation evaluations and comprised of materials that exceed a 75-year design life. Replacement of the rockfall barriers can be completed within or directly adjacent to the footprint of the existing barriers, creating little to no impact to existing facilities.

- Between Stations 218+00 and 236+00 there is no room to cut the slope back due to the potential for future failures to undercut the stone wall supporting Bigelow Boulevard.

- There appears to be adequate rockfall catchment area between Stations 226+00 and 236+00, as evidenced by past rockfall events not reaching the Busway in this area. While major mitigation efforts are not required in this area, the removal of loose rock blocks by slope scaling and removal of talus from the toe of slope and catchment area would reduce the likelihood that future rockfall impacts the busway.

- Soil slumps and slides are generally not a concern within the slope. The majority of the debris built up behind the rockfall barriers is derived from rockfall and weathering of shale and claystone.

- The accumulation of debris behind the both of the rockfall barriers has reduced their catchment capacity and in the case of Rockfall Fence No. 2, the barrier posts, cables, and facing have been compromised beyond repair for the majority of its length.

RECOMMENDED MITIGATION APPROACH

Based on the aforementioned evaluations and conclusions, we have developed a mitigation plan to stabilize the slope and protect the Busway from rockfall and landslide debris. These include short term maintenance solutions that, if implemented will improve the existing conditions as well as more extensive alternatives requiring further evaluation and specialized construction techniques. The limits of the recommended mitigation are included in the discussion below and shown on the plans in Attachment 2. Detailed cost estimates are included in Attachment 3 and conceptual sections and for the short and long term mitigation alternatives are included as Attachment 4.

A. Short Term maintenance recommendations include the following:

1. Station Limits:
221+25 to 225+00, Offset 20' – 40' Left
238+00 to 247+00, Offset 20' – 35' Left

Remove of debris from behind Rockfall Barriers 1 and 2. Removing the debris will create additional catchment volume behind the barriers. This will allow for future small rockfalls and talus to accumulate behind the existing barriers.

Estimated Construction Cost - $56,750.00

2. Station Limits:
222+62 to 223+12, Offset 22' Left

Replace the rockfall barrier between Stations 222+62 and 223+12. Given the poor condition of the barrier sections both ahead and back station of this area it is recommended that a new 70' long, 10' high barrier be constructed directly behind the existing barrier between Stations 222+52 and 223+22. This will serve to restore the functional catchment capacity to this area. In addition, the new barrier can be extended ahead and back station in the future should the PAAC decide to replace the existing barrier.

Estimated Construction Cost - $90,500.00

3. Station Limits:
226+00 to 236+00, Offset 20' – 60' Left

Remove the rockfall debris in the flat area adjacent to the Busway between Stations 226+00 and 236+00. Removing the debris in this area will decrease the likelihood that future rockfall will reach the Busway.

Estimated Construction Cost - $18,000.00

4. Remove the debris and re-establish the drainage on the sidewalk adjacent to Bigelow Boulevard at the top of the slope. Preventing the surface drainage from coming over stone wall towards the rock slope will slow down the weathering process and freeze/thaw degradation of the slope. This will require coordination with PennDOT maintenance forces.

Estimated Construction Cost - $0 – Provided PennDOT completes the work within their Right-Of-Way.

B. Long Term recommendations include the following:

The following long term mitigation alternatives have been tabulated by slope area taking into consideration the potential for rockfall to impact the Busway. While each of the alternatives evaluated will protect the Busway from future rockfall, the recommended alternative (highlighted for each area) is based on a combination of the estimated cost, anticipated disruption to Busway operations, and long term maintenance considerations. Estimated construction costs have been included for programming and planning purposes. The costs below include design and ancillary roadway construction items likely common to all alternates (e.g. Design, Maintenance and Protection of Traffic, Erosion and Sedimentation Controls and Construction Management). The limits of the selected mitigative treatments and cost estimates for each area will be refined during Final Design of the long term treatments.

Station Limits	Mitigation Alternative	Description of Alternative	Estimated Cost
Station 218+00 to 226+00 (Area From Pitt Tower to the 100' East of Rockfall Fence No. 1)	New Rockfall Barrier	10' High Rockfall Barrier Designed for Modeled Impact Energy along with the Re-establishment of the Catchment Area. Construction of the new barrier could be completed directly on/or adjacent to the existing barrier alignment. Construction will require temporary closure of the shoulder and eastbound Busway during non-peak times. This alternative will require periodic removal of debris from behind the new rockfall barrier.	$832,920
	Rockfall Drape	Steel Rockfall Drape Attached at Top of Slope. Construction will require permanent shoulder closure and temporary closure of the EB Busway during non-peak times. Allows Rockfall to Fall to Toe of Slope, where periodic maintenance would be required to remove the accumulated debris.	$1,164,250
	Anchored Rockfall Mesh	High Tensile Steel Rockfall Drape Attached to Slope Face with Rock Anchors. Construction will require permanent shoulder closure and temporary closure of the EB Busway during non-peak times. This alternate prevents rock from reaching the toe of slope requiring little to no long term clean up and maintenance.	$2,906,250
Station 226+00 to 236+00 (Area Between Rockfall Fences No. 1 and No. 2)	No-Build	Given the past rockfalls that have occurred in this area have not impacted Busway operations the Authority may choose a no-build option in this area. Periodic cleanup of the debris should be done to ensure the catchment area continues to have adequate capacity to store failed material.	$0
	Rock Slope Scaling and Debris Removal	Removal of Loose Rock Blocks from the Slope Face by Mechanical Methods and Removal of Debris from the Toe of Slope and Catchment Area Adjacent to East Busway. Construction will require permanent shoulder closure and temporary closure of the EB Busway during non-peak times. This alternative will require regular removal of the debris from the toe of the slope and existing catchment area.	$187,200

Station Limits	Mitigation Alternative	Description of Alternative	Estimated Cost
Station 226+00 to 236+00 (cont'd)	Rockfall Drape	Steel Rockfall Drape Attached at Top of Slope. Construction will require permanent shoulder closure and temporary closure of the EB Busway during non-peak times. Allows Rockfall to Fall to Toe of Slope, where periodic maintenance would be required to remove the accumulated debris.	$869,330
	Anchored Rockfall Mesh	High Tensile Steel Rockfall Drape Attached to Slope Face with Rock Anchors. Construction will require permanent shoulder closure and temporary closure of the EB Busway during non-peak times. This alternate prevents rock from reaching the toe of slope requiring little to no long term clean up and maintenance.	$3,389,930
Station 236+00 to 247+50 (Area From Beginning of Rockfall Fence No. 2 to 275' East of 26th Street Ramp Intersection)	New Rockfall Barrier	6' High Rockfall Barrier Designed for Modeled Impact Energy along with the Re-establishment of the Catchment Area. Construction of the new barrier could be completed directly on/or adjacent to the existing barrier alignment. Construction will require temporary closure of the shoulder and eastbound Busway during non-peak times. This alternative will require periodic removal of debris from behind the new rockfall barrier.	$925,640
	Slope Excavation	Excavating the Slope to a 1H:1V Slope Ratio and Creating a 10' Wide Catchment Area at the Toe of the Slope. Construction will require permanent shoulder closure and temporary closure of the EB and WB Busway during non-peak times. While excavation of the slope may be less expensive than the rockfall barrier, the removal of the material will create significant disruption to Busway Operations as the contractor will need to remove and dispose of the excavated material. In addition this alternate will require periodic removal of debris from the catchment area at the toe of the slope.	$837,550

CONSTRUCTION STAGING CONSIDERATIONS

Given the location of the site and the limited access to the rock slope, understanding the types of equipment that will be used and the required staging areas is of great importance when considering the construction sequencing and operations. The following assumptions have been made regarding the probable construction staging and limitations, and have been included in the cost estimates:

- Cleanout of the rockfall debris from the barriers can be completed with standard excavating equipment by most general contractors. The work would require the shoulder and one lane of the Busway to excavate, load, and remove the debris.

- Construction of new rockfall barriers is typically done by a specialty geotechnical contractor experienced with such construction. The barrier construction would also require the shoulder and one lane of the Busway for the duration of construction.

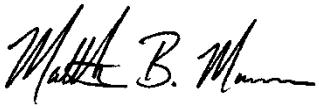
- Slope Scaling, Slope Drape Installation, and Rock Anchor construction would all require a specialty geotechnical contractor experienced with such construction working in conjunction with a general contractor. The existing catchment area between Stations 226+00 and 236+00 could be used to stage heavy equipment and materials (cranes, manlifts, drills, etc.).

FINAL DESIGN CONSIDERATIONS

Final design of the recommended slope stabilization measures will include refining the limits of slope stabilization treatments, completing the design plans design details and specifications for the selected alternatives, developing erosion and sedimentation control plans (if necessary), and terms and conditions. In addition further evaluation of the existing right-of-way will be required to determine if easements will be required from adjacent property owners. Estimated costs for the Design and Construction Consultation costs have been included in the cost estimates for each alternate.

We trust that this report meets the Authority's needs for the preliminary evaluations of the rock slope adjacent to the East Busway. If you have any questions or require any clarification please do not hesitate to contact at 412-922-5575.

Yours truly,
GANNETT FLEMING, INC.

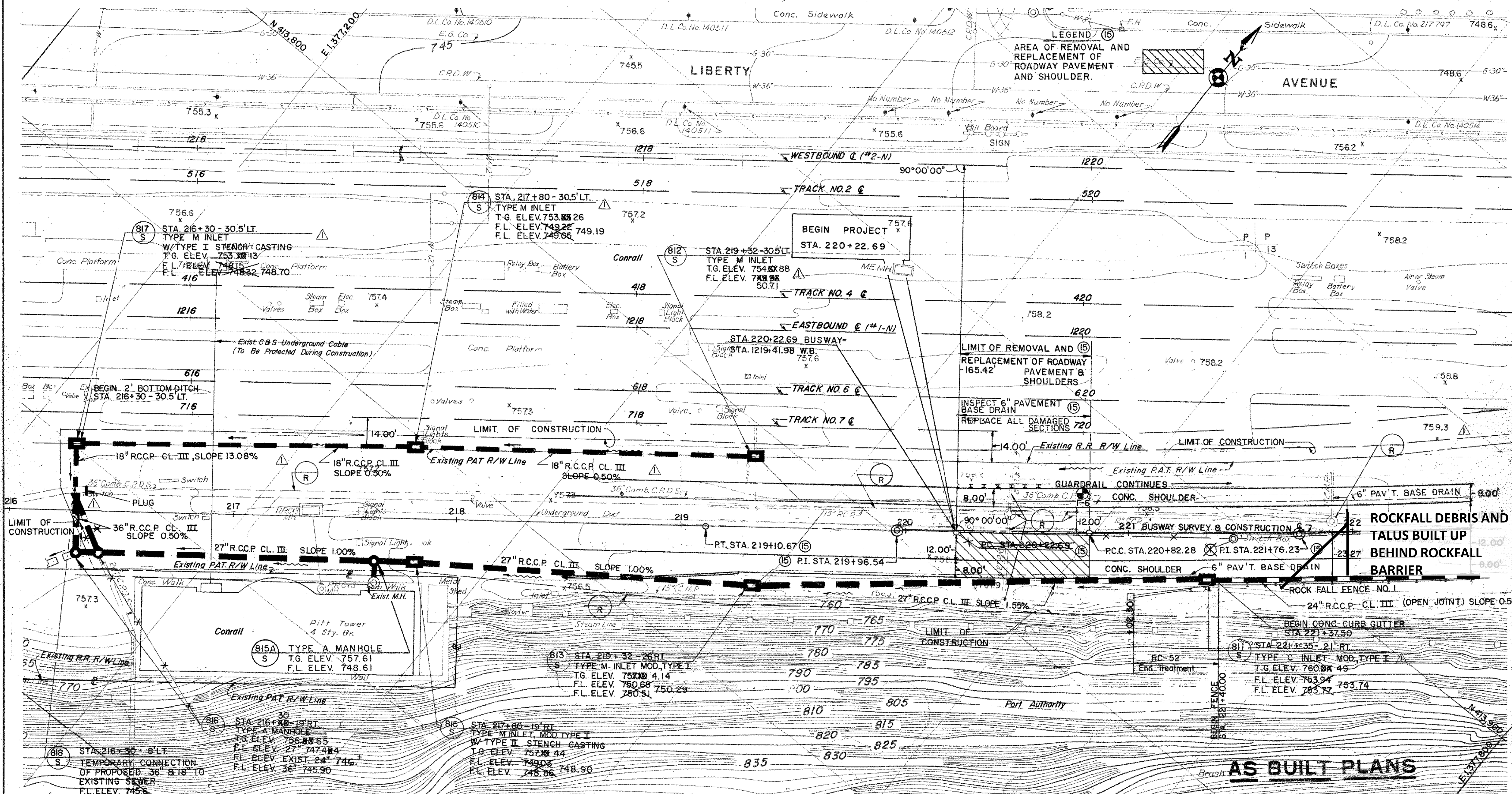


Matthew B. Morris, P.G.
Senior Project Manager

Enclosures

ATTACHMENT 1
FIELD RECONNAISSANCE PLANS AND PHOTOGRAPHS

COUNTY	MUNICIPALITY	SECTION	SHEET NO.
Allegheny	Pittsburgh	I	19



LIBERTY
AVENUE
LEGEND (15)
AREA OF REMOVAL AND REPLACEMENT OF ROADWAY PAVEMENT AND SHOULDER.
WESTBOUND ℄ (#2-N)
TRACK NO. 2 ℄
TRACK NO. 4 ℄
EASTBOUND ℄ (#1-N)
TRACK NO. 6 ℄
TRACK NO. 7 ℄
BEGIN PROJECT STA. 220+22.69
STA. 220+22.69 BUSWAY= STA. 1219+41.98 W.B.
LIMIT OF REMOVAL AND REPLACEMENT OF ROADWAY PAVEMENT & SHOULDERS 165.42'
INSPECT 6" PAVEMENT BASE DRAIN REPLACE ALL DAMAGED SECTIONS
LIMIT OF CONSTRUCTION
Existing PAT R/W Line
Existing R.R. R/W Line
GUARDRAIL CONTINUES
CONC. SHOULDER
6" PAV'T. BASE DRAIN
221 BUSWAY SURVEY & CONSTRUCTION ℄
P.T. STA. 219+10.67 (15)
(15) P.I. STA. 219+96.54
P.C.C. STA. 220+82.28
P.I. STA. 221+76.23
ROCKFALL DEBRIS AND TALUS BUILT UP BEHIND ROCKFALL BARRIER
ROCK FALL FENCE NO. 1
24" R.C.C.P. CL. III (OPEN JOINT) SLOPE 0.50%
BEGIN CONC. CURB GUTTER STA. 221+37.50
811 S STA. 221+35 - 21' RT. TYPE C INLET MOD. TYPE I T.G. ELEV. 760.49 F.L. ELEV. 753.74 F.L. ELEV. 753.77
RC-52 End Treatment
BEGIN FENCE STA. 221+40.00
812 S STA. 219+32-30.5' LT. TYPE M INLET T.G. ELEV. 754.88 F.L. ELEV. 750.71
814 S STA. 217+80 - 30.5' LT. TYPE M INLET T.G. ELEV. 753.26 F.L. ELEV. 749.19
817 S STA. 216+30 - 30.5' LT. TYPE M INLET W/TYPE I STENCH CASTING T.G. ELEV. 753.13 F.L. ELEV. 748.70
BEGIN 2' BOTTOM DITCH STA. 216+30 - 30.5' LT.
Exist. C&S Underground Cable (To Be Protected During Construction)
18" R.C.C.P. CL. III, SLOPE 13.08%
18" R.C.C.P. CL. III SLOPE 0.50%
36" R.C.C.P. CL. III SLOPE 0.50%
27" R.C.C.P. CL. III SLOPE 1.00%
27" R.C.C.P. CL. III SLOPE 1.55%
LIMIT OF CONSTRUCTION
PLUG
Pitt Tower 4 Sty. Br.
Conrail
815A S TYPE A MANHOLE T.G. ELEV. 757.61 F.L. ELEV. 748.61
813 S STA. 219+32 - 26' RT. TYPE M INLET MOD. TYPE I T.G. ELEV. 754.14 F.L. ELEV. 750.29
816 S STA. 216+30 - 19' RT. TYPE A MANHOLE T.G. ELEV. 756.65 F.L. ELEV. 27" 747.44 F.L. ELEV. EXIST. 24" 746.± F.L. ELEV. 36" 745.90
815 S STA. 217+80 - 19' RT. TYPE M INLET, MOD. TYPE I W/ TYPE II STENCH CASTING T.G. ELEV. 757.44 F.L. ELEV. 748.90
818 S STA. 216+30 - 8' LT. TEMPORARY CONNECTION OF PROPOSED 36" & 18" TO EXISTING SEWER F.L. ELEV. 745.6
Port Authority
CONTINUED ON SHEET NO. 21
AS BUILT PLANS

For Profile See Sheet No. 20
For Curve Data See Sheet No. 11
For Rock Fall Fence Details See Sheet No. 90
For Drainage Details See Sheet No. 58, 68

SCALE IN FEET
40 20 0 20 40

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION
△	3-31-80	Addendum No. 1 Revised Drainage			
(15)	7-12-82	REVISED AS SHOWN			

REVISIONS

DESIGNED: W.V.A.
DRAWN: S.W.P.
CHECKED: T.A.O./J.D.D.
APPROVED: P.J.B./R.C.M.
DATE: 3-10-80
SCALE: AS SHOWN
CONTRACT NO. EB-7

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER RAYMOND L. BUDNIK

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH PENNSYLVANIA

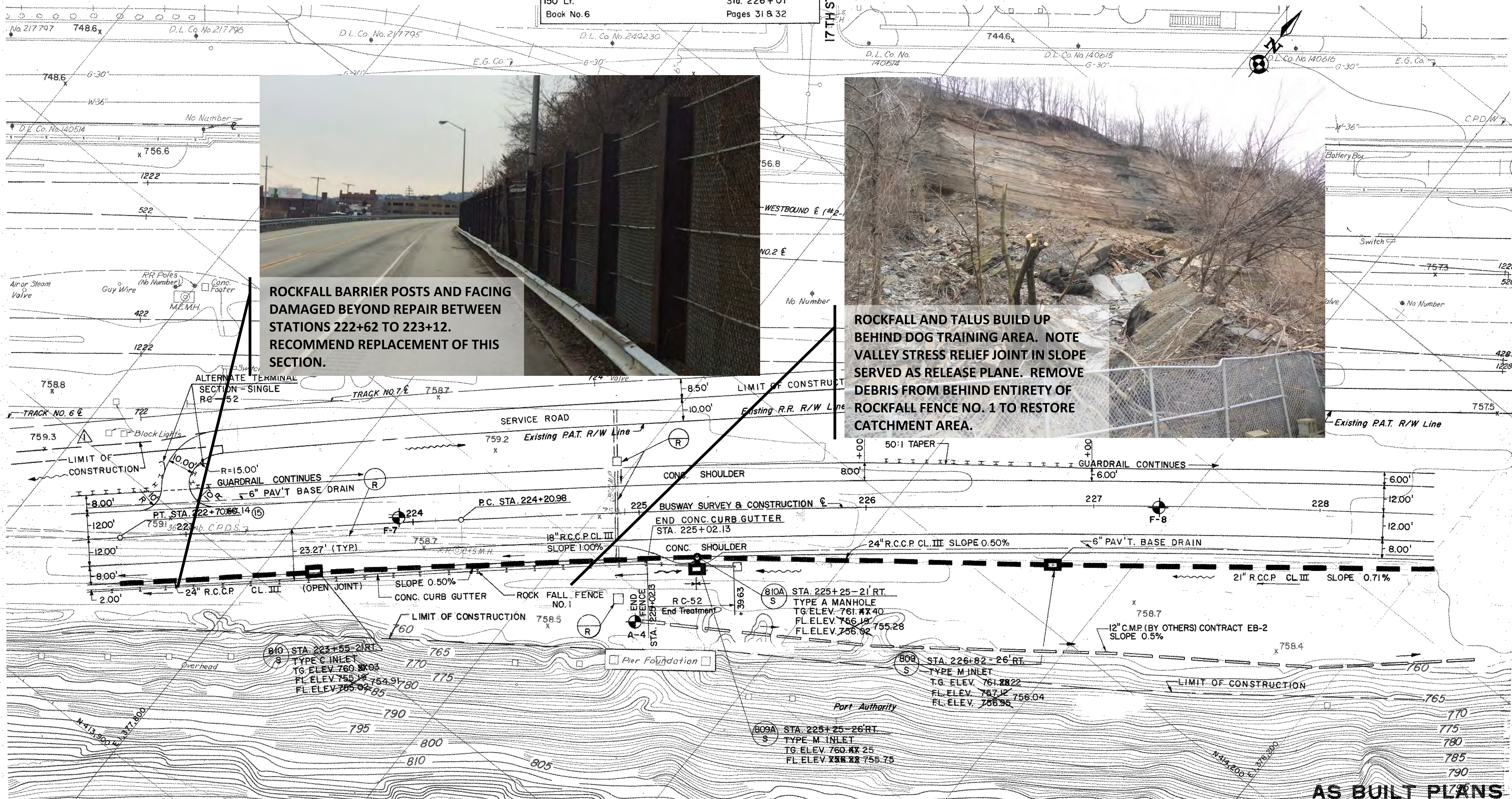
EAST BUSWAY
PLAN
STA. 220+22.69 TO STA. 222+50

MICHAEL BAKER, JR., INC.
CONSULTING ENGINEERS BEAVER, PENNSYLVANIA

COUNTY	MUNICIPALITY	SECTION	SHEET NO.
Allegheny	Pittsburgh	I & II A	21

B.M.#20-A1 Elev. 758.42
Square cut in top of concrete retaining wall.
150' Lt. Sta. 226+01
Book No.6 Pages 31 & 32

CONTINUED FROM SHEET NO. 19



ROCKFALL BARRIER POSTS AND FACING DAMAGED BEYOND REPAIR BETWEEN STATIONS 222+62 TO 223+12. RECOMMEND REPLACEMENT OF THIS SECTION.

ROCKFALL AND TALUS BUILD UP BEHIND DOG TRAINING AREA. NOTE VALLEY STRESS RELIEF JOINT IN SLOPE SERVED AS RELEASE PLANE. REMOVE DEBRIS FROM BEHIND ENTIRETY OF ROCKFALL FENCE NO. 1 TO RESTORE CATCHMENT AREA.

CONTINUED ON SHEET NO. 22

For Profile See Sheet No. 23
For Curve Data See Sheet No. 11
For Rock Fall Fence Details See Sheet No. 90,91

SCALE IN FEET
40 20 0 20 40

REVISIONS

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION
⚠	3-31-80	Addendum No. 1 Revise Limit of Construction, Delete C.I.L. (By Conrail)	(15)	7-12-82	REVISED AS SHOWN

DESIGNED:	W.V.A.
DRAWN:	J.P.K.
CHECKED:	T.A.O./J.D.D.
APPROVED:	P.J.B./R.C.M.
DATE:	3-10-80
SCALE:	AS SHOWN
CONTRACT NO.	EB-7

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER RAYMOND L. BUDNIK No. 8729-E

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH PENNSYLVANIA

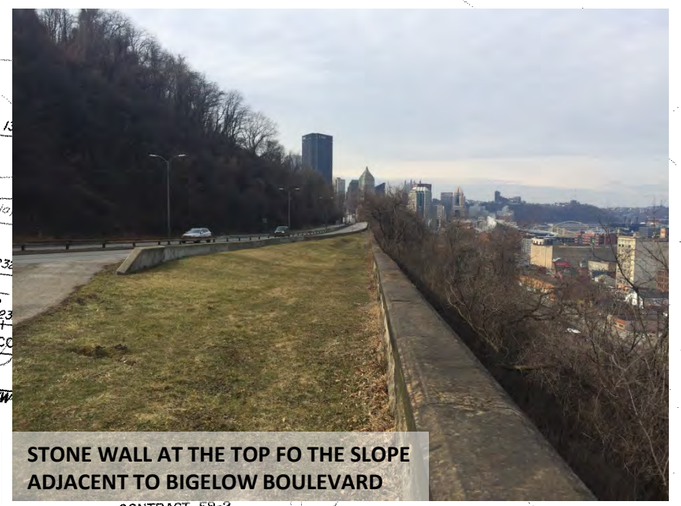
EAST BUSWAY
PLAN
STA. 222+50 TO STA. 228+50

MICHAEL BAKER, JR., INC.
CONSULTING ENGINEERS BEAVER, PENNSYLVANIA

COUNTY	MUNICIPALITY	SECTION	SHEET NO.
Allegheny	Pittsburgh	II A	22

ROCKFALL FROM TOP OF SLOPE. DEBRIS PATH EXTENDS TO EDGE OF BUSWAY. LARGE OVERHANGS POSE ADDITIONAL ROCKFALL THREAT TO BUSWAY. RECOMMEND REMOVAL OF ROCKFALL DEBRIS FROM CATCHMENT AREA BETWEEN STA. 230+00 AND 237+00.

UNDERCUT ROCKBLOCK NEAR TOP OF SLOPE ILLUSTRATES VALLEY STRESS AND TECTONIC JOINT SETS.



STONE WALL AT THE TOP FO THE SLOPE ADJACENT TO BIGELOW BOULEVARD

CONTINUED FROM SHEET NO. 21

CONTINUED ON SHEET NO. 24

CONTRACT EB-2

CONC. SHOULDER

BUSWAY SURVEY & CONSTRUCTION ℄

12.00'

8.00'

6" PAV'T. BASE DRAIN

21" R.C.C.P. CL. III SLOPE 0.71 %

CONC. SHOULDER

12" C.M.P. (BY OTHERS) CONTRACT EB-2

0.5% SLOPE

808 S STA. 229+50 -26' RT. A-6
TYPE M INLET
T.G. ELEV. 762.62
F.L. ELEV. 757.02

LIMIT OF CONSTRUCTION

805 S STA 232+18 -26' RT
TYPE M INLET
T.G. ELEV. 765.00
F.L. ELEV. 758.75

LIMIT OF CONSTRUCTION

Port Authority

Existing PAT R/W Line

P.T. STA. 233+15.51

BASE DRAIN OUTLET

6" PAV'T. BASE DRAIN

6.00'

12.00'

12.00'

8.00'

36" R.C.C.P. CLASS IV (BY OTHERS) CONTRACT EB-2

18" R.C.C.P. CLASS III SLOPE 1.00 %

8 L.F. 18" R.C.C.P. (BY OTHERS) CONTRACT EB-2

TYPE M INLET (BY OTHERS) CONTRACT EB-2

806 S STA. 233+59 - 35' RT.
CONN. PROP. 18" PIPE TO EXIST. PIPE
F.L. ELEV. 759.14

E. 1,318,300
N. 914,200

E. 1,318,780
N. 914,500

AS BUILT PLANS

For Profile See Sheet No. 23
For Curve Data See Sheet No. 11
For Drainage Details See Sheet No. 58

SCALE IN FEET
40 20 0 20 40

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION
1	3-31-80	Addendum No. 1 Delete C.I.L. (By Conrail) & Proposed C & S Cable (By Conrail)			

REVISIONS

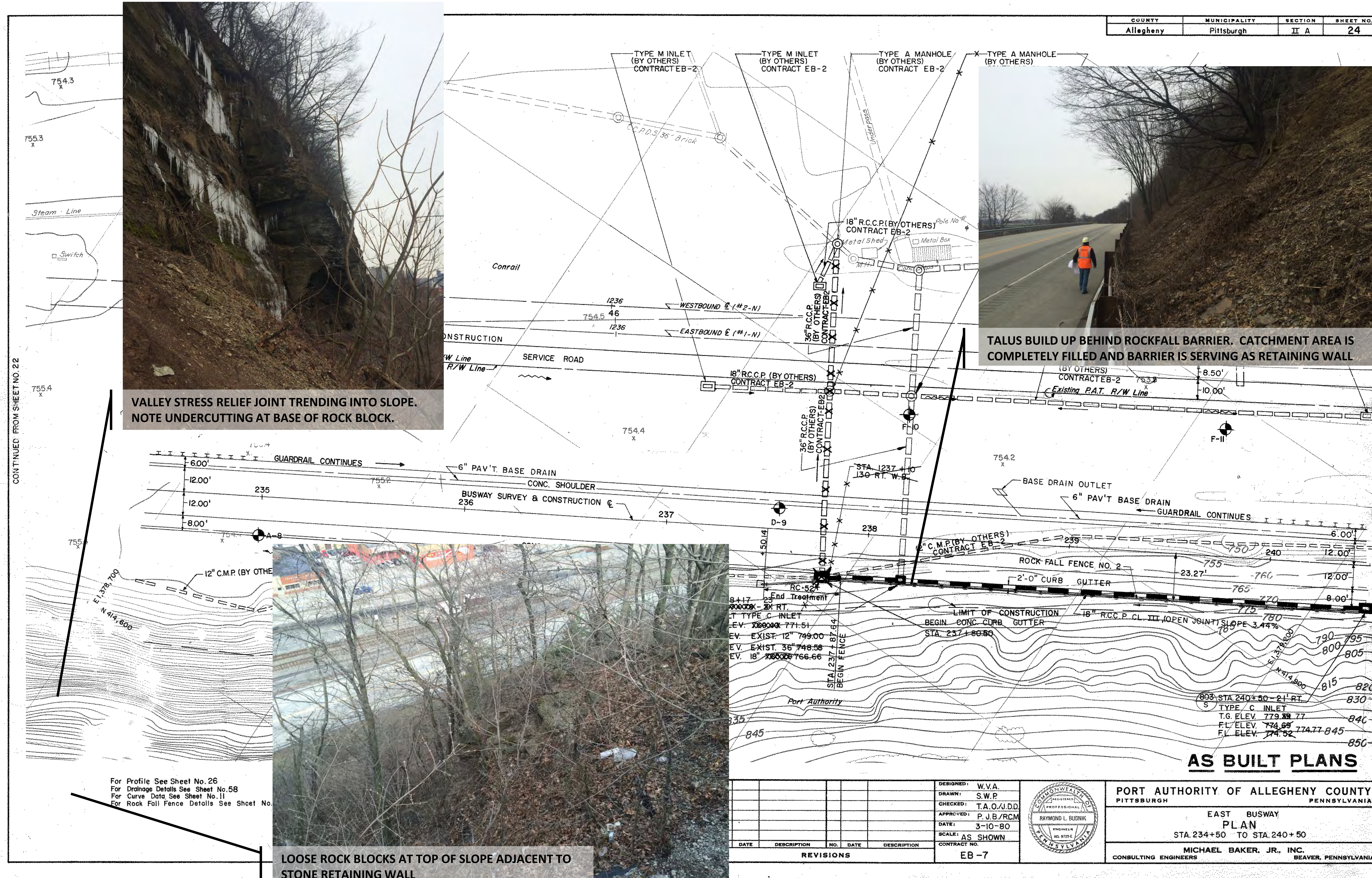
DESIGNED: W.V.A.
DRAWN: S.W.P.
CHECKED: T.A.O./J.D.D.
APPROVED: P.J.B./R.C.M.
DATE: 3-10-80
SCALE: AS SHOWN
CONTRACT NO. EB-7

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL ENGINEER RAYMOND L. BUDNIK NO. 8729-E

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH PENNSYLVANIA

EAST BUSWAY
PLAN
STA. 228+50 TO STA. 234+50

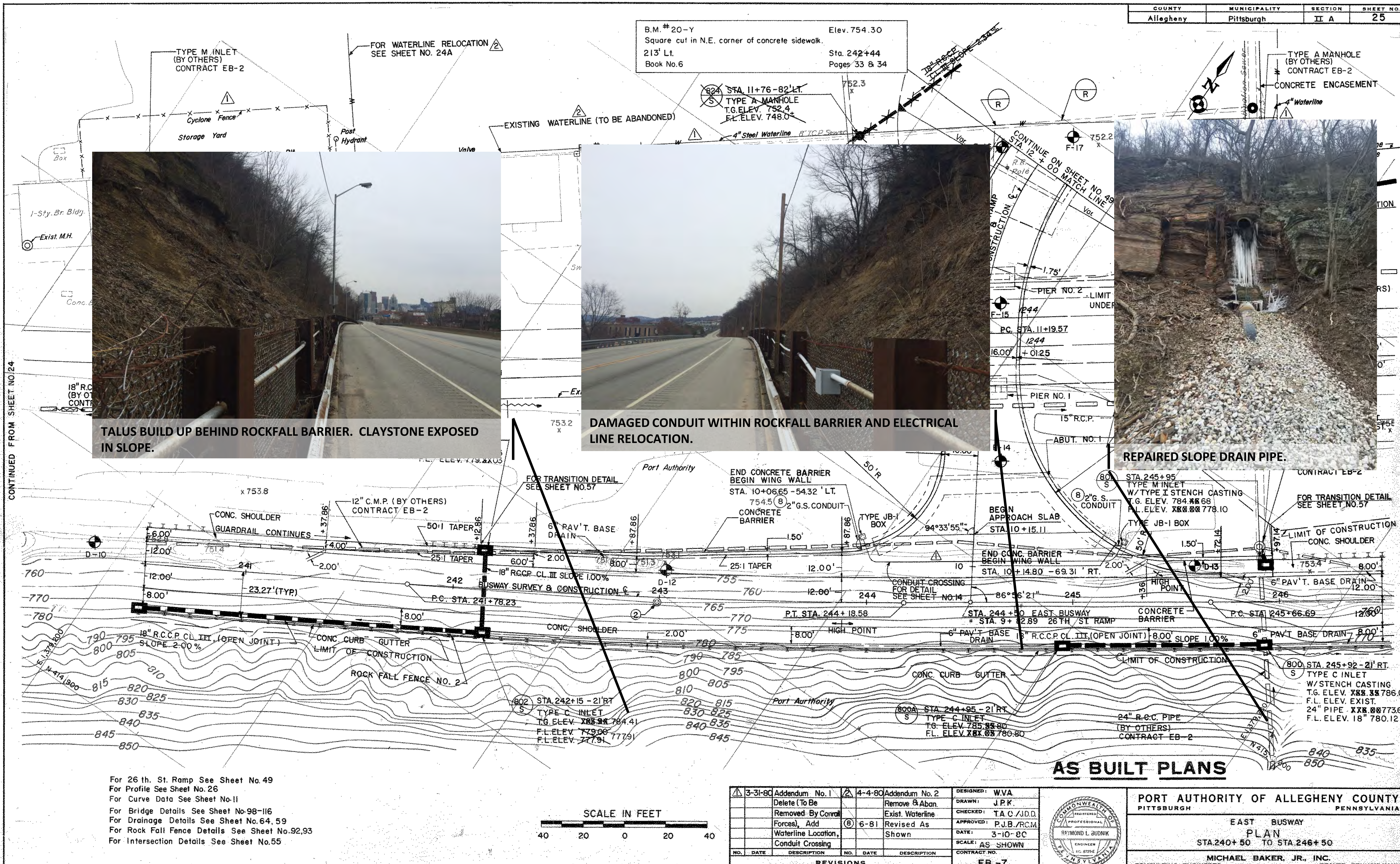
MICHAEL BAKER, JR., INC.
CONSULTING ENGINEERS BEAVER, PENNSYLVANIA



VALLEY STRESS RELIEF JOINT TRENDING INTO SLOPE. NOTE UNDERCUTTING AT BASE OF ROCK BLOCK.

TALUS BUILD UP BEHIND ROCKFALL BARRIER. CATCHMENT AREA IS COMPLETELY FILLED AND BARRIER IS SERVING AS RETAINING WALL

LOOSE ROCK BLOCKS AT TOP OF SLOPE ADJACENT TO STONE RETAINING WALL



TALUS BUILD UP BEHIND ROCKFALL BARRIER. CLAYSTONE EXPOSED IN SLOPE.

DAMAGED CONDUIT WITHIN ROCKFALL BARRIER AND ELECTRICAL LINE RELOCATION.

REPAIRED SLOPE DRAIN PIPE.

COUNTY	MUNICIPALITY	SECTION	SHEET NO.
Allegheny	Pittsburgh	II A	27

CONTINUED FROM SHEET NO. 25

CONTINUED ON SHEET NO. 28

SCARP TRACE IN PARK ADJACENT TO BIGELOW BOULDEVARD. NOTE DISPLACEMENT IN WALL RUNNING ALONG TOP OF SLOPE.

SCARP TRACE IN PARK ADJACENT TO BIGELOW BOULDEVARD.

TYPE M INLET (BY OTHERS) CONTRACT EB-2

F-1c

F-20 751.9

TYPE M INLET (BY OTHERS) CONTRACT EB-2

TYPE M INLET (BY OTHERS) CONTRACT EB-2

TT-A-5

F-21 752.3 Conc. Pad

Conc. Box Metal Lid

Br. & Metal Lid

752.4

Conrail

WESTBOUND ℄ (#2-N)

EASTBOUND ℄ (#1-N)

18" R.C.C.P. (BY OTHERS) CONTRACT EB-2

Existing P.A.T. R/W

755

N 415,300

E 1,379,700

753.4

GUARDRAIL CONTINUES

8.00'

6" PAV'T. BASE DRAIN

12.00'

8.00'

6" PAV'T. BASE DRAIN

D-14

247

23.27' (TYP.)

LIMIT OF CONSTRUCTION

END CONC. CURB GUTTER STA. 247+22.33

RC-52 End Treatment

759.83

STA. 247+22.33 END FENCE

6" C/P V.C. Pipe

N/F City of Pittsburgh

247+27.31 60.00' Rt.

501A

CONC. SHOULDER

+20

248

249

CONDUIT CROSSING (8) SEE SHEET 14

TYPE JB-1 BOX (8)

12" C.M.P. (BY OTHERS) CONTRACT EB-2

Existing P.A.T. R/W Line

REQUIRED P.A.T. R/W LINE

249+25.78 60.00' Rt.

BASE DRAIN OUTLET

A-15

PT. STA. 249+65.85

BUSWAY SURVEY & CONSTRUCTION ℄

250

251

D-16

CONC. SHOULDER 6" PAV'T. BASE DRAIN

18" RCCP CL. III SLOPE 3.83%

24" RCCP CL. III SLOPE 3.94 %

252

LIMIT OF CONSTRUCTION

12" C.M.P. (BY OTHERS) CONTRACT EB-2

GUARDRAIL CONTINUES

6" PAV'T. BASE DRAIN

8.00'

12.00'

12.00'

8.00'

F-26

791 S STA. 250+50-26' RT. TYPE M INLET T.G. ELEV. 771.99 FL. ELEV. 768.25 FL. ELEV. 767.55

792 S STA 252+50-26' RT. TYPE M INLET, MOD. TYPE I T.G. ELEV. 766.95 763.95 FL. ELEV. 760.03 759.62 FL. ELEV. 759.78

Wet Weather Spring

Port Authority

N 415,800

E 1,380,200

AS BUILT PLANS

For Profile See Sheet No. 29

For Curve Data See Sheet No. 11

For Rock Fall Fence Details See Sheet No. 93

SCALE IN FEET

40 20 0 20 40

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION
(8)	6-81	Revised As Shown			

REVISIONS

DESIGNED: W.V.A.
DRAWN: S.W.P.
CHECKED: T.A.O./J.D.D.
APPROVED: P.J.B./R.C.M.
DATE: 3-10-80
SCALE: AS SHOWN
CONTRACT NO. EB-7

COMMONWEALTH OF PENNSYLVANIA REGISTERED PROFESSIONAL RAYMOND L. BUDNIK ENGINEER NO. 8729-E

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH PENNSYLVANIA

EAST BUSWAY
PLAN
STA. 246+50 TO STA. 252+50

MICHAEL BAKER, JR., INC.
CONSULTING ENGINEERS BEAVER, PENNSYLVANIA

ATTACHMENT 2
SITE PLANS SHOWING CONCEPTUAL ALTERNATIVE MITIGATION LIMITS

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN
1. NEW ROCKFALL BARRIER FROM STA. 218+00 TO 226+00 WITH CLEANING OF CATCHMENT AREA (RECOMMENDED)
2. ROCKFALL DRAPE
3. ANCHORED ROCKFALL MESH

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

ALTERNATE 1: NEW ROCKFALL BARRIER BEGIN AT STA. 218+00 (10' HIGH)

ALTERNATE 1: CLEANOUT CATCHMENT AREA AT TOE OF SLOPE (WIDTH VARIES)

ALTERNATE 1 NEW ROCKFALL BARRIER (10' HIGH)

ALTERNATE 1: CLEANOUT OF ROCKFALL CATCHMENT AREA AT TOE OF SLOPE

M.L.K. EAST BUSWAY

EP

217+00 217+50 218+00 218+50 219+00 219+50 220+00 220+50 221+00 221+50 222+00 222+50 223

760 770 780 790 800 810 820 830 840 850 860 870 880 900

PITT TOWER

BIGELOW BLVD.

ALTERNATES 2 OR 3: AREA OF SLOPE DRAPE OR ANCHORED SLOPE DRAPE

NO.	DATE	DESCRIPTION

REVISIONS

Gannett Fleming

GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 117+00 TO STATION: 222+50

Port Authority connecting people to life

CONTRACT NO. 57779

DWG. NO. WQ 20 SHT. 1

$FILE
$DATE

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN

1. NEW ROCKFALL BARRIER FROM STA. 218+00 TO 226+00 WITH CLEANING OF CATCHMENT AREA; SLOPE SCALING AND CLEANING OF CATCHMENT AREA FROM STA. 226+00 TO 236+00 (RECOMMENDED)
2. ROCKFALL DRAPE
3. ANCHORED ROCKFALL MESH

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

ALTERNATE 1: CLEANOUT CATCHMENT AREA AT TOE OF SLOPE (WIDTH VARIES)

ALTERNATE 1: NEW ROCKFALL BARRIER (10' HIGH)

ALTERNATE 1: END ROCKFALL BARRIER AT STA. 226+00

ALTERNATE 1: END CLEARING OF ROCKFALL CATCHMENT AREA AT STA/ 226+00

ALTERNATE 1: CLEAR ROCKFALL DEBRIS AND TALUS FROM CATCHMENT AREA AT TOE OF SLOPE BETWEEN STA. 226+00 AND 236+00

ALTERNATES 1, 2 OR 3: AREA OF SLOPE SCALING, SLOPE DRAPE OR ANCHORED SLOPE DRAPE

ALTERNATES 2 OR 3: AREA OF SLOPE DRAPE OR ANCHORED SLOPE DRAPE

M.L.K. EAST BUSWAY

BIGELOW BLVD.

223+00 223+50 224+00 224+50 225+00 225+50 226+00 226+50 227+00 227+50 228+00 228+50 229+

760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920 930 940

NO.	DATE	DESCRIPTION

REVISIONS

Gannett Fleming

GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 223+00 TO STATION: 228+50

Port Authority connecting people to life

CONTRACT NO. 57779

DWG. NO. WO 20 SHT. 2

$FILE
$DATE

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN
1. SLOPE SCALING AND CLEANING OF CATCHMENT AREA FROM STA. 226+00 TO 236+00 (RECOMMENDED)
2. ROCKFALL DRAPE
3. ANCHORED ROCKFALL MESH

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

ALTERNATE 1: CLEAR ROCKFALL DEBRIS AND TALUS FROM CATCHMENT AREA AT TOE OF SLOPE BETWEEN STA. 226+00 AND 236+00

+50 229+00 229+50 230+00 230+50 231+00 231+50 232+00 232+50 233+00 233+50 234+00 234+50 2

M.L.K. EAST BUSWAY

760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920

ALTERNATES 1, 2 OR 3: AREA OF SLOPE SCALING, SLOPE DRAPE OR ANCHORED SLOPE DRAPE

BIGELOW BLVD.

NO.	DATE	DESCRIPTION

REVISIONS

$FILE
$DATE

Gannett Fleming
GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 229+00 TO STATION: 234+50

Port Authority
connecting people to life

CONTRACT NO. 57779
DWG. NO. WQ 20 SHT. 3

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN

1. SLOPE SCALING AND CLEANING OF CATCHMENT AREA FROM STA. 226+00 TO 236+00; NEW ROCKFALL BARRIER BEGINNING AT STA. 236+00 WITH CLEANING OF CATCHMENT AREA (RECOMMENDED)
2. ROCKFALL DRAPE UP THROUGH STATION 236+00 OR CUT SLOPE BEGINNING AT STATION 237+50
3. ANCHORED ROCKFALL MESH

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

ALTERNATE 1: CLEAR ROCKFALL DEBRIS AND TALUS FROM CATCHMENT AREA AT TOE OF SLOPE BETWEEN STA. 226+00 AND 236+00

ALTERNATE 1: NEW ROCKFALL BARRIER BEGIN AT STA. 236+00 (6' HIGH)

ALTERNATE 1: CLEANOUT OF ROCKFALL CATCHMENT AREA AT TOE OF SLOPE

ALTERNATE 1: CLEANOUT CATCHMENT AREA AT TOE OF SLOPE (WIDTH VARIES)

ALTERNATE 1 NEW ROCKFALL BARRIER (6' HIGH)

234+50 235+00 235+50 236+00 236+50 237+00 237+50 238+00 238+50 239+00 239+50 240+00 240+50

M.L.K. EAST BUSWAY

760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920

TOP OF 1H:1V CUT SLOPE

ALTERNATES 1, 2 OR 3: AREA OF SLOPE SCALING, SLOPE DRAPE OR ANCHORED SLOPE DRAPE

BIGELOW BLVD.

NO.	DATE	DESCRIPTION

REVISIONS

$FILE
$DATE

Gannett Fleming

GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 235+00 TO STATION: 240+50

Port Authority connecting people to life

CONTRACT NO. 57779

DWG. NO. WQ 20 SHT. 4

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

760

770

780

ALTERNATE 1: CLEANOUT CATCHMENT AREA AT TOE OF SLOPE (WIDTH VARIES)

ALTERNATE 1: NEW ROCKFALL BARRIER (6' HIGH)

EP

26TH STREET RAMP

EP

240+50 241+00 241+50 242+00 242+50 243+00 243+50 244+00 244+50 245+00 245+50 246+00 246+50

M.L.K. EAST BUSWAY

790 800 810 820 830 840 850 860 870 880 890 900 910 920 930 940

TOP OF OF 1H:1V CUT SLOPE

910 900

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN

1. NEW ROCKFALL BARRIER BEGINNING AT STA. 236+00 WITH CLEANING OF CATCHMENT AREA (RECOMMENDED)
2. CUT SLOPE FROM STA. 237+50 TO 247+50

NO.	DATE	DESCRIPTION

REVISIONS

$FILE
$DATE

Gannett Fleming

GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 241+00 TO STATION: 245+50

Port Authority
connecting people to life

CONTRACT NO. 57779

DWG. NO. WQ 20 SHT. 5

MITIGATION ALTERNATIVES CONSIDERED FOR AREA SHOWN
1. NEW ROCKFALL BARRIER FROM STA. 236+00 TO 247+50 WITH CLEANING OF CATCHMENT AREA (RECOMMENDED)
2. CUT SLOPE FROM STA. 237+50 TO 247+50

EAST BUSWAY SURVEY AND CONSTRUCTION CENTERLINE

ALTERNATE 1: CLEANOUT CATCHMENT AREA AT TOE OF SLOPE (WIDTH VARIES)

ALTERNATE 1: NEW ROCKFALL BARRIER END AT STA. 247+50 (6' HIGH)

TOP OF OF 1H:1V CUT SLOPE

M.L.K. EAST BUSWAY

EP

EP

245+50 246+00 246+50 247+00 247+50 248+00 248+50 249+00 249+18

760 770 780 770 790 800 810 820 830 840 850 860 870 880 890 910 840 850 860 870 880 890

780.05 HT

NO.	DATE	DESCRIPTION

REVISIONS

$FILE
$DATE

Gannett Fleming

GANNETT FLEMING, INC.
Foster Plaza 8
Suite 400
730 Holiday Drive
Pittsburgh, PA. 15220

SIGNATURE

APPROVED DATE

DESIGNED	JHF
DRAWN	DWP
CHECKED	JHF
IN CHARGE	JDM
DATE	DECEMBER 11, 2015
SCALE	.

PORT AUTHORITY OF ALLEGHENY COUNTY
PITTSBURGH, PENNSYLVANIA

EAST BUSWAY

SLOPE STABILIZATION STUDY

FROM STATION: 246+00 TO STATION: 249+00

Port Authority
connecting people to life

CONTRACT NO. 57779
DWG. NO. WQ 20
SHT. 6

ATTACHMENT 3
DETAILED COST ESTIMATES

PORT AUTHORITY OF ALLEGHENY COUNTY
EAST BUSWAY SLOPE STABILIZATION STUDY
SHORT TERM MITIGATION RECOMMENDATIONS
PRELIMINARY COST ESTIMATE

Debris Removal (No Design Required)

Begin Station Limit	End Station Limit	Work Item	Quantity	Unit	Unit Cost	Total
221+25	225+00	Remove Debris	417	CY	$ 25.00	$ 10,416.67
238+00	247+00	Remove Debris	833	SY	$ 25.00	$ 20,833.33
		Maintenance and Protection of Traffic	15	Day	$ 900.00	$ 13,500.00
		Construction Management	15	Day	$ 800.00	$ 12,000.00
					TOTAL	$ 56,750.00

Rockfall Barrier Replacement

Begin Station Limit	End Station Limit	Work Item	Quantity	Unit	Unit Cost	Total
222+62	222+12	Remove Barrier	50	LF	$ 25.00	$ 1,250.00
222+52	223+22	Rockfall Barrier	70	LF	$ 925.00	$ 64,750.00
		Maintenance and Protection of Traffic	10	Day	$ 900.00	$ 9,000.00
		Design (Assume 10% of Construction)	1	LS	$ 7,500.00	$ 7,500.00
		Construction Management	10	Day	$ 800.00	$ 8,000.00
					TOTAL	$ 90,500.00

Debris Removal (No Design Required)

Begin Station Limit	End Station Limit	Work Item	Quantity	Unit	Unit Cost	Total
226+00	236+00	Remove Debris	380	CY	$ 25.00	$ 9,500.00
		Maintenance and Protection of Traffic	5	Day	$ 900.00	$ 4,500.00
		Construction Management	5	Day	$ 800.00	$ 4,000.00
					TOTAL	$ 18,000.00

PORT AUTHORITY OF ALLEGHENY COUNTY
EAST BUSWAY SLOPE STABILIZATION STUDY
LONG TERM MITIGATION ALTERNATIVES
PRELIMINARY COST ESTIMATE

Station 218+00 Through 226+00

Item	Average Slope Height (ft)	Begin	End	Slope Length (ft)	Quantity	Unit	Unit Cost	Total
New Rockfall Barrier (10' High)	NA	21800	22600	800	800	LF	$ 925.00	$ 740,000.00
Maintenance and Protection of Traffic					32	Day	$ 950.00	$ 30,400.00
Design (Assume 5% of Construction)					1	LS	$ 38,520.00	$ 38,520.00
Construction Management					32	Day	$ 750.00	$ 24,000.00
							Total	$ 832,920.00
Rockfall Drape	150	21800	22600	800	13,340	SY	$ 80.00	$ 1,067,200.00
Maintenance and Protection of Traffic					25	Day	$ 950.00	$ 23,750.00
Design (Assume 5% of Construction)					1	LS	$ 54,547.50	$ 54,547.50
Construction Management					25	Day	$ 750.00	$ 18,750.00
							Total	$ 1,164,250.00
Anchored Rockfall Mesh	150	21800	22600	800	13,340	SY	$ 200.00	$ 2,668,000.00
Maintenance and Protection of Traffic					60	Day	$ 950.00	$ 57,000.00
Design (Assume 5% of Construction)					1	LS	$ 136,250.00	$ 136,250.00
Construction Management					60	Day	$ 750.00	$ 45,000.00
							Total	$ 2,906,250.00

PORT AUTHORITY OF ALLEGHENY COUNTY
EAST BUSWAY SLOPE STABILIZATION STUDY
LONG TERM MITIGATION ALTERNATIVES
PRELIMINARY COST ESTIMATE

Station 226+00 Through 236+00

Item	Average Slope Height (ft)	Begin	End	Slope Length (ft)	Quantity	Unit	Unit Cost	Total
Rock Slope Scaling	NA	22600	23600	1000	160	Hour	$ 800.00	$ 128,000.00
Hauling	NA				20	Day	$ 850.00	$ 17,000.00
Maintenance and Protection of Traffic					20	Day	$ 950.00	$ 19,000.00
Design (Assume 5% of Construction)					1	LS	$ 8,200.00	$ 8,200.00
Construction Management					20	Day	$ 750.00	$ 15,000.00
							Total	$ 187,200.00
Rockfall Drape	140	22600	23600	1000	15,560	SY	$ 50.00	$ 778,000.00
Maintenance and Protection of Traffic					30	Day	$ 950.00	$ 28,500.00
Design (Assume 5% of Construction)					1	LS	$ 40,325.00	$ 40,325.00
Construction Management					30	Day	$ 750.00	$ 22,500.00
							Total	$ 869,330.00
Anchored Rockfall Mesh	140	22600	23600	1000	15,560	SY	$ 200.00	$ 3,112,000.00
Maintenance and Protection of Traffic					70	Day	$ 950.00	$ 66,500.00
Design (Assume 5% of Construction)					1	LS	$ 158,925.00	$ 158,925.00
Construction Management					70	Day	$ 750.00	$ 52,500.00
							Total	$ 3,389,930.00

PORT AUTHORITY OF ALLEGHENY COUNTY
EAST BUSWAY SLOPE STABILIZATION STUDY
LONG TERM MITIGATION ALTERNATIVES
PRELIMINARY COST ESTIMATE

Station 236+00 Through 247+50

Item	Average Slope Area (sf)	Begin	End	Slope Length (ft)	Quantity	Unit	Unit Cost	Total
New Rockfall Barrier (6' High)	NA	23600	24750	1150	1,150	LF	$ 700.00	$ 805,000.00
Maintenance and Protection of Traffic					46	Day	$ 950.00	$ 43,700.00
Design (Assume 5% of Construction)					1	LS	$ 42,435.00	$ 42,435.00
Construction Management					46	Day	$ 750.00	$ 34,500.00
							Total	$ 925,640.00
Slope Excavation	500	23600	24750	1150	22,000	CY	$ 25.00	$ 550,000.00
Maintenance and Protection of Traffic					122.22	Day	$ 950.00	$ 116,111.11
Design (Assume 5% of Construction)					1	LS	$ 33,305.56	$ 33,305.56
E&S Control (Assume 7% of Construction)					1	LS	$ 46,627.78	$ 46,627.78
Construction Management					122	Day	$ 750.00	$ 91,500.00
							Total	$ 837,550.00

ATTACHMENT 4
CONCEPTUAL MITIGATION SCHEMATICS

222+00.00

CONCEPTUAL ROCKFALL BARRIER ALTERNATE

BIGELOW
BOULEVARD

RE-ESTABLISH
CATCHMENT AREA AT
TOE OF SLOPE

EDGE OF BUSWAY/
NEW 10' HIGH
ROCKFALL BARRIER

M.L.K. EAST BUSWAY
CENTERLINE

930 920 910 900 890 880 870 860 850 840 830 820 810 800 790 780 770 760 750 745

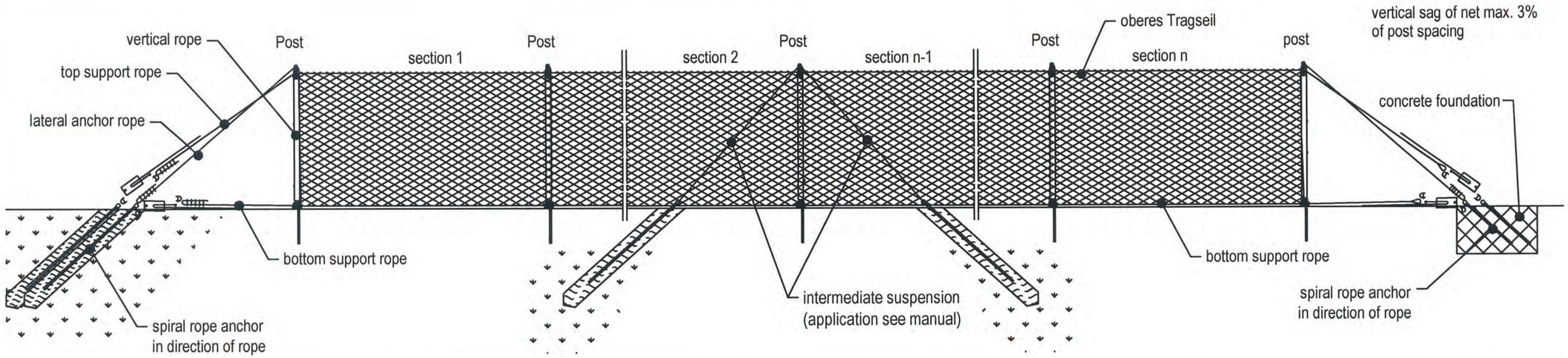
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250

K:\057779 - PAAC Open End R13-09-A\WO20- E.Busway Slide Study\E. Prj Wrk\A. CADD\PAAC BUSWAY MESH+BREAK+CONT-ACAD.dwg, 3/14/2016 5:53:43 PM

PAAC BUSWAY MESH+BREAK+CONT-ACAD.dwg

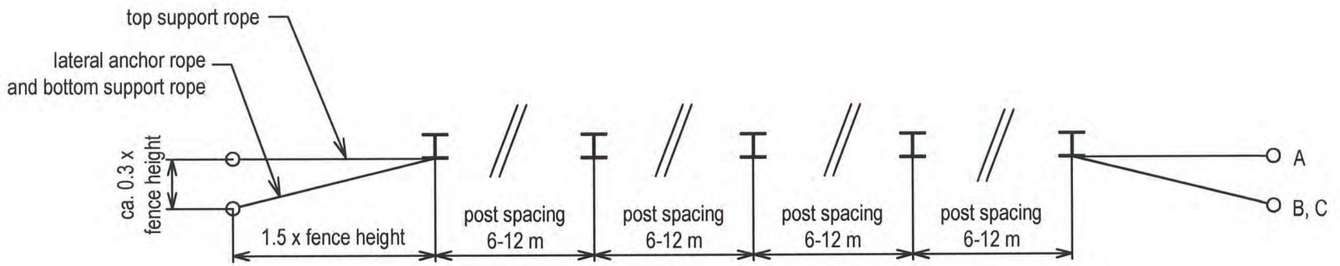
12/18/2009

SStrickland

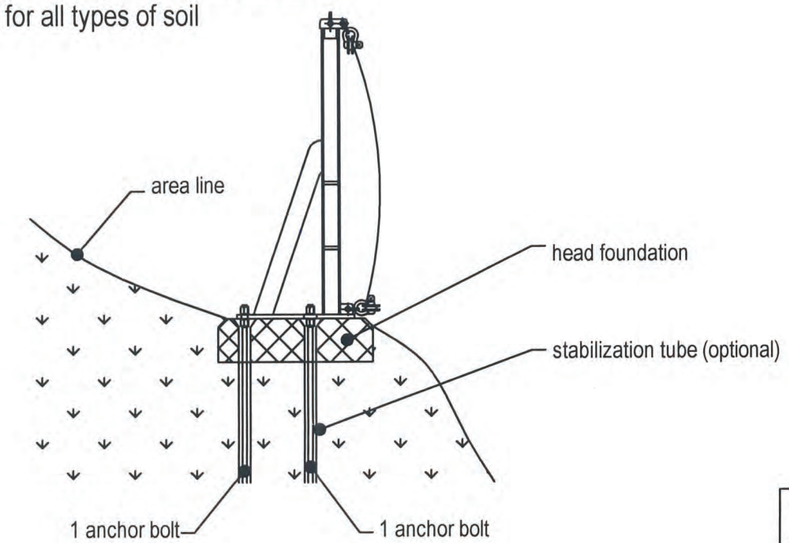


layout of anchor points

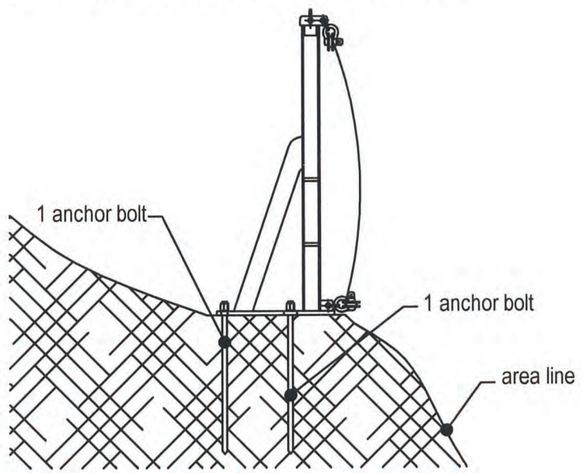
(Details in product manual GBE-500A-R)



anchoring concrete foundation for all types of soil



anchoring in bedrock: with two anchor bolts



NOTE:
Rockfall, landslides, debris flows or avalanches are sporadic and unpredictable. Causes can be e.g. human (construction, etc.) or environmental (weather, earthquakes, etc.). Due to the multiplicity of factors affecting such events it is not and cannot be an exact science that guarantees the safety of individuals and property.
However, by the application of sound engineering principles to a predictable range of parameters and by the implementation of correctly designed protection measures in identified risk areas the risks of injury and loss of property can be reduced substantially.
Inspection and maintenance of such systems are an absolute requirement to ensure the desired protection level. The system safety can also be impaired by events such as natural disasters, inadequate dimensioning parameters or failure to use the prescribed standard components, systems and original parts; and/or corrosion (caused by pollution of the environment or other man-made factors as well as other external influences).

modification:	M:%	substitute for: GS-1122e ed. 15.12.10
-		replaced by:

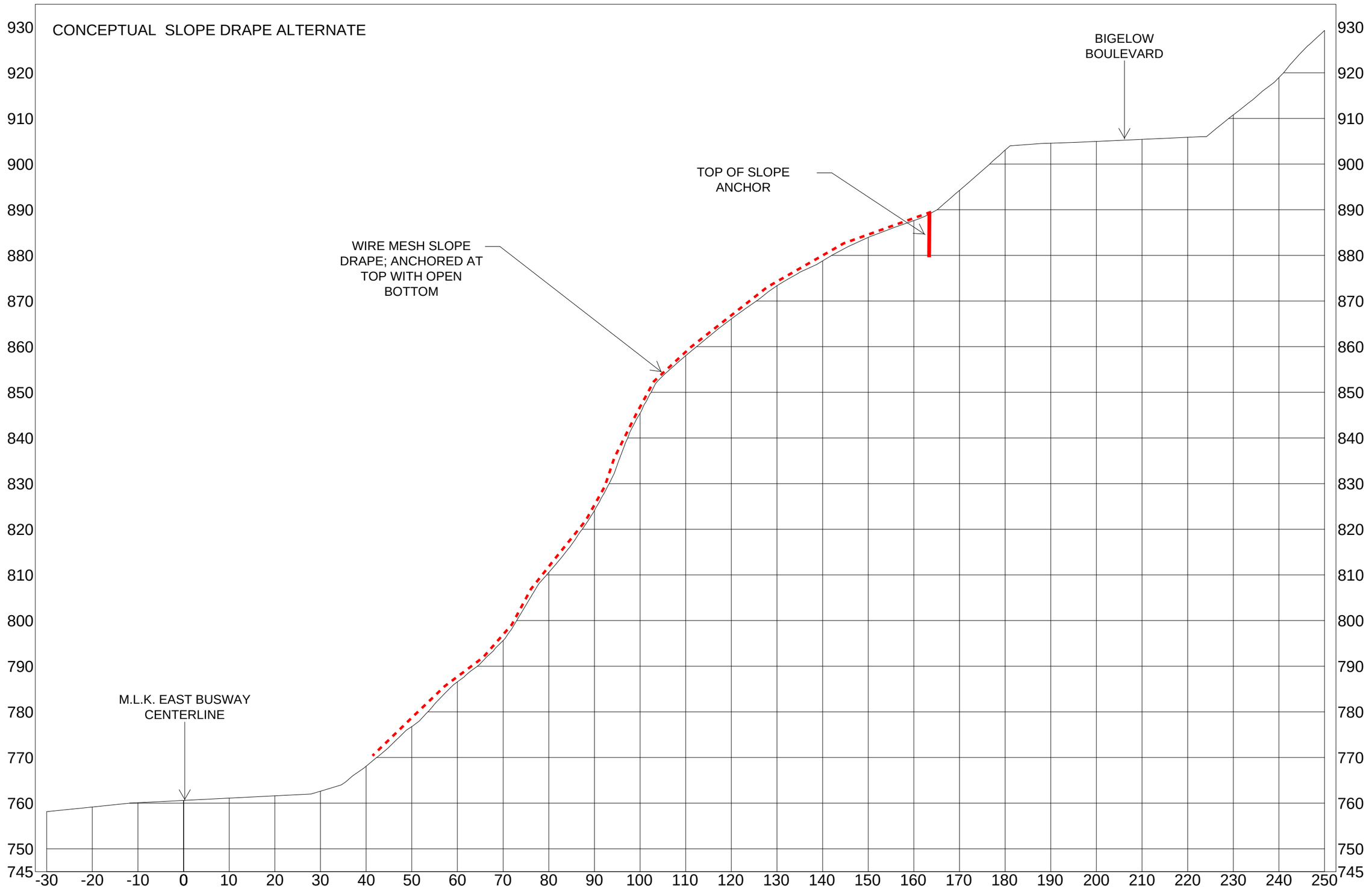
Rockfall protection barrier **GBE-500A-R system** **EOTA classification 2 (500 kJ)**	drawn	07.01.14	kw
	checked	07.01.14	WO
	approved	07.01.14	Ro

GEOBRUGG AG
CH-8590 Romanshorn

GS-1122 e

222+00.00

CONCEPTUAL SLOPE DRAPE ALTERNATE



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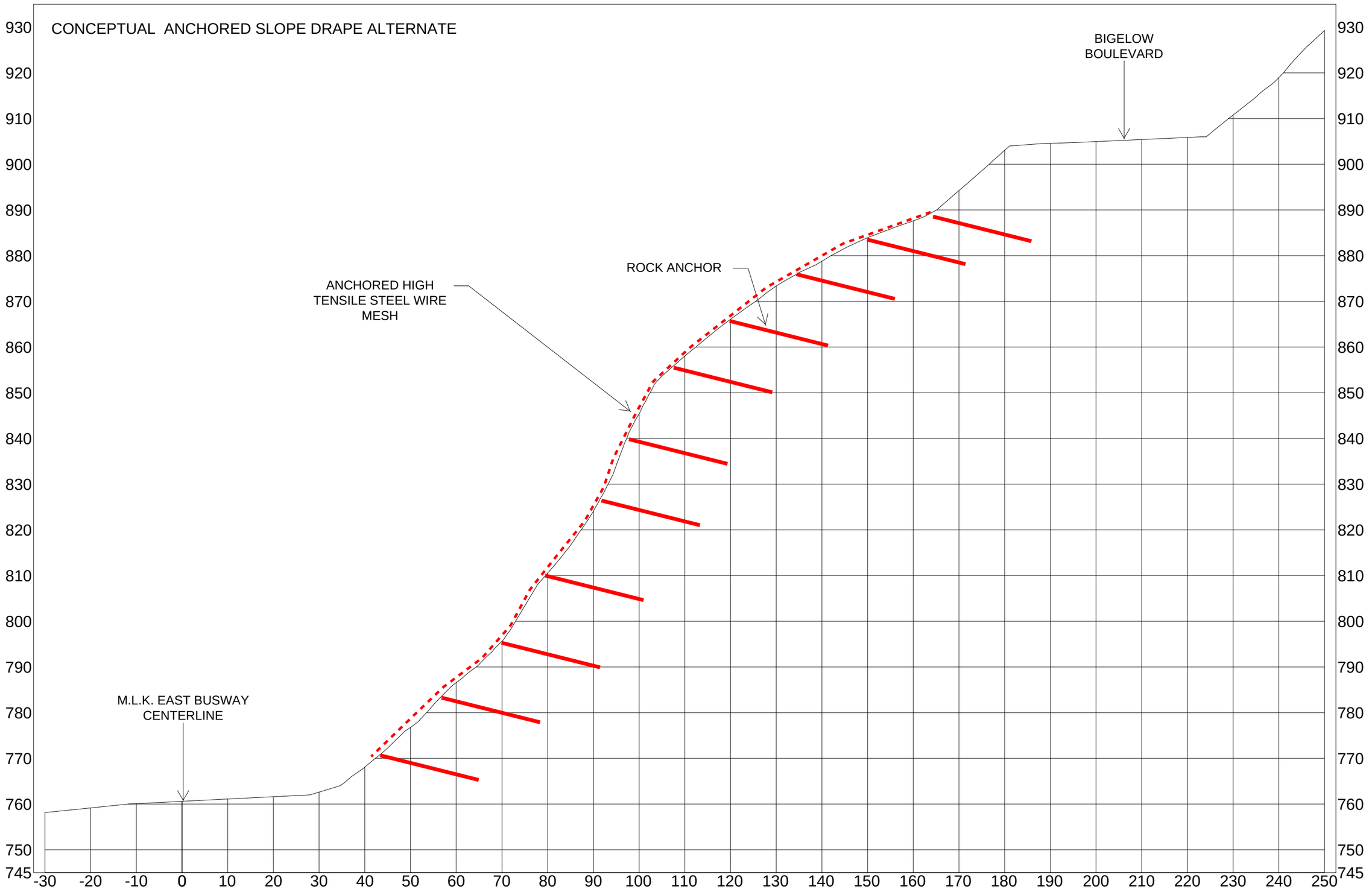
CONCEPTUAL ANCHORED SLOPE DRAPE ALTERNATE



232+00.00

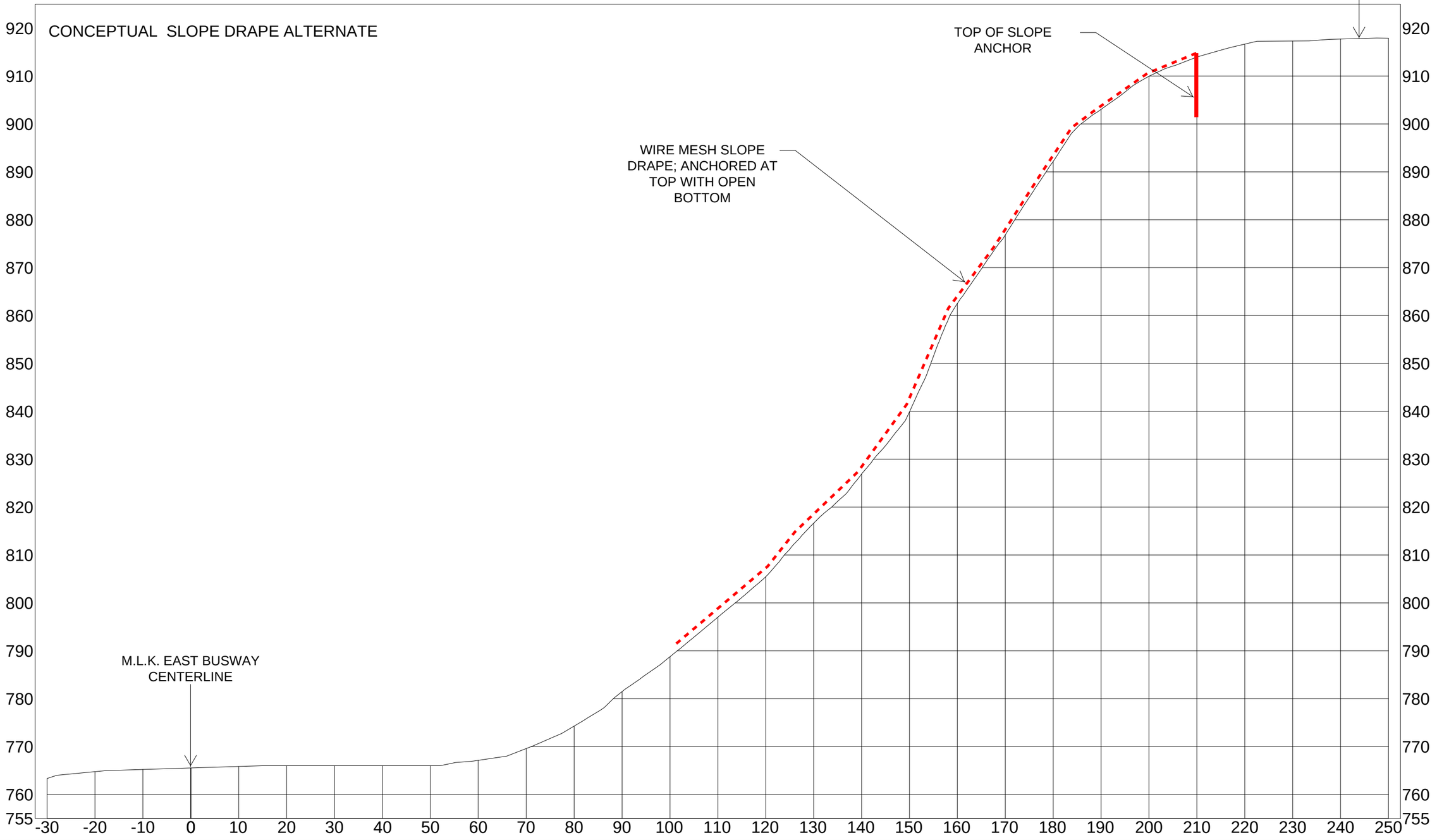
CONCEPTUAL SLOPE DRAPE ALTERNATE

BIGELOW BOULEVARD

TOP OF SLOPE ANCHOR

WIRE MESH SLOPE DRAPE; ANCHORED AT TOP WITH OPEN BOTTOM

M.L.K. EAST BUSWAY CENTERLINE



232+00.00

CONCEPTUAL ANCHORED SLOPE DRAPE ALTERNATE

BIGELOW BOULEVARD

ANCHORED HIGH TENSILE STEEL WIRE MESH

ROCK ANCHOR

M.L.K. EAST BUSWAY CENTERLINE

920 910 900 890 880 870 860 850 840 830 820 810 800 790 780 770 760 755

-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250

PAAC BUSWAY MESH+BREAK+CONT-ACAD.dwg

12/18/2009

SStrickland

243+00.00

CONCEPTUAL ROCKFALL BARRIER ALTERNATE

RE-ESTABLISH CATCHMENT AREA AT TOE OF SLOPE

EDGE OF BUSWAY/ NEW 6' HIGH ROCKFALL BARRIER

M.L.K. EAST BUSWAY CENTERLINE

950 940 930 920 910 900 890 880 870 860 850 840 830 820 810 800 790 780 775

-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250

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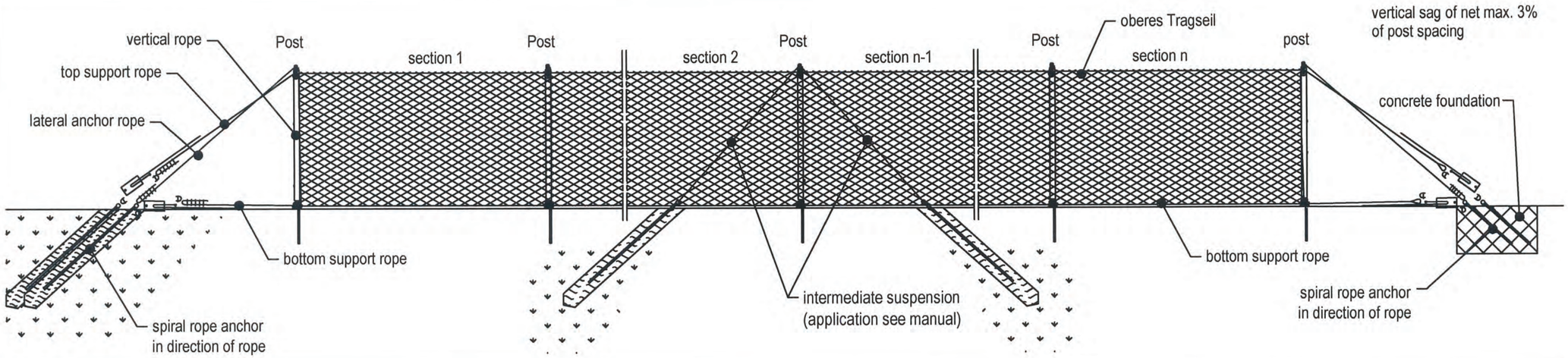
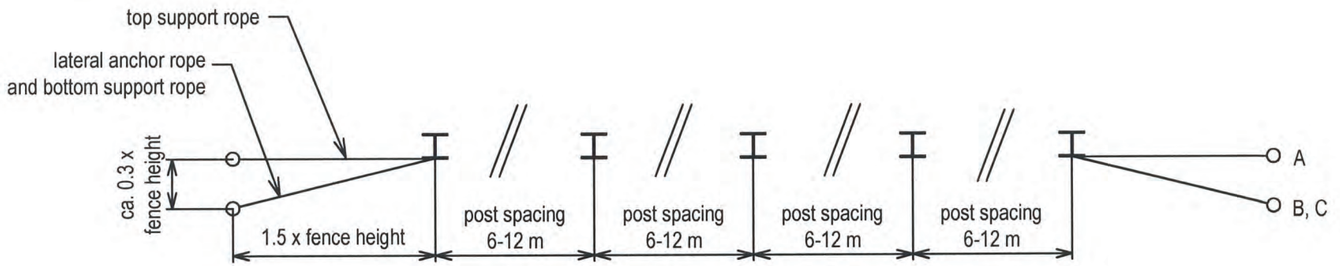
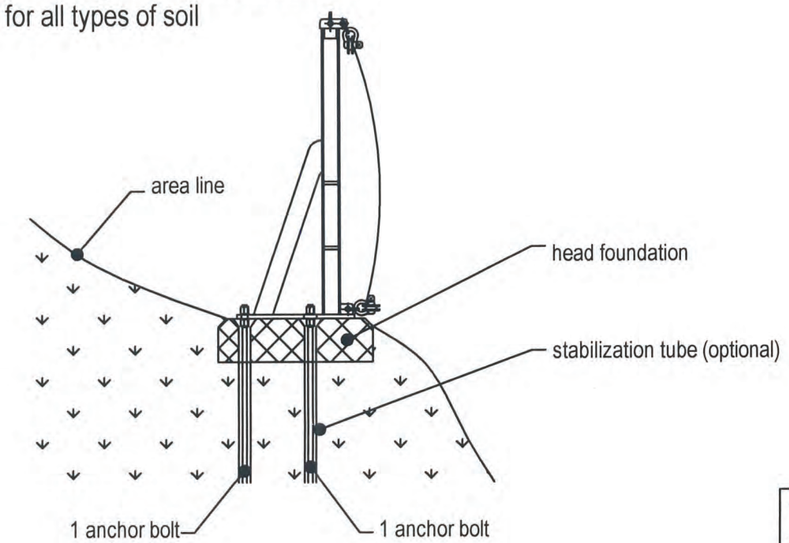


layout of anchor points

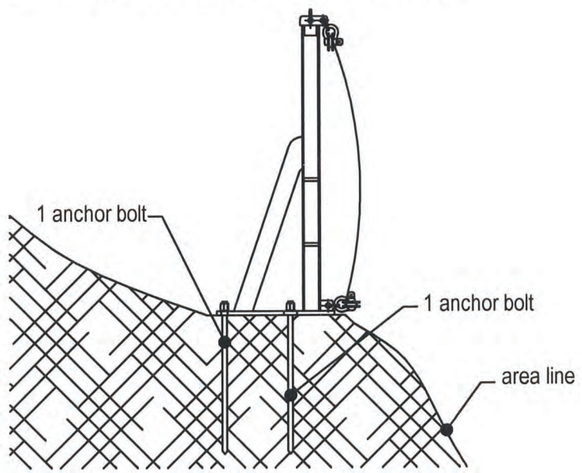
(Details in product manual GBE-500A-R)



anchoring concrete foundation for all types of soil



anchoring in bedrock: with two anchor bolts



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modification:	M:%	substitute for: GS-1122e ed. 15.12.10
-		replaced by:

Rockfall protection barrier **GBE-500A-R system** **EOTA classification 2 (500 kJ)**	drawn	07.01.14	kw
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	approved	07.01.14	Ro

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243+00.00

CONCEPTUAL CUT SLOPE ALTERNATE