GOLDER

May 10, 2019 Project No. 19120896

Mr. Ethan Thomas
Transportation Geologist
Vermont Agency of Transportation
Geotechnical Engineering Section
2178 Airport Road, Building B
Berlin, Vermont 05641

RE: PRELIMINARY ROCKFALL MITIGATION DESIGN, FAIRLEE ESCARPMENT SOUTHBOUND INTERSTATE 91, MILEPOST 92.7, FAIRLEE, VERMONT

Mr. Thomas:

Further to your request, Golder Associates Inc. (Golder) has prepared this design report to document recent rockfall history, response measures following a vehicle strike, and recent site tours and preliminary design elements recommended to mitigate rockfall potential at the Fairlee Palisades escarpment at Milepost 92.7 on the southbound barrel of Interstate 91 in Fairlee, Vermont (Photo 1). We have conducted our services in accord with our VTrans on-call geotechnical contract PS0475 executed December 1, 2015, and in accordance with the scope of services presented our proposal dated April 2, 2019.

BACKGROUND

A rockfall occurred on Tuesday November 27th, 2018, at Milepost 92.7. The rockfall included roughly 5-8 cubic yards of material, some of which rolled into the travelled lanes and a vehicle strike occurred. The rockfall zone at the Fairlee escarpment has been treated in the past by installation of a wire mesh drape (1996) when Alan McBain was the Transportation Geologist, with the mesh installed where the escarpment is both close to the roadway and tallest. North of the mesh-covered portion of the slope, the rock slope is dished and farther from the roadway, providing a large runout zone and ditch for catchment of falling rocks. Roughly 400 feet north of the draped mesh the lower portion of the escarpment slope is less steep and is closer to the roadway, and the overall height of the escarpment is less going northward (Photos 1-3). Golder visited the site with Ethan Thomas on November 30, 2018, viewed the rockfall source area with binoculars and photographed the rock face and ditch areas. Physical access to the slope crest was considered hazardous without additional safety equipment due to snow and ice on the slopes.

At the time of the November 30, 2018 site visit, Golder observed that the slope crest had many large trees with roots growing into the rock joints describing blocks all along the crest of the slope. A couple dead trees were noted, commonly an indication that a rock block had shifted and water had sufficiently drained from the rock mass joints behind the blocks to kill the trees. Roots were also visible in the face of the rockfall source area suggesting that root jacking had caused or contributed to the rockfall or exacerbated dilation of the joints in the rock at the crest of slope, loosening the block substantially. Along the crest of the rock slope many crest blocks were observed with dilated (opened) joints.

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Two large blocks that reportedly fell three weeks before the November 27 rockfall event were observed south of the November 27 rockfall location during our November 30 site visit (Photo 2). Both blocks rolled out in the ditch and did not reach the roadway or shoulder. At the time of our November 30 site tour Golder concluded that the slope is in need of maintenance scaling in the near term (Photo 5). Observation of the November 27 rockfall source area did not reveal apparent evidence of imminent rockfall conditions, and weather and surface (snow and ice) conditions did not allow close observation of the entire crest and toe from the draped mesh to the rockfall source (roughly 400+ feet of crest). Despite the two rockfall events over three weeks' time, Golder did not believe the observed conditions warranted an immediate emergency response during Winter conditions and recommended that the slope be addressed in the Spring of 2019. Additional maintenance patrols and signage were recommended, together with marking existing rockfall blocks with spray paint so that any new rockfalls could be readily recognized and appropriate actions taken as needed. VTrans subsequently implemented these recommendations.

Initial regional geologic mapping assigned the bedrock to the Late Ordovician Fairlee Quartz Monzonite, suspected of belonging to the Late Ordovician Highlandcroft plutonic rocks of western New Hampshire.[1] This mapping describes the lithology consisting of greenish gray, with local pink tinges, coarse-grained granitic rock, containing bluish-gray quartz, perthitic microcline and oligoclase or andesine, with secondary chlorite, sericite and green biotite. The rock is generally crushed and foliated. More recent regional mapping assigns the Fairlee Quartz Monzonite an Early Devonian age, and describes it as greenish-gray, pink-tinged, weakly foliated, coarse-grained to porphyritic biotite granite of the Fairlee pluton.[2] The rock mass has been subjected to fault movement, including a prominent fault surface dipping moderately to the northeast exposed in the slope north of the wire mesh. Drag folds on the upper block indicate a normal sense of movement.[3] The drag folds created vertical joint sets that in part form the rock blocks susceptible of falling form the slope. Unconfined compressive strengths reported for Quartz Monzonite range up to 25,000 pounds per square inch (psi).

Slope Crest Observations and Conclusions

To further assess the condition of the rock slope and crest, Golder returned to the site on April 10 and 12, 2019, to access the crest of the slope and conduct limited rope access observation of slope conditions at the crest from the existing rockfall drape at the south end of the project northward to just north of the source area of the November 27 rockfall. At ten locations along the slope crest, our field crew tied off and rappelled part-way down the slope to observe bedrock jointing, rock mass characteristics, and the condition of the joints. Photographs were taken at each rappel location and at other points along the slope crest where the condition of the rock slope was visible through trees growing on the slope.

The condition of the slope crest was worse than envisaged during our November 30 site visit. The crest is heavily weathered and substantial root jacking of rock blocks and progressive ice riving and snow/ice jacking of open joints was observed. Joint apertures ranged from fractions of an inch to over 16 inches with some blocks observed to be on the verge of toppling (Photo 3 and Photos 5-13). The backslope above the crest rises another

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[1] Hadley, J.B., 1951. Geology of the Bradford-Thetford Area, Orange County, Vermont. Vermont Geological Survey, Bulletin No. 1, 36 p., 2 plates.

[2] Ratcliffe, N.M., Stanley, R.S., Gale, M.H., Thompson, P.J., and Walsh, G.J., 2011. Bedrock Geologic Map of Vermont. U.S. Geological Survey Scientific Investigations Map 3184, 3 sheets, scale 1:100,000.

[3] Westerman, D.S., Eliassen, T.D. and Wright, S.F., 2003. Highway Geology Symposium Field Trip Guide for Central Vermont. 54th Highway Geology Symposium, Burlington, Vermont, September 25, 2003, 20 p.

50 to 100 feet and has a gentler slope. The backslope is strewn with quartz monzonite boulders (Photo 4), ranging from a few feet to over ten feet in nominal size that were deposited during glaciation where the Palisades were a leeward or pluck-slope.

Joints in the rock face vary across the slope face due to the presence of the major fault described above at mid-slope that is visible near the northern limits of the draped rockfall mesh installed in 1996 (Figures 1 and 2). Conjugate joints to this fault are striking sub-parallel to the slope face and dipping at roughly 20 to 30 degrees out of the face and 70-90 degrees into the face. Joint spacing of the sub-vertical fractures is on the order of 1-2 feet, and as the joints weather, they can fill with soil and be exploited by tree roots and are subject to frost action. As the joints progressively dilate, they favor toppling of slabs of rock (Photos 13 to 19). The shallow dipping conjugate joints form steps or benches in the slope face and release surfaces at the base of slabs and blocks. A third set of sub-vertical joints striking perpendicular to the face form the third set of faces/edges in the blocks and slabs (Photos 18 and 22). Spacing of the shallow joints is generally over 10 feet and spacing of the third set of joints ranges from a few feet to over ten feet, allowing formation of thin slabs with face areas of 40 to over 100 square feet (Photo 24 and Figures 1-5).

The heavily weathered condition of many of the slabs and blocks on the face suggest that stabilization, at least of the features with open joints greater than 1-inch, may be more complicated than scaling the rocks down (Photo 28). For some slabs, the first two joints are too dilated for rock dowels (Photo 17) and once scaled, the remaining rock may need to be secured with untensioned rock dowels.

The condition of the 1996 drape is good. Drape anchors observed appeared intact and uncorroded and most of the border cables and double-twist mesh panels are in good condition. A few holes in the mesh were noted and appear to have been caused by falling slabs of rock. Consideration should be given to patching holes, trimming vegetation that may be growing through the mesh, clearing accumulated debris that has not passed to the bottom of the drape and performing other minor maintenance activities as part of the slope stabilization project this year. As with all types of barriers, maintenance is a required activity and the performance of high angle maintenance can probably be most cost effectively done when trained rock slope technicians are already on site.

RECOMMENDATIONS

As we discussed in the field, trees should be cut and removed from the crest and for at least 15 feet behind the crest. Similarly, trees on the lower slope segments in the project area should be removed to limit potential future root jacking. After cutting, stumps should be treated with an herbicide to keep suckers/new growth from developing on the stumps. Because of the location, we envision this task will be completed in large part by the specialty scaling contractor.

The presence of many blocks and slabs with highly dilated joints (apertures to 16” or more) will necessitate scaling such features down from the slope. Where slabs cannot be scaled or can only be partially removed, remaining blocks and key blocks holding the remaining rock mass in place should be doweled with fully-grouted, untensioned rock bolts. Placement of rock dowels should be developed in the field based on scaled rock slope conditions. Rock dowel design should focus on stabilizing key blocks and slabs to retain rock masses and inhibit further joint dilation. Open joints (<1-inch) along the crest should be cleaned and slush-grouted to limit infiltration of water and soil, and wider joints should be capped with hand-packed grout. We envision that rock blocks with joints wider than 1-inch that extend more than 2 feet below the crest will be hand scaled using standard 4-foot mine scaling bars, air bags and other hand scaling methods after being cleaned of soil and root debris. Remaining blocks should be secured with rock dowels as directed by the engineer.

Rock dowels should be drilled perpendicular to the face azimuth and raked 15-20 degrees down from horizontal. All bars drilled on a given day should grouted the same day without exception. Grout should consist of cementitious non-shrink grout with an unconfined compressive strength of 7,500 pounds per square inch (psi) at 28 days and a high early strength of 5,000 psi at three days. Verification testing of the rock dowels should be performed through sacrificial pullout tests for each encountered rock type (two minimum) to verify assumed bond values used for dowel design and grout testing. Tests of fully grouted anchors are not particularly suitable unless a pullout cone test is performed, requiring a large beam and reaction (bearing) points spaced at least ½ the length of the dowel from the hole collar. On rappel this is not feasible and subsequent tests on fully grouted bars should be conducted only where excessive grout takes have occurred, drilling and installation of a bar has met with significant difficulty, or at the direction of the engineer (estimated at 5 dowels). Grout cubes (metal molds only) should be taken daily for each grouting episode (including sacrificial pullout tests) or for every 10 dowels, whichever is greater. Based on the sacrificial tests, grout testing results, and on-site installation observation, dowels should be accepted or rejected by the engineer.

Figures 1 through 10 present our preliminary design identifying known areas that should be scaled and contain our estimated (conservative) number of rock dowels for budgeting purposes. Rock dowels have been estimated as 10- to 15-foot galvanized, Grade 75, No. 8 continuous threadbar. For cost estimating purposes, 1,200 to 1,500 (upset) linear feet of rock dowels should be budgeted.

Rock Stabilization Contractor Qualifications and Project Safety

The project rock slope ranges from 180 to 225 feet high. Scaling the upper two-thirds of the slope, removal of trees and installation of rock dowels should be completed by a contractor that specializes in high-angle work. We estimate that the 3D surface area of this portion of the slope is on the order of 77,500 square feet. Hand scaling methods are recommended because mechanical (machinery) methods lack the finesse to scale only what is necessary and often damage remaining slope features such that minor rockfalls from machine-damaged rock surfaces occur for several years after scaling. Highly efficient scaling by an experienced specialty contractor can also reduce the requirement for bolting by as much as half by not leaving partially scaled and damaged rock on-slope. Most importantly, experienced high scalers will know when a particular rock may have the potential to reach the roadway and interfere with traffic during scaling.

The project slope heights and complexity of the contemplated work call for a specialty contractor with an excellent safety record. High scalers should be experienced or apprenticed following rope access training and working under an experienced scaler and supervisor. Safety records for the prime and specialty contractors should be reviewed as part of the contractor’s qualifications in the bid submittal, and the bid documents should require identification of the firm performing high scaling by each bidder and not allow substitution. Due to the complexity of the project, we recommend VTrans require that the bidders include a representative of their specialty rock slope subcontractor for an on-site prebid meeting to review the site conditions in detail.

To facilitate construction and moving materials to the slope crest, we recommend that VTrans improve the access road to the crest of the slope that originates from a powerline corridor road west of the slope.

Maintenance and Protection of Traffic

The setback of the slope from the edge of pavement of the southbound I-91 barrel ranges from roughly 100-110 feet at the southern end of the project to 22 feet at the northern end of the project slope. Thus, the southern end of the slope offers a larger runout zone for scaled rocks falling from the crest than the north end of the project does. The November 27 rockfall and rock strike are evidence of this. Several approaches can be used to protect traffic during scaling. Traffic stops, rolling traffic stops, and installation of berms and temporary barriers can be considered; however, when using traffic stops, there may be delays in the scaling efforts while waiting for the traffic stops to be implemented and impact the project schedule.

With the emphasis on completing the project expeditiously within a three-month envelope of time (early August to mid-November 2019), Golder recommends that the southbound barrel of traffic be shunted onto Route 5 at the Bradford exit north of the project and re-enter the southbound barrel at the Fairlee exit. A similar approach was used in 1996 when the Palisades wire mesh drape was constructed, though at that time both barrels were diverted to Route 5. Traffic on the northbound barrel should be stopped only when the high scalers are preparing to bring a large block down and indicate that it could reach the median. Traffic stops should be limited to a period of 20 minutes (maximum) from the time of the stop to the release of traffic. An experienced scaling contractor should be able to request traffic stops only for those scaled rocks that might reach the northbound roadway.

Additional protection of the southbound roadway can also be provided by a temporary rockfall barrier (movable barrier incorporating rockfall barrier infrastructure). Such a barrier may obviate the need for northbound traffic stops. Additionally, the contractor should stage a large (e.g., Caterpillar 966) loader and sweeper equipment where it can rapidly access each barrel to remove rocks that may roll onto the roadway.

Construction Oversight – Field Design

The limits of scaling are relatively easy to delineate at this time. However, locations and depths of rock dowels cannot be identified with certainty until the slope is scaled. As the slope is scaled, the engineer can observe how well integrated the slope is and better judge the need for adding slope reinforcement. Key blocks that should be stabilized, and slabs that need to be knit together to reinforce the crest are best identified during and after scaling and tree removal. Similarly, cracks along the crest that should be filled with hand packed grout or slush grouted won't be fully identified until vegetation is removed from the crest and the slope is scaled. For these reasons, and to economize on the number of rock dowels installed, Golder recommends that we be retained to provide field design services during scaling and rock dowel installation.

Mitigation Estimate

As noted above, design of rock reinforcement will have to be completed in the field as blocks that cannot be scaled (too large/dangerous or not deteriorated enough) are identified during scaling and reinforcement can be designed. We have developed a preliminary cost estimate based on the conditions observed in the field (discrete blocks at spot locations), our judgement, and past VTrans costs for various elements of the work.

We have estimated scaling time at 230 hours (23 full days) to include tree removal, with scaling time based on discrete spot scaling, crest scaling and industry scaling values for 500 square feet per day per scaler, an estimated 77,500 square feet of slope, 6 days/week, and a 7-person (plus foreman) scaling crew, and the hourly scaling rates VTrans has seen in the past few years. Clearing and grubbing is estimated at 14 days, some of which should be completed concurrently with scaling. Based on our crest observations and observations made on rappel, we have estimated that 100 dowels up to 15 feet in length may be needed to stabilize some blocks and slabs. We recommend that VTrans carry 1,500 linear feet of rock dowels at $130/foot, and that we work to reduce the number of dowels through efficient scaling and field design of support. Cracks along the crest of the slope should be cleaned (by grubbing and blowpipe) and surface sealed with hand-packed grout. A quantity of hand-packed grout of 25 gallons has been estimated. We understand that the access roadway used for the 1996 construction will be re-opened so that compressors, material and grout plants can be staged at the slope crest.

Our preliminary estimated cost is presented in Table 1.

CLOSURE

This design report is preliminary in nature and represents our professional opinion based on field observations and preliminary calculations. It has been prepared in accordance with generally accepted geological engineering principals and practice based on limited available data and we make no other warranty express or implied. All of the services used for this assignment were professional services performed by reasonable and prudent design professionals.

We trust this preliminary design meets your current needs. Please contact Pete Ingraham or Jay Smerekanicz should you have any questions regarding the interpretation or contents of this report.

Sincerely,

Golder Associates Inc.

Jay R. Smerekanicz
Senior Consultant and Associate

Peter C. Ingraham, P.E.
Program Leader and Principal

JRS/PCI/drb

Attachments:	Table 1	Preliminary Quantity Estimates and Cost Opinion
	Figures 1-10	Rock Slope Mitigation
	Appendix A	Photo Log

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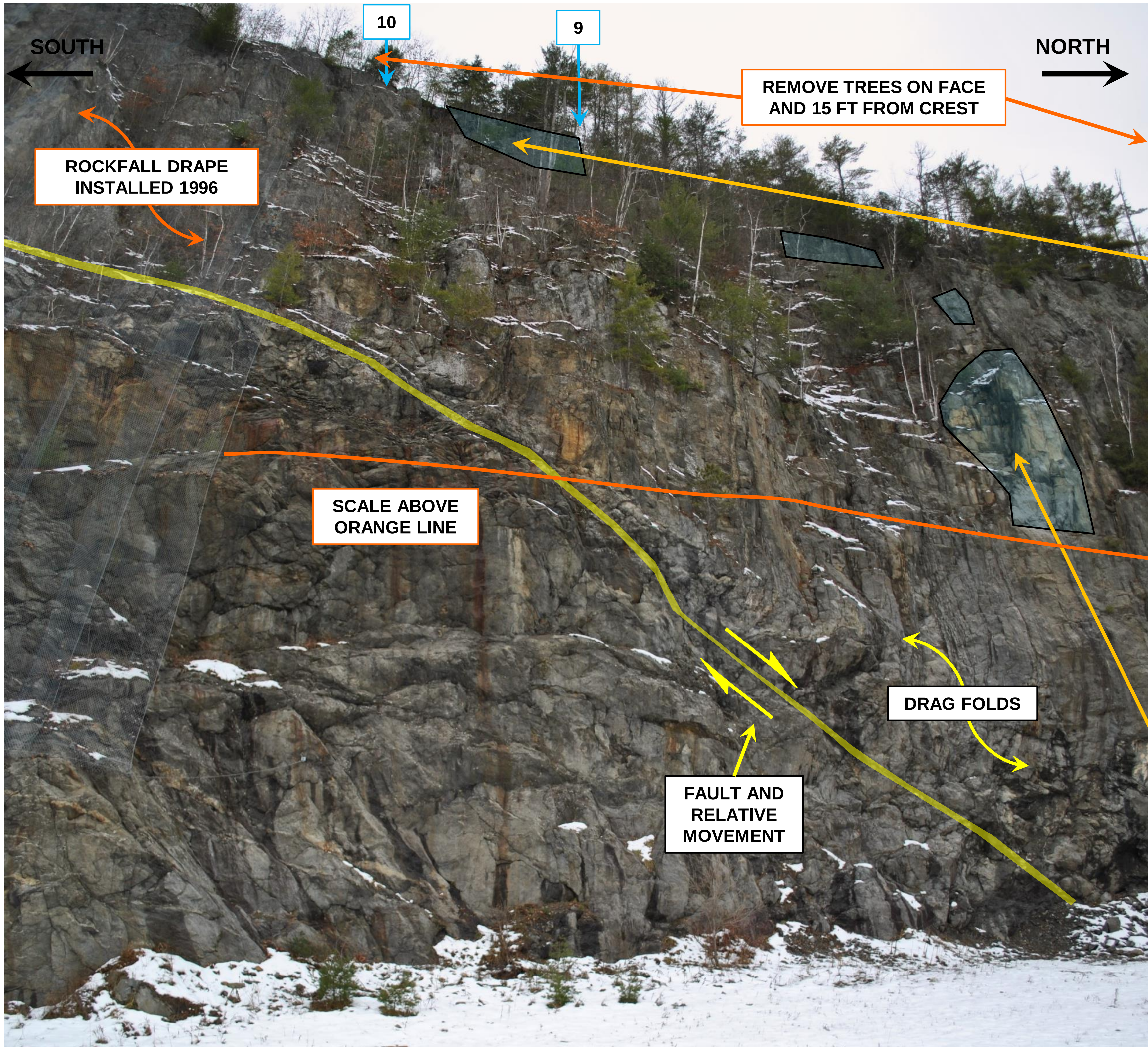
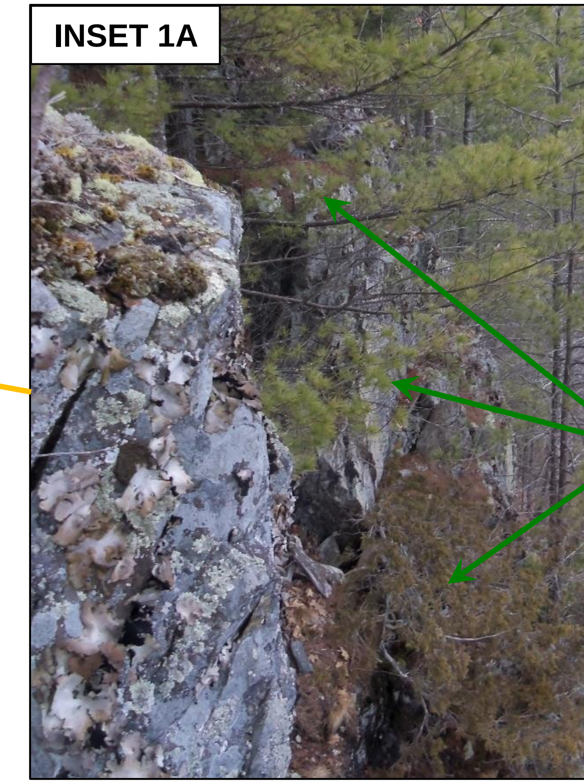
FIGURES





REMOVE DILATED BLOCKS, DOWEL REMAINING SLABS (4 DOWELS)

REMOVE PILLAR AND LOOSE BLOCKS, DOWEL REMAINING KEY BLOCKS (4 DOWELS)

LEGEND:

10 — RAPPEL 10 LOCATION

NOTES:

1.) DITIGAL PHOTOGRAPHS TAKEN NOVEMBER 30, 2018 AND APRIL 10-12, 2019. MITIGATION ELEMENTS/ NOTES ARE REPEATED ON SOME PHOTOGRAPHS
2.) NOT TO SCALE - FEATURE LOCATIONS AND STATIONS ARE APPROXIMATE.
3.) DURING CONSTRUCTION, VTRANS ENGINEERING GEOLOGIST/GEOTECHNICAL ENGINEER MAY IDENTIFY ADDITIONAL STABILIZATION MEASURES OR FIELD CHANGES TO THE DESIGN.

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Job No.	19120896	SCALE:	N/A
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REV BY:	PCI	DR ST:	01

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ROCK SLOPE MITIGATION
FAIRLEE IM 091-2(86)

VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 1

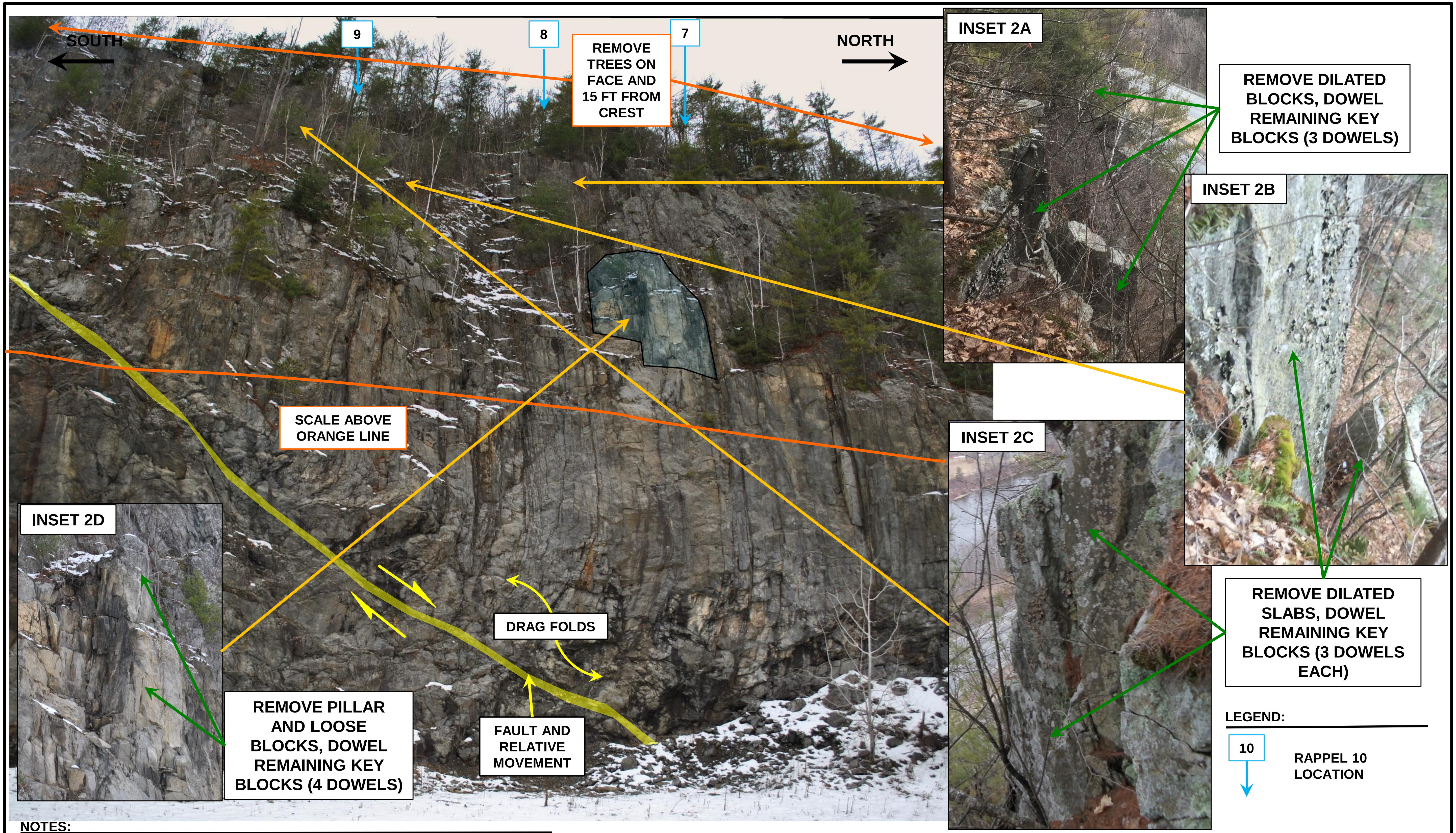

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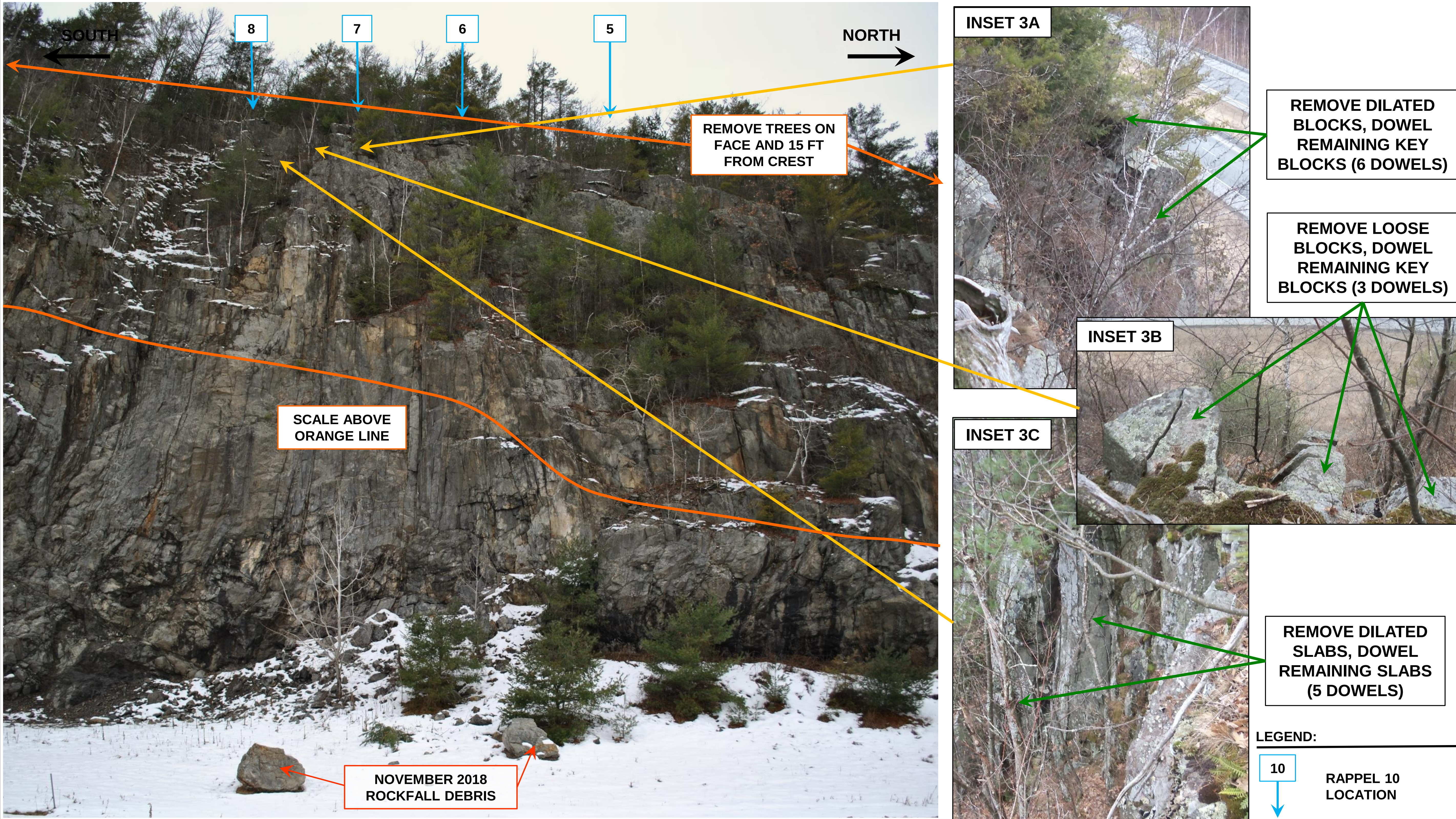
Figure: 2



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ROCK SLOPE MITIGATION
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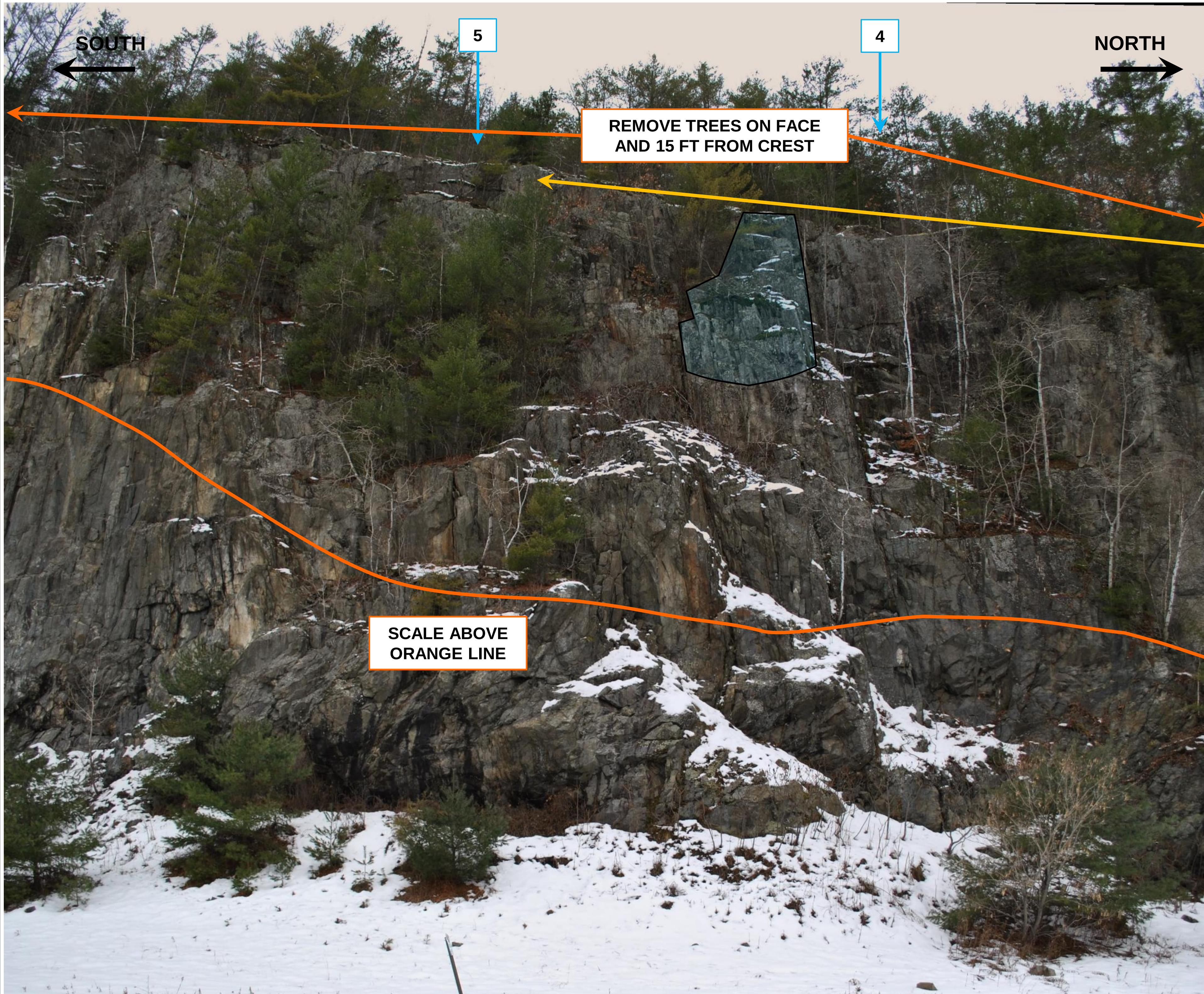
VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 3



REMOVE DILATED BLOCK, DOWEL REMAINING KEY BLOCKS (5 DOWELS)

LEGEND:

10 RAPPEL 10 LOCATION

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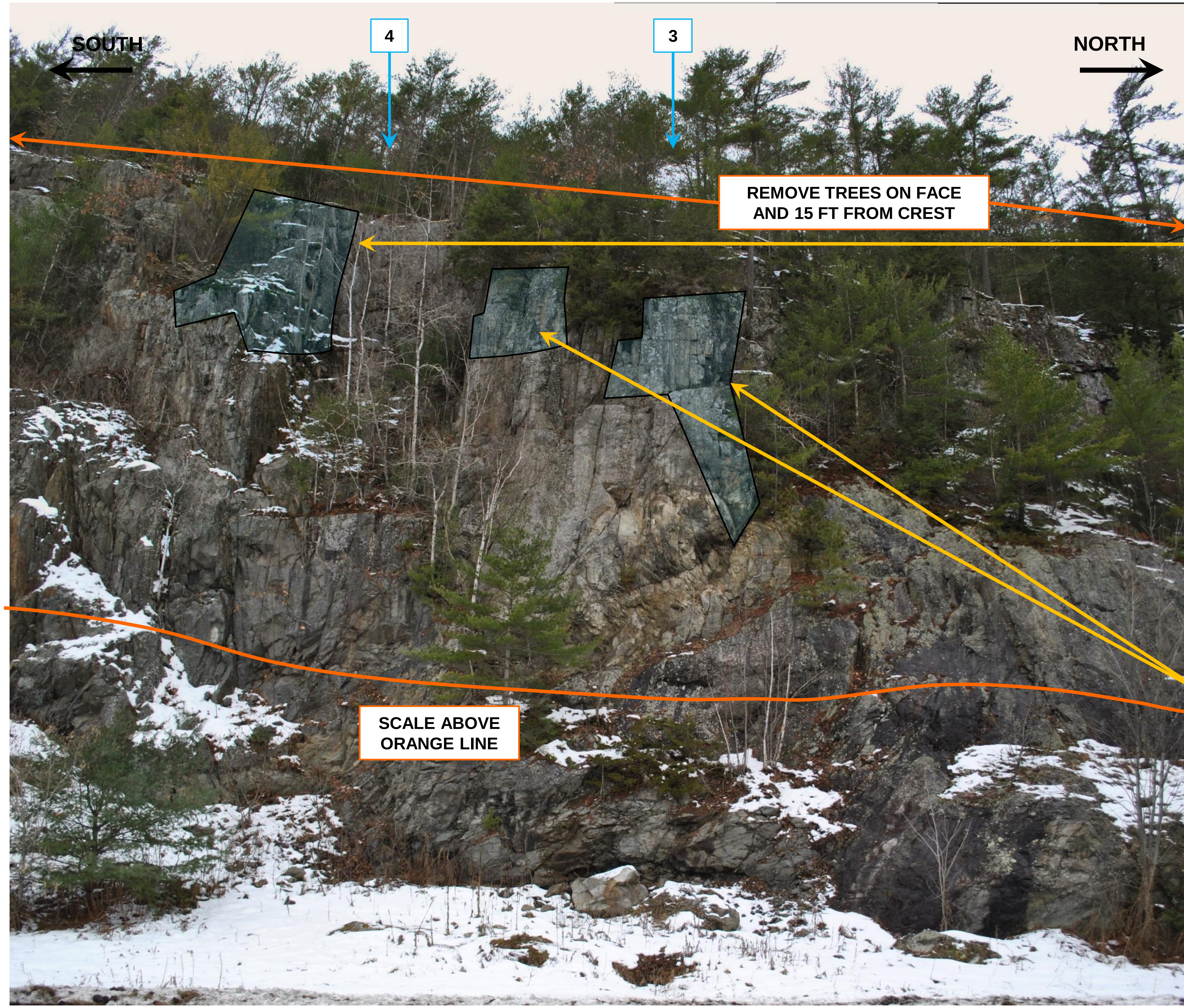
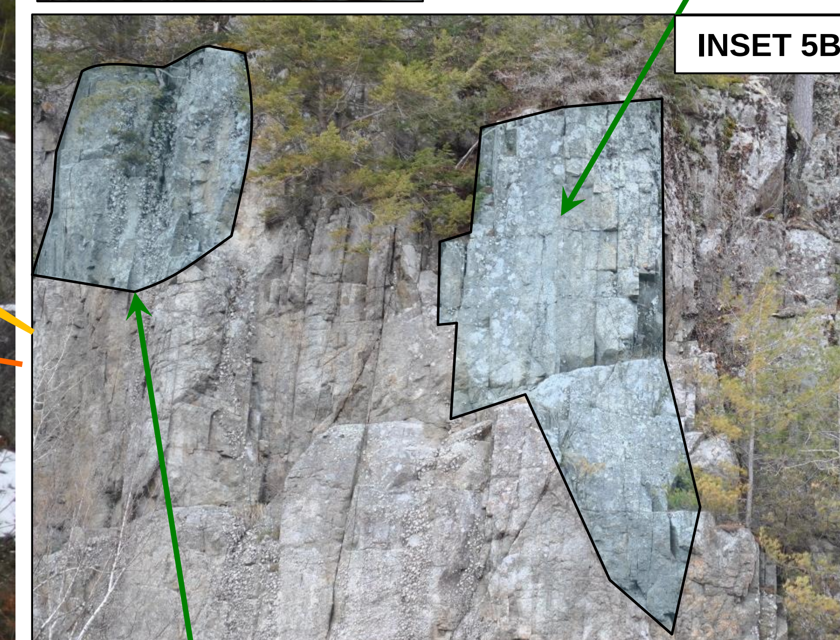
VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 4



REMOVE DILATED BLOCKS/PILLAR, DOWEL KEY BLOCKS OR SLABS (6 DOWELS)

REMOVE DILATED BLOCKS, DOWEL KEY BLOCKS (10 DOWELS)



REMOVE DILATED BLOCKS, DOWEL KEY BLOCKS (8 DOWELS)

LEGEND:

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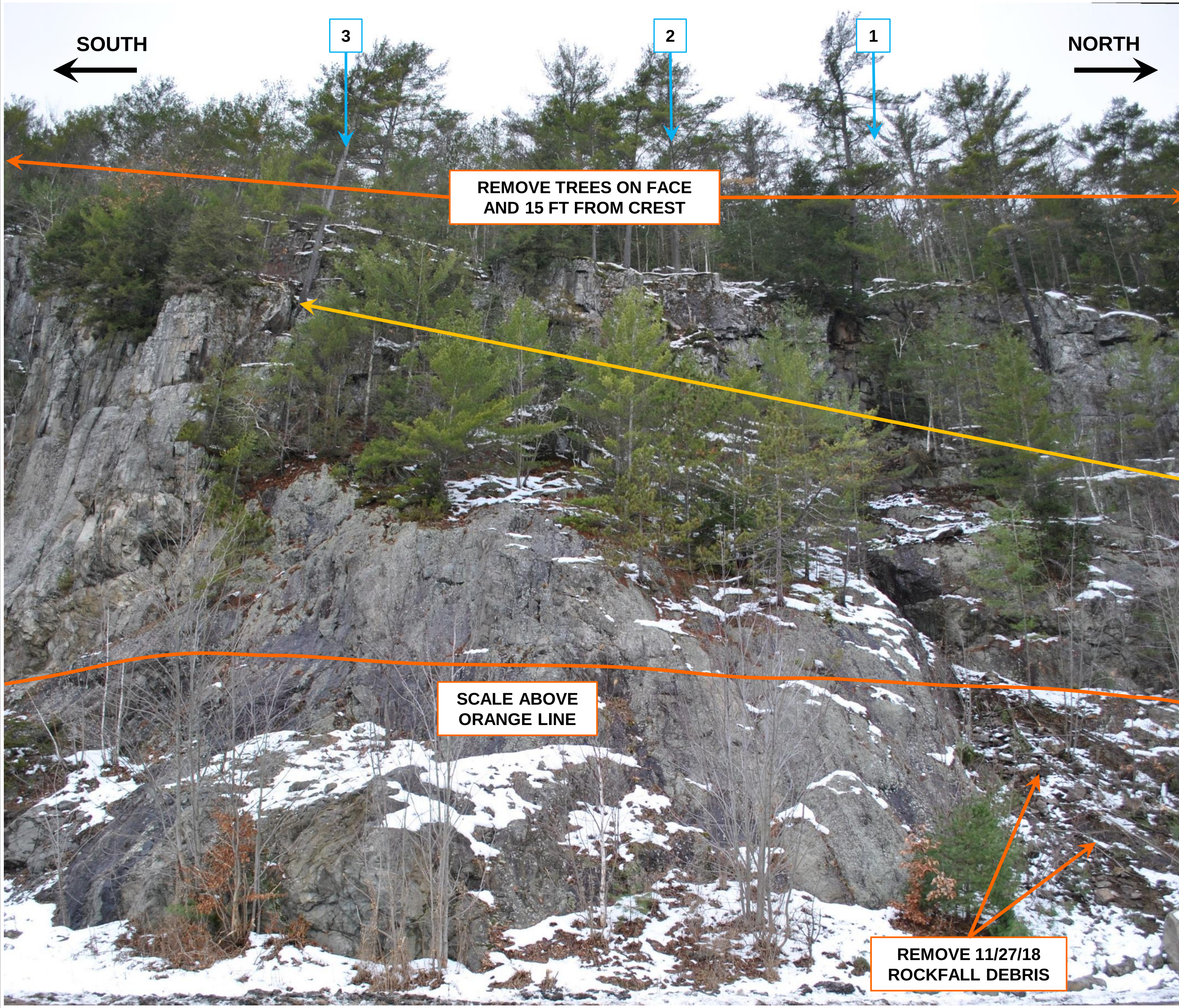
ROCK SLOPE MITIGATION
FAIRLEE IM 091-2(86)

VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 5



REMOVE DILATED BLOCK, DOWEL REMAINING KEY BLOCKS (2 DOWELS)

LEGEND:

10 — RAPPEL 10 LOCATION

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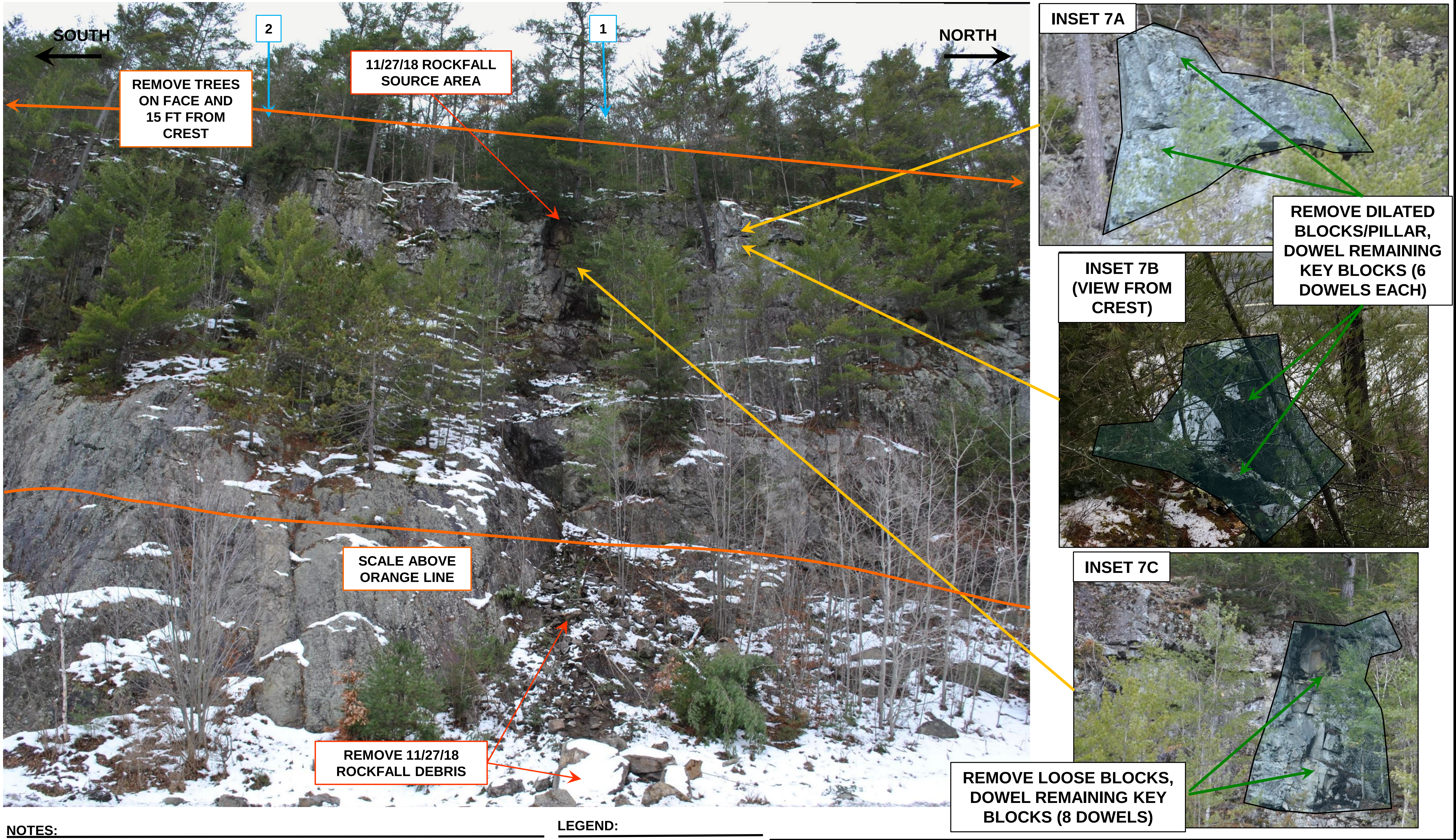
Figure: 6



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VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 7

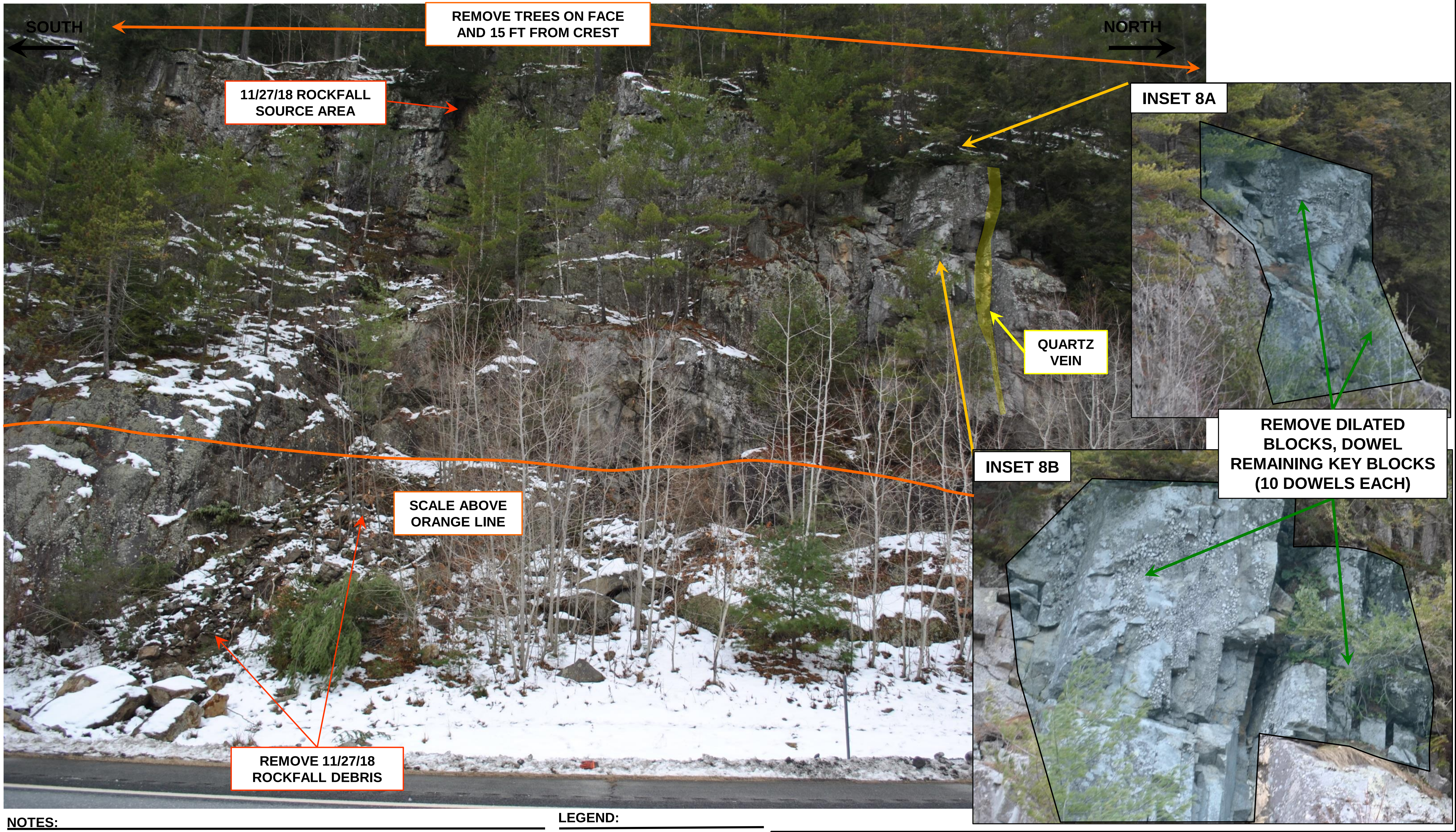

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Figure: 8

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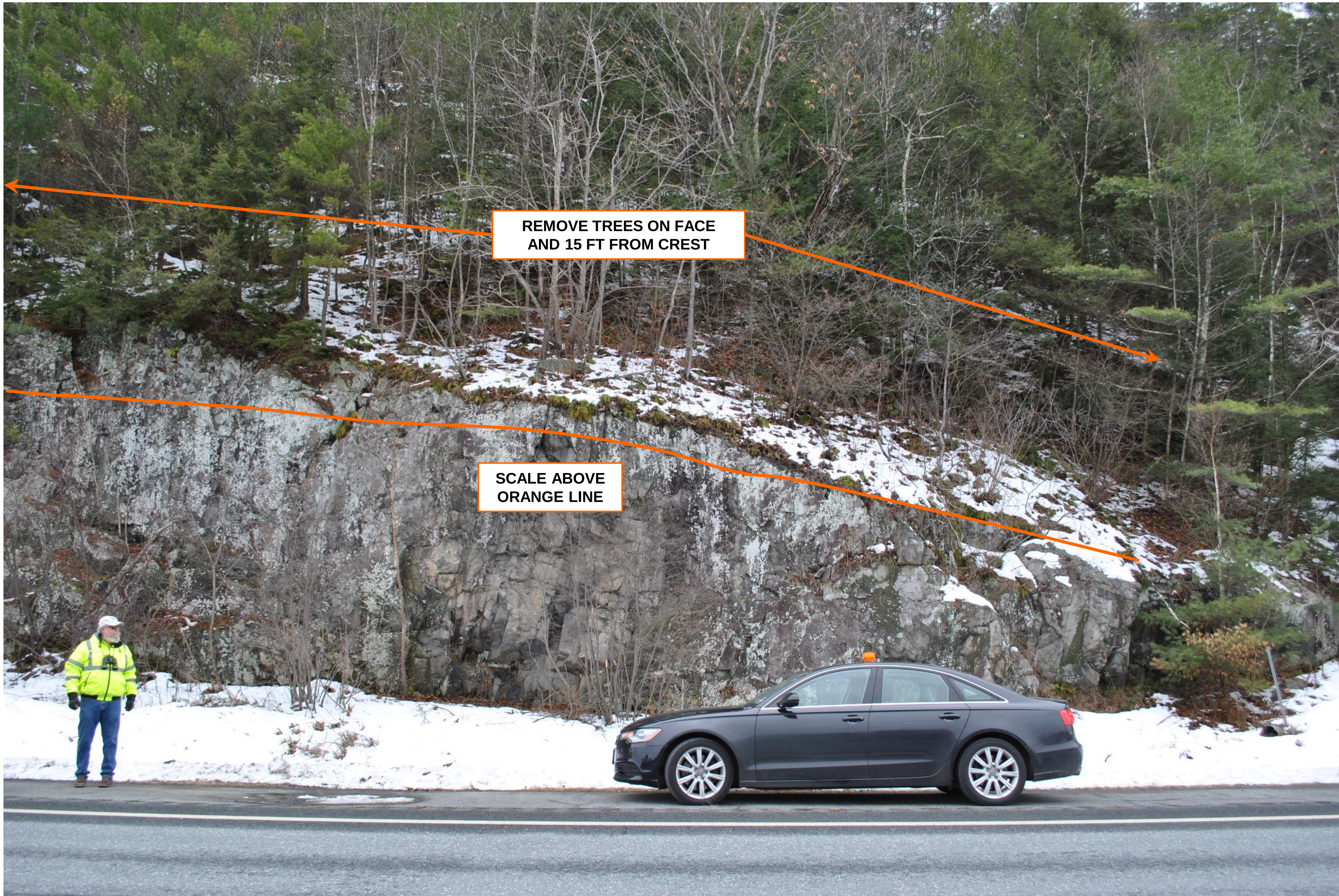
Golder Associates

ROCK SLOPE MITIGATION
FAIRLEE IM 091-2(86)

VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 9

SOUTH ← → NORTH



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ROCK SLOPE MITIGATION
FAIRLEE IM 091-2(86)

Golder Associates

VTRANS FAIRLEE I-91 ROCK SLOPE

Figure: 10

APPENDIX A

PHOTO LOG

PHOTO 1

Annotated Google Earth images showing site location, and recent rockfall areas.

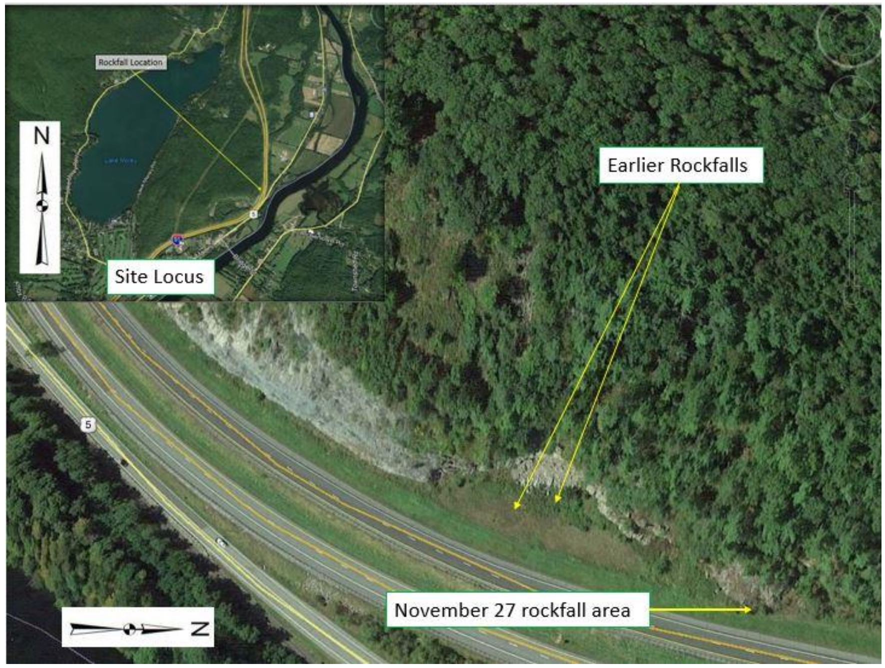


PHOTO 2

North end of rockfall drape showing recent rockfall event locations. View to south from SB LT shoulder. Photo date 11/30/18.

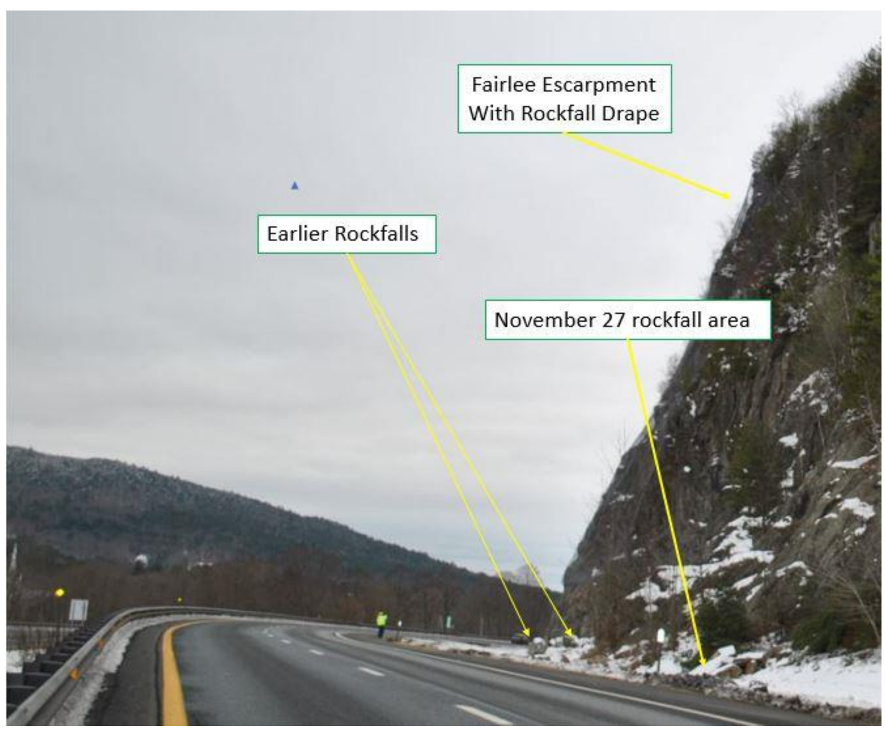


PHOTO 3 Rappel 1, view to north from crest showing detached blocks forming pillar as shown in Insets 7A and 7B of Figure 7. Photo date 04/10/19 (IMG_7142.jpg).	
PHOTO 4 Rock block sitting on near horizontal surface about 5 ft from crest at Rappel 3 location. Photo date 04/10/19 (IMG_7143.jpg).	

PHOTO 5

Typical loose rock block conditions at crest between Rappel 3 & 4 locations. Photo date 04/10/19 (IMG_7152.jpg).

PHOTO 6

Typical detached block/slab conditions just below crest, between Rappel 4 and 5 locations. Photo date 04/10/19 (IMG_7155.jpg).

PHOTO 7 Typical dilated and detached rock blocks and slabs just below crest at Rappel 7 location, as shown in Inset 3A of Figure 3. View to north. Photo date 04/10/19 (IMG_7158.jpg).	
PHOTO 8 Rappel 1 at crest, view to south showing source area of November 27, 2018 rockfall event, and shown in Inset 7C of Figure 7. Note large white pine sending roots into open joints leading to root jacking and on-going joint dilation. Photo date 04/10/19 (100_3368.jpg).	

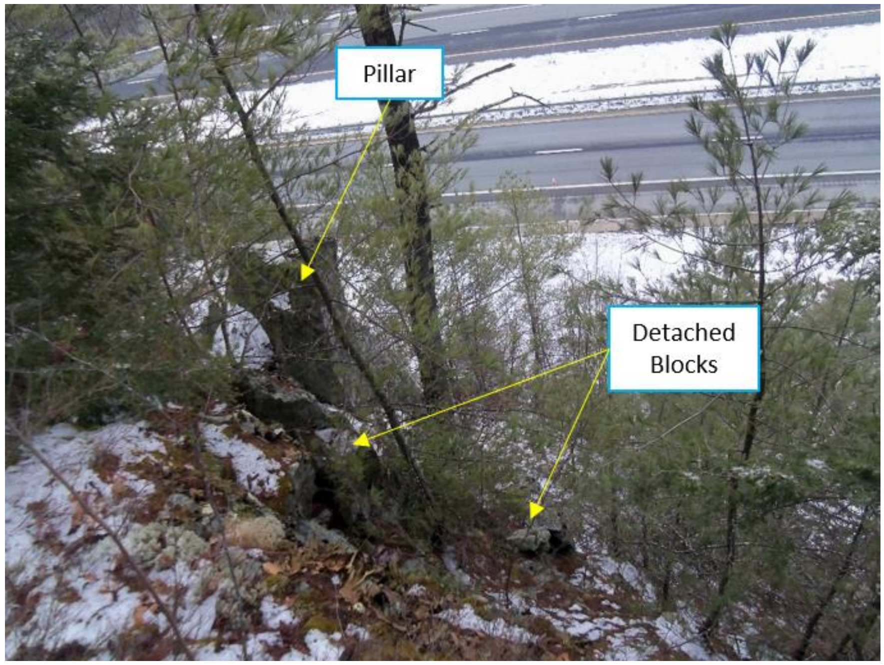
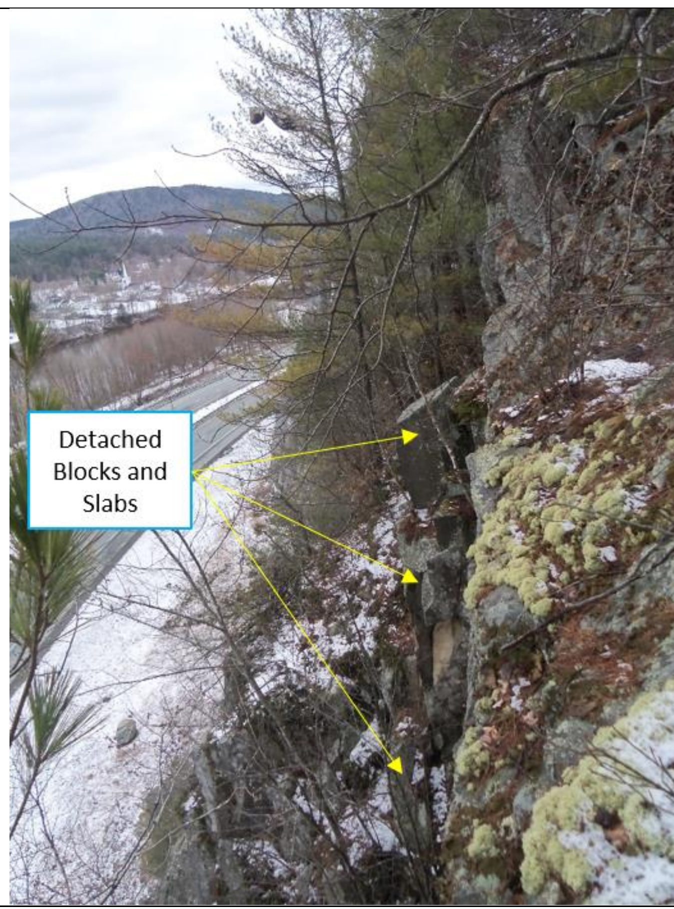
PHOTO 9 Rappel 1, at crest, view to north of detached rock blocks forming pillar, as shown in Insets 7A and 7B of Figure 7. Photo date 04/10/19 (100_3370.jpg).	
PHOTO 10 Rappel 4 at crest, view to south showing detached rock blocks and slabs, as shown in Inset 5A of Figure 5. Photo date 04/10/19 (100_3388.jpg).	

PHOTO 11

Rappel 4 at crest, view of upper slope area showing detached slabs in Photo 10 above (right), and loose rock blocks on steeply dipping slope. Photo date 04/10/19 (100_3389.jpg).

PHOTO 12

Rappel 5 at crest, view to north showing dilated block. Dilation at least 1 ft wide. Photo date 04/10/19 (100_3393.jpg).

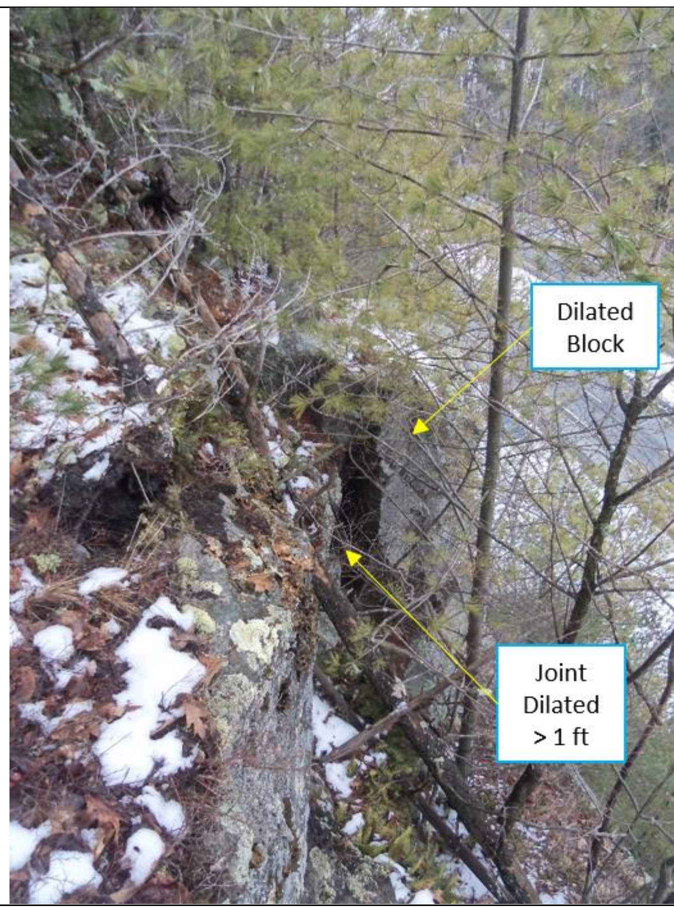


PHOTO 13 Rappel 5 at crest, view showing general loose rock block conditions as slope crest rises to south. Photo date 04/10/19 (100_3399.jpg).	
PHOTO 14 Rappel 6 at crest, view to north showing general loose rock block conditions. Photo date 04/12/19 (100_3403.jpg).	

PHOTO 15 Rappel 7 at crest, view to north showing general loose rock block conditions. Note dilations >1” wide, with shallow dipping basal joints to east, and more closely spaced subvertical joints dipping steeply to the northwest, favoring a toppling failure mode. Photo date 04/12/19 (100_3417.jpg).	
PHOTO 16 Rappel 7, view downward below crest showing loose, detached rock blocks and slabs. Photo date 04/12/19 (100_3421.jpg).	

PHOTO 17

Rappel 7, view to south showing typical detached slabs developed along closely spaced near vertical joint sets. Note trees aligned with vertical joint sets. Photo date 04/12/19 (100_3423.jpg).

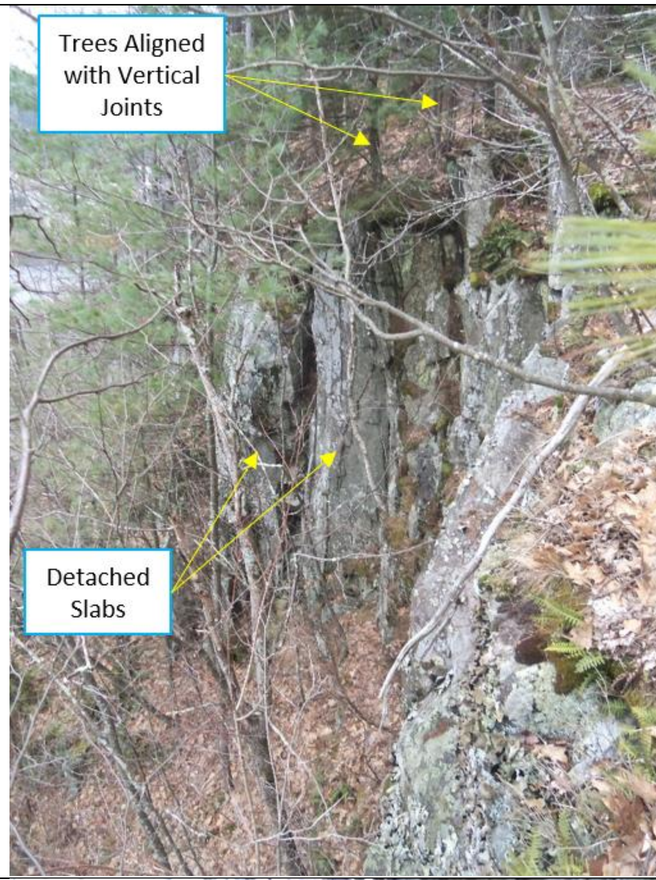


PHOTO 18

Rappel 9, view to south showing typical detached slabs developed along closely spaced near vertical joint sets. Photo date 04/12/19 (100_3423.jpg).

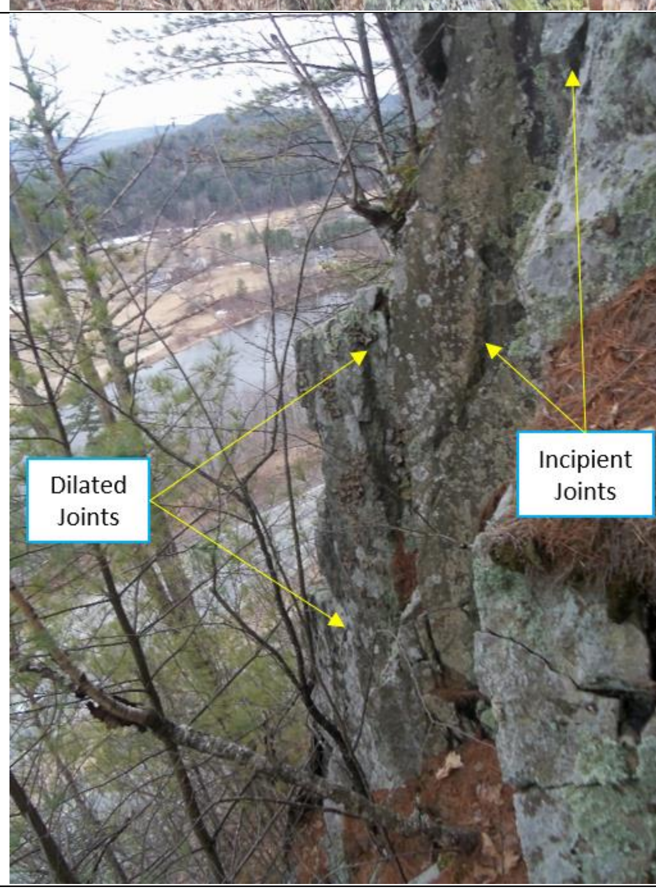


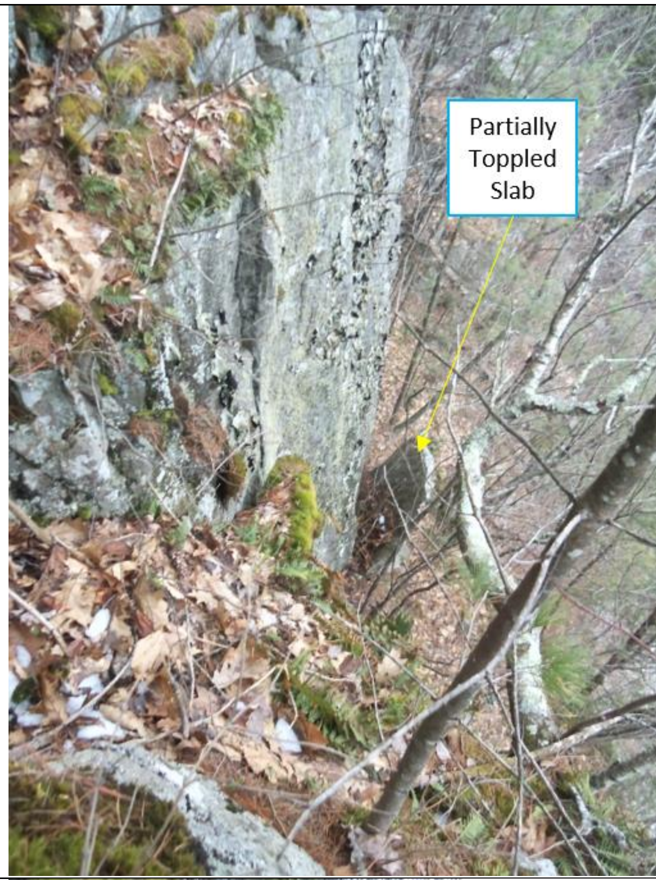
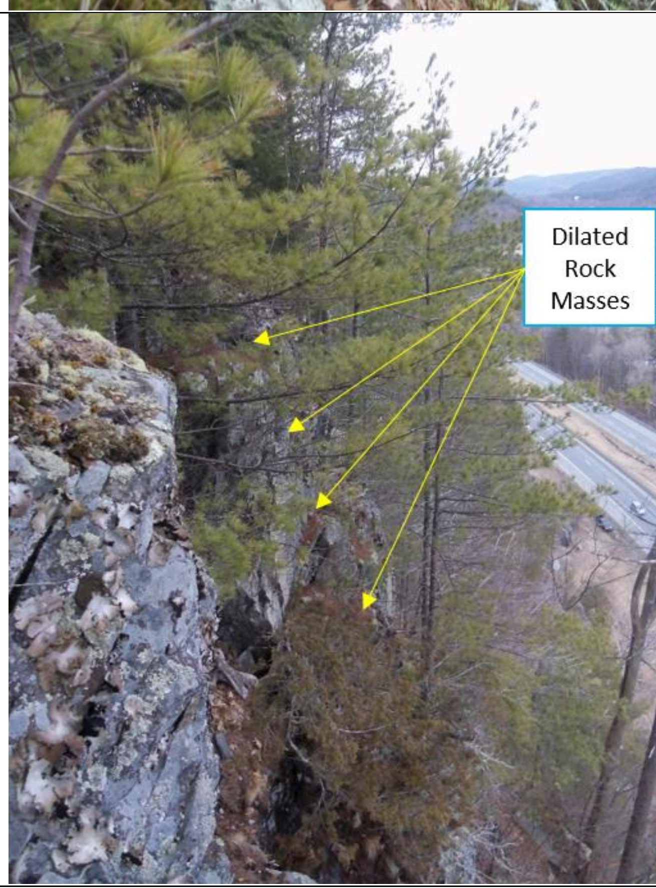
PHOTO 19 Rappel 9, view to north showing partially toppled rock slab at base of larger rock slab with incipient dilated vertical joint. Photo date 04/12/19 (100_3430.jpg).	
PHOTO 20 Rappel 10, view to north showing dilated rock masses at crest. Photo date 04/12/19 (100_3439.jpg).	

PHOTO 21

Rappel 10, view to south of rockfall drape below crest. Note open hole at drape mesh seam, and small, detached, partially toppled rock block. Photo date 04/12/19 (100_3444.jpg).

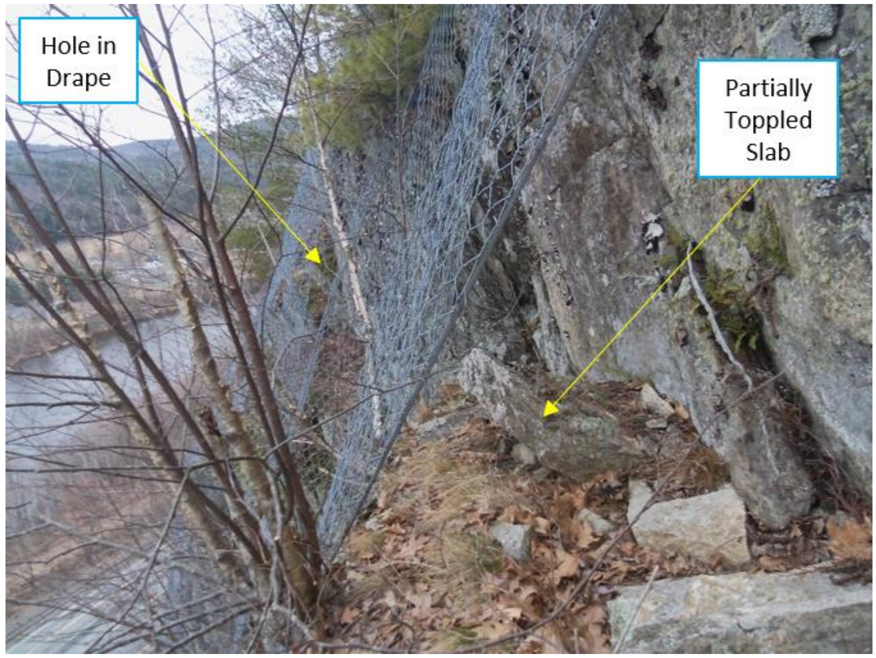


PHOTO 22

Dilated blocks at north end of slope bisected by near vertical quartz vein of Insets 8A and 8B of Figure 8 (left), and Rock block/pillar shown in Inset 9A of Figure 9 (right). Photo date 04/12/19 (DSC_2892.jpg).

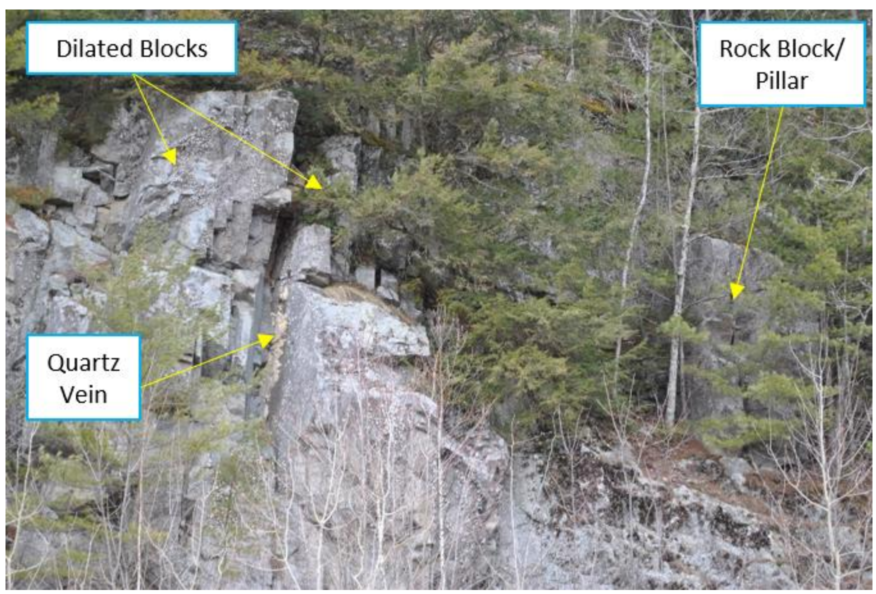


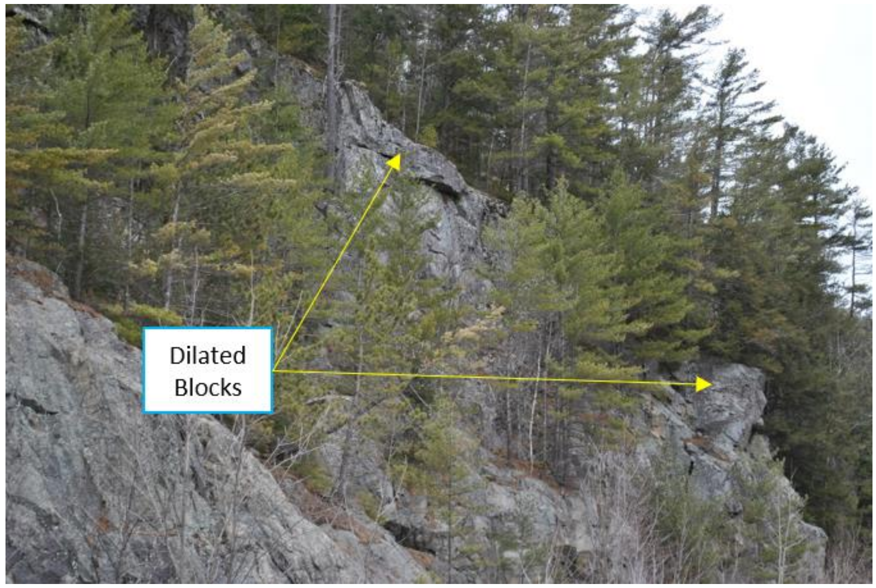
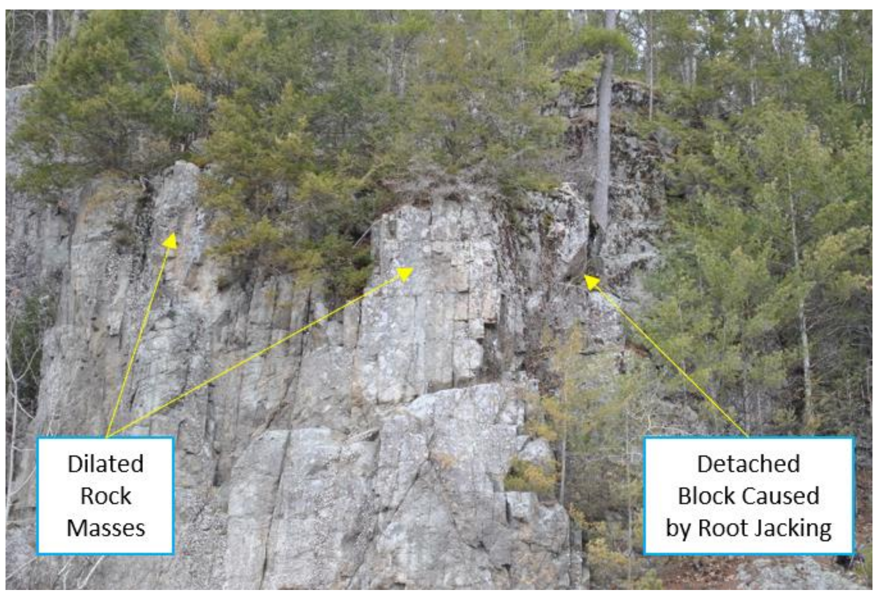
PHOTO 23 Dilated blocks shown in Insets 7A and 7B of Figure 7 (left), and Insets 8A and 8B of Figure 8 (right). Photo date 04/12/19 (DSC_2908.jpg).	
PHOTO 24 Dilated rock mass, including partially detached rock block affected by root jacking by white pine, as shown in Insets 5B and 6A of Figures 5 and 6. Photo date 04/12/19 (DSC_2901.jpg).	

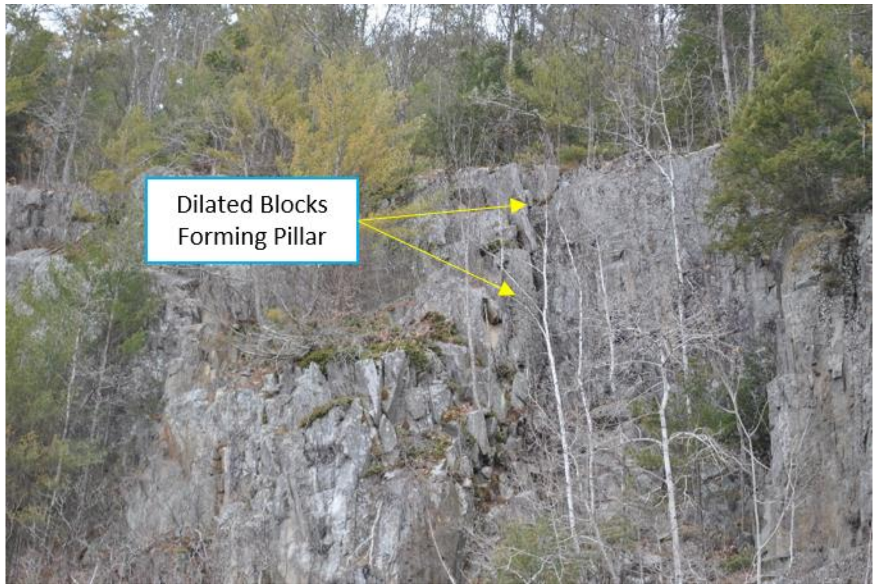
PHOTO 25 Dilated rock blocks forming pillar near crest of slope, as shown in Inset 5A of Figure 5. Photo date 04/12/19 (DSC_2902.jpg).	
PHOTO 26 Dilated rock blocks at crest, as shown in Figures 3, 4 and 5. Note trees at crest on face causing root jacking of rock blocks. Photo date 04/12/19 (DSC_2907.jpg).	

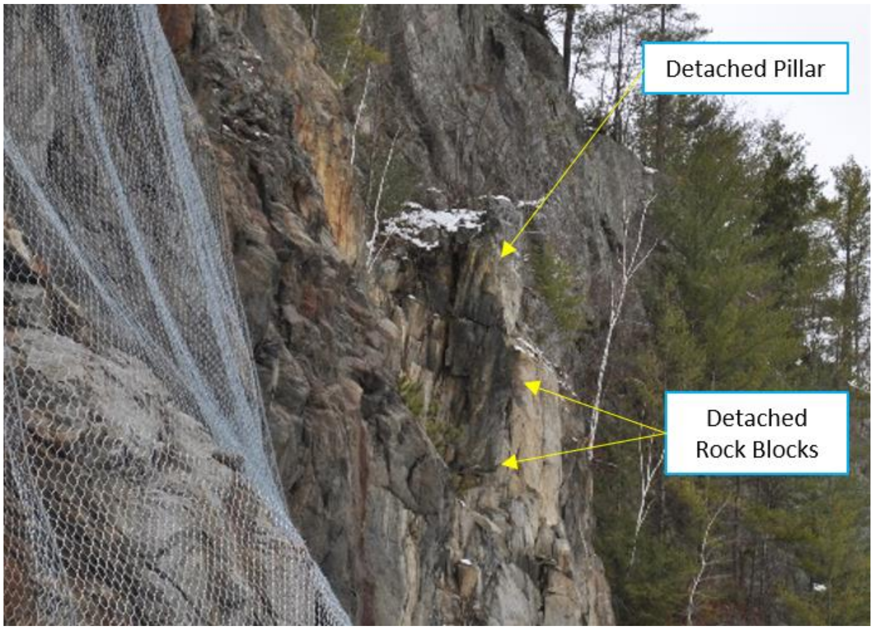
PHOTO 27 View to north of detached pillar and rock blocks shown in Inset 2D of Figure 2. Photo date 11/30/18 (DSC_2373.jpg).	
PHOTO 28 Zoomed-in view to north of detached pillar and rock blocks shown in Photo 27 above and Figure 2. Photo date 11/30/18 (DSC_2374.jpg).	

PHOTO 29 View to south of southern end of rock slope, showing northern extent of rockfall drape, and rockfall debris in ditch from November 2018 rockfall event. Photo date 04/12/19 (DSC_2905.jpg).	
PHOTO 30 View to north of northern end of rock slope. Photo date 04/12/19 (DSC_2920.jpg).