Alaska Department of Transportation & Public Facilities

Research & Technology Transfer

Catastrophic Icefall Hazard Assessment, Avoidance Procedures & Mitigations Strategies-Phase I Literature Review

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The incidence of icefall is one of the most underrepresented and underappreciated of all the natural hazards. Falling pieces of ice are subject to melting and sublimation, and evidence of such events may be gone in a matter of days or even hours. There is very little existing research and engineering design criteria relative to icefall hazard mitigation. AKDOT&PF is undertaking research aimed at better understanding icefall hazards and eventually quantifying risk of impact along state highways, in an effort to mitigate icefall hazards. The research project was broken down into two (initial) distinct phases. This research report summarizes the results of the Phase No. 1 Literature Review, which includes potential sources of data that could be included for further site-specific studies. Sources of data include personal communications, documented icefall events, media accounts, technical literature, Alaska-specific documents, Alaska-specific web based sources, and potential software (for technical evaluations). Data sources are ranked according to perceived value for use during Phase No. 2 studies. Data ranked as “high” and “moderate” value will likely be further referenced during Phase No. 2 site-specific studies at seven key sites throughout the State of Alaska.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4		mm
ft	feet	0.3048		m
yd	yards	0.914		m
mi	Miles (statute)	1.61		km
		AREA		
in^2	square inches	645.2	millimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.4046	hectares	ha
		MASS (weight)		
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg
		VOLUME		
fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	liters
ft^3	cubic feet	0.0283	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

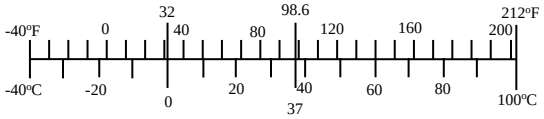
Note: Volumes greater than 1000 L shall be shown in m^3

		TEMPERATURE (exact)		
ºF	Fahrenheit temperature	5/9 (ºF-32)	Celsius temperature	ºC
		ILLUMINATION		
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m^2	cd/cm^2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
km^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.471	acres	ac
		MASS (weight)		
g	grams	0.0353	Ounces (avdp)	oz
kg	kilograms	2.205	Pounds (avdp)	lb
mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces (US)	fl oz
liters	liters	0.264	Gallons (liq)	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		TEMPERATURE (exact)		
ºC	Celsius temperature	9/5 ºC+32	Fahrenheit temperature	ºF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/cm^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi



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ACKNOWLEDGEMENTS

First off, we would like to pay our respects to Ms. Kalia (aka "Kitty") Breskin, P.E. (deceased in 2015), formerly with the Maine Department of Transportation (Maine DOT). Kitty served Maine DOT as Senior Geotechnical Engineer for nearly 20 years, with an unwavering emphasis on public safety and a passion like no other. Kitty's willingness to tackle challenging icefall hazards in northern Maine, even in light of such limited published research on the subject, served as a catalyst for future icefall mitigation studies. Her pioneering approach, dedication to public safety, and not-so-subtle encouragement will never be forgotten.

We would like to thank Alaska DOT&PF for their willingness to formally address icefall hazard evaluation and mitigation, as they will be the first in the nation to do so. If there is any state agency in the nation with the determination to deal with this hazard, it is without a doubt Alaska DOT&PF.

We would also like to specifically acknowledge the contributions of the following individuals at Alaska DOT&PF:

- Matthew Murphy, Central Region/Highway Data;
- Anna Bosin, Research Engineer/Project Manager;
- Barry Benko, Chief Engineering Geologist;
- Scott Thomas, Central Region/Traffic Engineer;
- Craig Boeckman, Central Region/Engineering Geologist;
- Burrell Nickeson, Central Region/Maintenance & Operations Specialist;
- Jason Sakalaskas, Northern Region/Maintenance Engineer;
- Carolyn Morehouse, Chief of Research, Development & Technology Transfer;
- David Stanley, Chief Engineering Geologist (Retired);

EXECUTIVE SUMMARY

The incidence of icefall is one of the most underrepresented and underappreciated of all the natural hazards. Falling pieces of ice are subject to melting and sublimation, and evidence of such events may be gone in a matter of days or even hours. There is very little existing research and engineering design criteria relative to icefall hazard mitigation. AKDOT&PF is undertaking research aimed at better understanding icefall hazards and eventually quantifying risk of impact along state highways, in an effort to mitigate icefall hazards. The research project was broken down into two (initial) distinct phases. This research report summarizes the results of the Phase No. 1 Literature Review, and includes potential sources of data that could be included for further site-specific studies. Sources of data include personal communications, documented icefall events, media accounts, technical literature, Alaska-specific documents, Alaska-specific web based sources, and potential software (for technical evaluations). Data sources are ranked according to perceived value for use during Phase No. 2 studies. Data ranked as “high” and “moderate” value will likely be further referenced during Phase No. 2 site-specific studies at seven key sites throughout the State of Alaska.

Based on our review, key data sources for Phase No. 2 will consist of upslope topographic data (e.g. LiDAR or aerial photogrammetry) and location/sources of water, site-specific slope info from the USMP, meteorological/climatological data, and comparisons of past and future (Phase No. 2) slope monitoring data.

Initial candidate solutions for icefall mitigation are also described, and could include total slope reconfiguration, catchment ditch enhancement and roadway widening, mechanical scaling using inflatable air bags, diversion/capture of upslope water sources, and use of rockfall barriers.

1. INTRODUCTION

We are pleased to submit this letter report ("Report") to the Alaska Department of Transportation and Public Facilities ("AKDOT&PF") that documents the findings of Phase No. 1 of our detailed icefall hazard mitigation literature review. This Report and its supporting attachments were completed in general accordance with the approved Scope of Work ("SOW"), as defined in the agreement entitled: *Professional Services Agreement* ("PSA"), No. 02563003, executed 5 October 2015.

The AKDOT&PF, Research Development and Technology Transfer Program is conducting research relative to icefall hazard evaluation and mitigation. There are currently no civil engineering design criteria or established icefall mitigation measures that DOT's nationwide can rely upon to minimize potential liabilities borne by this hazard. The need for this research study is partly driven by an icefall event along the Seward Highway on 6 April of 2012, whereby a motorist was struck by falling ice. Since the April 2012 event, there have been subsequent periods of ice build-up during winter months at sites along the Seward Highway. AKDOT&PF is actively researching ways to identify and monitor icefall hazards along State highways, and mitigate subsequent icefall risk, where present.

We were engaged by AKDOT&PF in 2015 to assist with this research, due to our previous experience and research with respect to icefall hazards. Initially, our SOW consisted of an all-encompassing research project, one that included both a literature review and site-specific studies. After careful deliberation, AKDOT&PF decided that the research project should be broken into two distinct phases, those being Phase No. 1 (the Literature Review described herein) and Phase No. 2, which will entail site-specific icefall hazard evaluations at seven key sites throughout Alaska. The proposed sites for site-specific evaluation include MP 113 NB/SB, MP 75.5 SB, MP 56-58 NB, and MP 52 SB along the Seward Highway; and, MP 13, MP 20, and MP 38 along the Richardson Highway. By completing Phase No. 1 first, the project team streamlined potential work during Phase No. 2 by developing a clear understanding of the data that could be relied

upon for future site-specific studies. The remainder of this Report describes the process for the literature review and presentation of the results. The last section of this Report provides key conclusions and recommends a course of action relative to the development of the Phase No. 2 scope of work.

2. LITERATURE REVIEW

As further described in Appendix B (Research Plan) of the PSA, the literature review generally consisted of a review of information from both external sources (i.e. outside State of Alaska) and internal sources (originating from within Alaska). Throughout the duration of our work, we conducted numerous phone calls, face-to-face discussions, and electronic communications. We completed an exhaustive review of on-line resources relative to icefall hazards, and reviewed numerous sources of journalistic and research media. We looked at available data from internal sources like AKDOT&PF's Unstable Slope Management Program ("USMP"), and as-built plans at key sites along the Richardson and Seward Highways. More specifically, our Phase No. 1 Literature Review consisted of an assessment of the following sources of information:

1. Review of Data from External Sources (outside State of Alaska):
    B. International literature and information sources, where available;
    C. Our sources from previous work (e.g. State of Maine, previous publications & presentations);
    D. Communication with various northern-tier state DOT's and FHWA (e.g. Colorado DOT experience);
    E. Manufacturer Data (e.g. Geobrugg's Swiss icefall barrier);

2. Review of Data from Internal Sources (within State of Alaska):
    A. Previous documented icefall cases (Alaska Department of Law and other internal sources);
    B. Unstable Slope Management Program (USMP) and Geotechnical Asset Management (GAM) datasets in the vicinity of the seven following sites:
        - Seward Highway: MP 113 NB/SB; MP 75.5 SB; MP 56-58 NB; and, MP 52 SB;
        - Richardson Highway: MP 13; MP 20; and, MP 38
    C. Public domain internet and periodical search (e.g. newspaper articles, web searches);
    D. Available MMS data logs for sites along the Seward Highway;

E. RWIS station data and highway camera views;

F. As-built data for locations along Seward and Richardson Highways.

The information that was reviewed during Phase No. 1 was logged within data tables, which are included as appendices to this Report. The following section describes our presentation format of the seven data tables and our justification for use of a color-coded ranking system.

3. PRESENTATION OF RESULTS

As described in our approved SOW, the primary deliverable for Phase No. 1 are the data tables attached to this Report. The data tables were sent in draft form on 17 December 2015 and discussed on a subsequent conference call with AKDOT&PF on 22 December 2015. Furthermore, both the tables and letter report were subject to minor revisions in early February 2016, based on comments from AKDOT&PF. Based on our review of the types of data described in the preceding section, we ultimately decided to arrange the information within seven distinct data tables. The tables included as Appendix No. 1 consist of the following:

- Personal Communications on Icefall – Describing phone, face-to-face, and electronic communications with various entities who may have relevant information on icefall hazards, mitigation methods or specific events;
- Documented Icefall Events – Table contains information on known icefall events, including dates, locations, and existence of photos;
- Media Accounts of Icefall Events – Contains links to various news media stories on icefall events throughout North America;
- Technical Literature on Icefall – Contains a listing of technical literature, including journal articles, technical presentations, manufacturer product write-ups, and graduate theses;
- Alaska-Specific Documents for Icefall Evaluations – Includes relevant pages from as-built plans and USMP sites along Seward and Richardson Highways;
- Alaska-Specific Online/Web-Based Systems for Icefall Evaluation - Provides links to web based resources for future icefall hazard evaluations, primarily related to sites for meteorological/climatological queries, traffic and road condition data;
- Potential Software for Use with Icefall Analyses – Table provides a listing and links to various geotechnical engineering software packages that could be used for Phase No. 2 icefall analyses.

As part of our evaluation of all the information, we decided to use a color coded ranking system to distinguish high value data from data that is less valuable. We used red shading in the attached tables to denote high value for subsequent Phase No. 2 studies. Likewise, we used blue shading to indicate items of low value for future icefall studies. Yellow shading is used for items of intermediate importance, where there is the likelihood that the information sources may have to be revisited again to establish value. This is helpful when viewing the tables, as the ranking system helps the user immediately key-in on important data. Please also make note of the attached Question and Response Logs, included here as Appendix No. 2.

4. CONCLUSIONS

The Phase No. 1 literature review helped to distill what sources of data were available and the value of such data for subsequent icefall hazard evaluations in the State of Alaska. As we asked more questions, we continued to find additional information relative to icefall; however, with diminishing returns. We believe that we have discovered an abundance of information that will continue to be useful. Based on our findings, as indicated in the attached data tables, it is our opinion that the most valuable sources of information that will be utilized in Phase No. 2 site-specific icefall hazard studies will include the following:

1. LiDAR/Topographic Data – Upslope topographic data will prove to be immensely helpful for determination of snowpack depths (i.e. water storativity), surface water drainage routes, slope angles, and upslope water sources. We understand that both Northern and Central Regions have access to some of this data;
2. Slope Condition Photos – Photos of ice accumulation on subject slopes over the years and photo documentation of rock slope conditions during warm and wet periods of the year. It will be critically important to understand rock slope conditions in winter and summer months, and even more important to look for signs of steady-state surface water discharge over the crest of the subject slopes. The importance of consistent up-slope water sources cannot be over-stated for Phase No. 2 studies, as continuous water seepage can lead to persistent ice growth and cascading;
3. Key Site Visits & Slope Inspection – Based on a combination of future site visits and data from previous visits by AKDOT&PF staff, site-specific observation will be used to understand slope conditions and season-to-season variations in ice development;
4. Data from USMP – Site-specific slope information from the USMP will prove to be invaluable during Phase No. 2 studies, and will be relied on heavily;
5. As-Built Plans & Existing Condition Surveys – Available as-built documents will be important in developing an understanding of initial constructed roadway features like catchment ditch width,

shoulder width, and roadway geometry. We note that initial conditions are subject to change due to slope weathering, so data from existing condition surveys (where available) will prove to be valuable;

6. Meteorological Data – Real-time and short-term predictions of weather using RWIS and NWS will be important to developing an understanding of both ice build-up conditions and temporal controls on ice block release. It is important to note that climatic variability will prove to be the most challenging part of future icefall evaluations.

As further indicated on the attached data tables, there are a range of potential short and long-term icefall mitigation solutions that could be employed at hazardous sites across the State of Alaska. We must note that the adequacy of such solutions cannot be confirmed until site-specific studies are completed as part of Phase No. 2. It should be further noted that availability of right-of-way will be a determining factor in the selection process. Based on our review, it is our opinion that the following solutions appear to be worthy of further consideration during Phase No. 2 technical evaluations (not in any specific order):

1. Icefall Barriers – Constructed and deployed in similar fashion to rockfall barriers, although designed for icefall impacts (could be designed for both rockfall and icefall). Such barriers could be installed roadside (if room for deflection) or upslope depending on right-of-way restrictions, slope geometry, and ice block failure modes;
2. High-Strength Draped Netting – Option would consist of installation of draped netting in similar fashion to that of traditional rockfall netting; however, the differences with draped icefall netting would consist of the following:
    A. Netting would only be partially deployed at the crest of the slope, until such time as it is needed. During times of ice ablation, the netting would be unrolled over the ice to restrict ice block deflection and horizontal travel distance;

B. Use of pre-installed anchors at a variety of key locations to help “field fit” netting anchorage points to variable ice conditions;

C. Use of high-strength netting material in order to withstand significant forces.

3. Diversion of Upslope Surface Water – In our opinion, this solution would prove to be the most effective, as minimizing the availability of “free” water would result in a significant reduction in ice development. The largest impediment to this approach may be encroachment(s) beyond the right-of-way;
4. Ice Removal – Although challenging and potentially risky to those involved in the operation, ice could be removed through use of “light” explosive charges or preinstalled inflatable air bags. The air bags could be installed at locations of observed ice build-up. Note that this method of ice removal has never been attempted before, and would rely on real-time monitoring of ice thickness in the field. Once critical (maximum) thickness has been established, the bags could be inflated and ice removed. This approach would require temporary traffic pattern alterations. If utilized, a pilot-scale installation should be considered (possibly MP 113 along Seward);
5. Slope Geometry Modifications – Likely the most costly and time consuming of the possible solutions, but also highly effective at mitigating icefall hazards. Could consist of localized slope modifications all the way up through total slope layback and construction of a combined rockfall and icefall catchment ditch;
6. Roadway Alterations – Establish icefall impact zone width and construct/add local roadway width (possibly extra or new lane) for construction of catchment ditch. Could also consider an “icefall shed” or wall-type structure through areas with elevated icefall impact risk.

Note that many of the potential solutions highlighted herein would require significant short-term monitoring, as icefall mitigation techniques are in their infancy and site-specific ice development data needs to be collected.

5. RECOMMENDATIONS FOR PHASE NO. 2 STUDIES

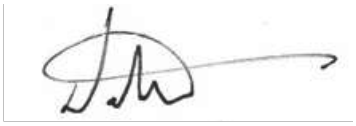
During Phase No. 1 scoping, we provided Alaska DOT&PF with a general outline of what we envision for the Phase No. 2 SOW. We have revisited this outline shown below, and updated it based on our completion of the literature review. Although Phase No. 2 will entail a separate negotiated SOW, we anticipate that Phase No. 2 will generally consist of the following tasks:

1. Preliminary icefall hazard assessments for rock slopes at the seven (7) specific locations utilized for Phase No. 1. Key-in on upslope water sources using LiDAR/topography and site visits along hiking trails;
2. Icefall impact risk assessment based on failure mode, catchment ditch width, lane width, and ADT traffic data;
3. Icefall hazard mitigation preliminary engineering solutions appropriate for the candidate sites;
4. Methods for ice removal during build-up periods;
5. Final report with feasibility-level recommendations for DOT management, including a matrix of potential mitigation options, predictive thresholds (including climatic factors), site monitoring, preliminary cost estimates, and an evaluation of associated risks;
6. Development of a field site monitoring plan/guide for use by M&O staff;
7. Creation of a short-term icefall management and action plan for M&O staff, including emergency actions;
8. Staff training for hazard identification, reporting, and response protocol;
9. Recommended icefall hazard study results to be incorporated into GAM for comprehensive state-wide hazard and risk assessment. Consider possible use of an Ice Condition Rating or Icefall Hazard Rating Index, to be incorporated within the USMP or other GAM.

Upon conclusion of Phase No.1, we will submit a CD to AKDOT&PF which contains this Report and key data that was archived as part of the literature review. This will include key photos, the Report contained herein, and other important pieces of data that could be relied upon as part of Phase 2 studies.

We appreciate the opportunity to submit this deliverable in support of AKDOT&PF's ongoing icefall hazard evaluation research project, and look forward to helping you with upcoming additional phases of work. Please contact the undersigned if you wish to discuss this Report or any aspects of the research project.

Sincerely,
SCARPTEC, INC.



David J. Scarpato, P.E.
President & Rock Engineering
Technical Expert

Appendices:

1. Appendix No. 1 – Key Sheet & Table Nos. 1 to 7 (9 sheets);
2. Appendix No. 2 – Question/Response Log (2 sheets)

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APPENDIX NO. 1

Key Sheet & Table Nos. 1 to 7

Alaska DOT & PF
Icefall Evaluation
Phase I - Literature Review
Scarptec, Inc.
Rev. Date: 02/25/16

RANK KEY:	VALUE:	DESCRIPTION:
	High	Helpful and reliable source of data for Phase 2 work
	Moderate	Possible usefulness in Phase 2 work, but may revisit
	Low	Low likelihood of usefulness for Phase 2 work

KEY SHEET - IMPORTANT COMMENTS RELATIVE TO THE USE OF THESE TABLES	
1	The information contained in these tables was developed based upon AKDOT&PF's need for data during Phase II of the icefall studies. There may be additional sources of information that were found, but were not included herein as such sources are not expected to be beneficial to Phase II studies.
2	Continue to update this info log table during Phase 2, to keep track of critical info and correspondence.
3	See key above for color coded ranking of data value.
4	Icefall Candidate Sites Listing (from approved Scope of Work for Phase No. 1): - Seward Highway - MP 113 NB/SB; MP 75.5 SB; MP 56 - 58 NB; MP 52 SB (4 sites) - Richardson Highway - MP 13; MP 20; MP 38

Alaska DOT & PF
Icefall Evaluation
Phase I - Literature Review
Scarptec, Inc.
Rev. Date: 02/25/16

TABLE 1 - PERSONAL COMMUNICATIONS ON ICEFALL

Item No.	Contact Date	Contact Type	Contact Name(s)	Affiliation	Title(s)	Relevant Information
1	9/14/2015	In-Person and email	Ty Ortiz	Colorado DOT	Sr. Eng. Geologist	Periodic icefall issues at I-70, Glenwood Canyon and use of ice posts w/ rockfall barrier beneath. Also suggested contact Mike Dowdle/Steve Pollak/Dave Gerraghty at BC Min. of Transport
2	2010-2014	In-Person and email	Kalia "Kitty" Breskin (Deceased)	Maine DOT	Sr. Geotechnical Engineer	Icefall hazards & technical evaluations in Acadia NP and U.S. Route 2 (H&A projects)
3	2012-2015	In-Person and email	Tom Elliasson	VTRANS	Sr. Eng. Geologist	Discussion of state-wide icefall hazards; observation of ice in ditches
4	12/1/2015	In-Person	Crystal Pelham	NHDOT	Sr. Eng. Geologist	Periodic icefall near Exit 8 on I-93 just north of Manchester, but events contained in ditches.
5	2011	In-Person	John Jamerson	NJDOT	Sr. Eng. Geologist	No icefall issues other than small icicles; but ice been found to stress anchored netting systems for rockfall mitigation
6	2011	Email	Tom Badger	WASDOT	Chief Eng. Geologist	No known major icefalls that have impacted roadway
7	2011	Email	Joe Hudak	MinnDOT	Asst. Engineering Geologist	No known icefall impacts to roadways, but seen some small events in ditches
8	8/12/2013	Email	Bill Capaul	Idaho DOT	District Sr. Geologist	Localized icefall issues in NE part of state, near MT line. Included photo.
9	8/12/2013	Email	Jeff Jackson	Montana DOT	Geotechnical Engineer	No "known" icefall issues
10	8/7/2013	Email	Jim Coffin	Wyoming DOT	Chief Eng. Geologist	No "known" icefall issues, but vigorous iceclimbing community (1,000 ft high) and avalanche hazards.
11	8/7/2013	Email	Jim Higbee	Utah DOT	Geotechnical Engineer	No "known" icefall issues
12	2011	Email	Barry Siel	FHWA	Sr. Geotechnical Engineer	Not familiar with any icefall events imapcting roadways
13	4/7/2012	Email	Dave Stanley	Alaska DOT	Chief Eng. Geologist	Seward Highway Icefall Event on 6 April 2012.
14	3/5/2015	Email	Matt Murphy	Alaska DOT	Emergency Support Specialist/Highway Avalanche Program	Info. From Norwegian Ministry of Transport on Norway's treatment of icefall hazards; Photos of icefall netting and design guide.

TABLE 1 - PERSONAL COMMUNICATIONS ON ICEFALL (CONTINUED)						
Item No.	Contact Date	Contact Type	Contact Name(s)	Affiliation	Title(s)	Relevant Information
15	2/20/2015	Phone	Anna Bosin	Alaska DOT	Research Engineer	Photos of rockfall events along MP113 area in 2015.
16	9/14/2015	In-Person and email	John Metzgeyer	IDS	Technical Sales	Radar methods used to monitor ice slide deformation in diamond/kimberlite mine in NWT
17	9/15/2015	In-Person	David Wood	Wood & Associates, Ltd.	Owner	Dealt with icefall issues in Ontario, Canada on two occasions (railway and hydroelectric facility)
18	9/15/2015	In-Person	Dave Gauthier	BGC	Senior Geotechnical Engineer	Dealt with icefall issues in Ontario, Canada with Dave Wood (above) on railway
19*	8/21/2013	Email	Francis Gauthier	Simon Fraser University	Post-Doctoral Fellow/CNHR	Francis is a alpine geomorphologist specializing in mass wasting of ice/snow/rock/soil in mountain environments. He completed his PhD on thermodynamics of ice decay/fracture, and has developed statistical methods to predict ice falls and ice "walls".
20	3/19/2014	In-Person and email	Tim Shevlin	Geobrugg/America/NW	NW Sales Engineer	Discussed proposed icefall barrier for AK RR Corp.
21	3/21/2014	In-Person and email	Dave Hamre	Alaska RR Corp.	Avalanche Program Director	Proposed study for icefall barrier for AK RR Corp. but did not win FHWA grant. Dave mentioned that they have used drill and blast techniques to scale ice in key locations along the railway.
22	9/15/2015	In-Person	Todd Reccord	Ameritech Slope Constructors	U.S. Operations Manager	Todd had construction/install ideas for remote ice slab removal systems using pneumatic packers and ethylene glycol
23	10/14/2015	In-Person	Andy Buechi	Geobrugg/Canada	Canadian Rep.	Discussed icefall barrier design & construction concepts. Also discussed avalanche and debris flow barriers.
24	9/14/2015	In-Person	Ghislain Brunet	Maccaferri/USA	North American Business Unit Manager	Has observed icefall and ice build-up/stressing on netting systems
25	10/7/2015	Phone	Burrell Nickeson	AKDOT&PF	Maintenance & Operations (M&O) Specialist	Potential info. from ice climbing community at: http://www.alaskaiceclimbing.com/
26	9/25/2015	In-Person	Eric Gottheld	MSHA	Senior Civil Engineer/Mine Waste & Geotechnical Division	Coal mine in PA with periodic icefall issues
27	9/14/2012	In-Person and email	Rachel Saxby	Alaska Division of HS & EM, Mitigation Division	(Unknown Title)	Photo of 6 April 2012 Seward Highway icefall event
28	12/15/2015	Email	Mike Dowdle	B.C. Ministry of Transportation	Manager - Rockwork Engineering	Discussion of icefall hazards in B.C.; At least two events in Terrace. MoT installing avalanche fences. Can also contact Scott Garvin, Avalanche Hazards Program Mgr.
29	1/7/2015	Phone	Jason Sakalaskas; Bob Dunning; Doug Lammers; Peter Carter	AKDOT&PF	M&O Specialist; M&O Valdez District Superintendent; M&O NR Maintenance Manager; and Avalanche Forecaster, respectively	Discussed specific conditions along Richardson Highway outside Valdez, and key areas that have had icefall events documented over the years, including MP 13/14, MP 20. No known icefall at MP 38 but ice build-up conditions exist.
30	12/18/2015	Email	Craig Boeckman	AKDOT&PF	CR Regional Geologist	Craig sent along photos from 18 December 2015, showing ice build-up in the vicinity of MP 113.2, MP 110.5, and MP 105.5.

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TABLE 2 - DOCUMENTED ICEFALL EVENTS

Item No.	Date(s)	Country	State/Province	Location	Photos	Comments
1	4/6/2012	USA	Alaska	Seward Highway, MP113	Yes	Documented icefall event resulting in serious injury to motorist. Haley & Aldrich, Inc. (D. Scarpato) hired as expert witnness in defense of State of Alaska. Submitted report to Alaska Dept. of Law on technical scientific and geotechnical enginering opinion of event. AK Dept. of Law may have records via FOIA request.
2	2/4/2011	Canada	British Columbia	Terrace	Yes	Documented icefall event resulting in injury to bus driver and four occupants
3	2/14/2011	Canada	British Columbia	Terrace	Yes	Second icefall a week later after 2/4/11 event. Article discusses an older icefall in 1988 resulting a fatality
4	4/2008; 4/2010; 4/2011	USA	Maine	U.S. Route 2, Bethel/Gilead	Yes	Documented icefall event. At least 3 events; 1 large mass released during construction, then 2 smaller events during subsuquent melting seasons. Haley & Aldrich, Inc. (D. Scarpato) completed a feasibility level icefall hazard assessment and mitigation concept, including conceptual design of icefall barrier. Due to funding issues, the concept never made it further
5	4/19/2015	USA	Alaska	Seward Highway, MP113.7	Yes	Rockfall event, followed by unconfirmed smaller icefall event
6	3/13/2009	Canada	NWT	Confidential Open Pit Diamond Mine	Yes	Two icefall events; 1 uncontrolled, another monitored with radar, drilled, and shot. See IDS project write-up.
7	??	USA	Colorado	I-70/Glenwood Canyon	No	Unknown if ice has entered roadway, but ice blocks have fallen. ColDOT installed 4-in. dia. concrete filled "ice poles" to break-up/cut falling ice, which is then captured by a rockfall barrier fence below the poles.
8	??	USA	Maine	Acadia N.P., Route 3, Bar Harbor	No	Unconfirmed verbal accounts of periodic and small ice shedding events. Haley & Aldrich, Inc. (D. Scarpato) designed a very wide combined Ice & Rockfall Catchment Ditch for capture based on 90% retention.
9	Various	USA	Colorado	Mother Cline, U.S. Rt. 550, Ouray	No	Ice build-up on rock cut, that can overhang toward the roadway. On-call contractors remove the ice based on roadway monitoring. Note that AK Dept. of Law may have old black and white photos of this area from ColDOT, based on input from experts during Lawton case.
10	2007 - Current	USA	West Virginia	Coal Mine	Yes	Unconfirmed icefall events. MSHA geotechnical engineer (Eric Gottheld) contacted us at AEG meeting, and we discussed potential icefall at an undisclosed box cut open pit coal mine. Mine operators appear to have minimized ice and rockfall concerns.
11	??	USA	Alaska	Seward Highway, MP 52	No	Ice blocks the size of Beluga Whales have been known to periodically fall, hence the term for icefall or large "belugas" coming off the slope.
12	??	USA	Alaska	Richardson Highway, MP 13/14	No	Small chunks of ice have periodically entered roadway in Keystone Canyon. Significant ice build-up with thriving ice climbing community.
13	??	USA	Alaska	Richardson Highway, MP 20	No	Cliffs with ice build-up a few hundred feet up-slope beyond woodline. At one time, ice fell through woods and entered the roadway.

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TABLE 3 - MEDIA ACCOUNTS OF ICEFALL EVENTS

Item No.	Item Description	Pub. Date(s)	Pub. Entities	Web Link #1	Web Link #2	Web Link #3
1	Possible Icefall/Definite Rockfall MP113.7, Seward Highway, Alaska	2/19/2015	KTUU, Alaska Dispatch News	http://www.ktuu.com/news/news/seward-highway-closed-near-anchorage-by-rock-slide-crash/31359146	http://www.adn.com/article/20150219/seward-highway-reopened-after-closure-prompted-rockslide	http://www.adn.com/slideshow/photos-rock-slide-seward-highway
2	Rockfall near MP113, Seward Highway, Alaska	9/14/2015	KTUU, Alaska Dispatch News	http://www.ktuu.com/news/news/rockslide-closes-northbound-lanes-of-seward-hwy-near-mile-113-monday/35262542	http://www.adn.com/article/20150914/boulders-fall-seward-highway-exact-same-spot-february-rockslide	
3	"*Legislature allocates $8.4M to pay settlements, judgments against state* "	4/4/2015	Alaska Dispatch News	http://www.adn.com/article/20150404/legislature-allocates-84m-pay-settlements-judgments-against-state		
4	Article: "*Winning the fight against snow*"	3/12/2014	Jernbaneverket (Norwegian Railway Service)	http://www.jernbaneverket.no/en/startpage1/News/Winning-the-fight-against-snow/		
5	Terrace, B.C. icefall incident	2/5/2011	Terrace Daily; Terrace Standard; The Northern View; Mirth Wisdom Provocative Reason	http://www.mwpr.ca/go7611a/GREYHOUND_ACCIDENT_WITH_ICE_NEAR_TO_CA...	http://www.terracedaily.ca/show7605a0x300y1z/GREYHOUND_STRIKES_FALLING_BLOCK_OF_ICE_ON_HIGHWAY_16, February 5 2011.	http://www.terracestandard.com/news/115532094.html
6	Another (2nd) Terrace B.C. icefall event	2/14/2011	Mirth Wisdom Provocative Reason	http://www.mwpr.ca/go7639a/ANOTHER_NEAR_MISS_WITH_FALLING_BLOCKS_OF_ICE_ON_HIGHWAY_16		http://www.terracestandard.com/news/116144459.html
7	State award re: Lawton case	5/7/2015	Turnagain Times	http://turnagaintimes.com/currentissue/2015-05-07/lawton-settlement.html 9/	http://www.turnagaintimes.com/currentissue/2015-05-07/lawton-settlement.html	
8	Seward Highway Icefall event MP113, 6 April 2012	4/13/2012; 4/6/2012; 4/8/2012	Anchorage Daily News; Alaska Dispatch News	http://www.adn.com/article/20120412/transportation-department-investigating-ice-falltrapped-woman	http://www.adn.com/article/20120406/falling-ice-traps-driver-closes-highway	http://www.adn.com/article/20120408/tow-truck-driver-aided-rescue-woman-pinned-fallen-ice
9	Seward Highway Icefall event MP113, 6 April 2012	4/6/2012; 4/8/2012; 4/19/2012	KTUU	http://articles.ktuu.com/2012-04-06/emergency-crews_31302338	http://articles.ktuu.com/2012-04-08/critical-condition_31309549	http://www.turnagaintimes.com/currentissue/2012-04-19/trooper-report.html
10	Seward Highway Icefall event MP113, 6 April 2012	4/12/2012	Alaska Dispatch News	http://www.adn.com/article/20120412/transportation-department-investigating-ice-fall-trapped-woman	http://www.adn.com/slideshow/ice-fall-accident	http://www.adn.com/article/20120409/falling-ice-block-called-unusual
11	Seward Highway Icefall area MP113 videos	Various	YouTube	https://www.youtube.com/watch?v=mit5JdrKSDI	https://www.youtube.com/watch?v=ivNOE-73Mt4	https://www.youtube.com/watch?v=kg6z63yztVE
12	Seward Highway Icefall area MP113 videos	Various	YouTube, KTUU	http://www.ktuu.com/news/news/web-extra-seward-highway-mile-113-ice-fall/24042460	https://www.youtube.com/watch?v=e4C2BynFHEQ	https://www.youtube.com/watch?v=lS9tivN4AbA
13	Avalanches, Richardson Highway	1/26/2014	Alaska Dispatch News	http://www.adn.com/slideshow/photos-massive-avalanches-close-richardson-highway		
14	Avalanche Fence - Highway 16, 35 Mile Area, B.C.; Fence intended to reduce icefall also. Same general area as Terrace icefall event	2/16/2015	Tran BC - Ministry of Transportation and Infrastucture Online	http://tranbc.ca/2015/02/16/behind-the-scenes-hanging-from-a-rock-face-for-avalanche-safety/#sthash.b2UBS06X.icoY3FGE.dpbs		
15	Seward Highway MP113 area ice build-up on 12 December 2015	12/12/2015	Alaska Dispatch News			

TABLE 4 - TECHNICAL LITERATURE ON ICEFALL		
Item No.	**Detail**	**Hyperlink (if available)**
1	Scarpato, D., Presented and published paper entitled: *Icefall Hazards Along U.S. Transportation Corridors - Are Rockfall Catchment Ditches Sufficient?* GSI Advanced Rockfall Mitigation Workshop, Springfield, MA., 1 December 2015.	
2	Scarpato, D., Presented and published paper entitled: *Icefall Hazards Along U.S. Transportation Corridors - Are Rockfall Catchment Ditches Sufficient?* Association of Environmental & Engineering Geologists Annual Meeting, Pittsburgh, PA., 25 September 2015.	
3	Scarpato, D., Presented and published paper entitled: *Icefall Hazards Along U.S. Transportation Corridors - Are Rockfall Catchment Ditches Sufficient?* 66th Highway Geology Symposium, Sturbridge, MA., 15 September 2015.	http://www.highwaygeologysymposium.org/past_proceedings.asp
4	Scarpato, D., Woodard, M., Presented and published paper entitled: *Evaluation and Mitigation of Icefall Hazards for Civil Engineering Works* , International Snow Science Workshop (ISSW), Anchorage, Alaska, 20 September 2012.	http://arc.lib.montana.edu/snow-science/item/1598
5	Scarpato, D., Woodard, M., presented: *Rockfall Assessment & Mitigation* , a 1 day short course to ASCE – Vermont Section, Geo-Institute, held at Norwich University, 22 April 2012. (Presented module on icefall hazards)	
6	Scarpato, D., presented: *Rockfall Assessment & Mitigation in New England* , American Society of Civil Engineers – Vermont Section, Geo-Institute Sponsored Meeting, Norwich University, Norwich, Vermont, October 2011. (Presented module on icefall mitigation)	
7	Scarpato, D., Woodard, M., Breskin, K., Steinert, B., presented *The Icing on The Cake – Evaluation & Mitigation of Hazards Resulting from Ice Accumulation on Rock Slopes* , Association of Environmental & Engineering Geologists, Annual Meeting, Anchorage, Alaska, 22 September 2011.	
8	GeoBrugg Case Study - Tecco Ice Drape, Icefall Prevention, Felsentor Ramsau, Germany, May 2007.	http://www1.geobrugg.com/contento/Portals/35/media/Ramsau_Fotodok_e_screen.pdf
9	Norway Icefall Hazard Mitigation Criteria entitled: *Sikring av vegar mot isras* ; forwarded by Matt Murphy of AKDOT&PF, from Norwegian Ministry of Transportation. Manuscript in Norse language. Photos of "ice netting" also included.	
10	"Physical Modeling of Permafrost Melting in Rock Slope"; by M.C.R Davies, O. Hamza, and C. Harris; Permafrost, by Phillips Springman, and Arenson (eds), copyright 2003, Swets & Zeitlinger, Lisse, ISBN 90 5809 582 7	http://research.iarc.uaf.edu/NICOP/DVD/ICOP%202003%20Permafrost/Pdf/Chapter_031.pdf
11	"Rheology of Ice-Rock Systems and Interfaces"; by B. Ladanyi; Permafrost, by Phillips Springman, and Arenson (eds), copyright 2003, Swets & Zeitlinger, Lisse, ISBN 90 5809 582 7	http://research.iarc.uaf.edu/NICOP/DVD/ICOP%202003%20Permafrost/Pdf/Chapter_110.pdf
12	"Glacial Geologic Processes", D. Drewry, Edward Arnold Pub., London, U.K., 1986.	
13*	F. Gauthier, 2013 PhD dissertation on thermodynamic approach to modeling ice block releases along highways in Quebec. LES GLACES DE PAROI, Glaciologie, thermodynamique et prévision des chutes de blocs de glace sur les routes du nord de la Gaspésie (Québec, Canada); Univ. of Laval	
14*	Waterfall ice: mechanical stability of vertical structures, J. WEISS, M. MONTAGNAT, B. CINQUIN-LAPIERRE, P.A. LABORY, L. MOREAU, F. DAMILANO, D. LAVIGNE, Journal of Glaciology, Vol. 57, No. 203, 2011	https://www.researchgate.net/publication/233492248_Waterfall_ice_Mechanical_stability_of_vertical_structures

TABLE 5 - ALASKA-SPECIFIC DOCUMENTS FOR ICEFALL EVALUATION

Item No.	Date	Doc. Type	Origin	Description	Relevant Pages
1	1/21/2014	Drawing	AKDOT&PF/Traffic & Safety	Two Lane Roadway Detour Using Roadside Pullouts for temporary traffic diversion around ice build-up on slope	
2	1/21/2014	Notes & Comm.	AKDOT&PF/Anchorage Highways/M&O	Site evaluation notes and internal communications relative to temporary traffic diversion around ice build-up on slope	
3	Various	Activity Reports	AKDOT&PF/Anchorage Highways/M&O/CR	Seward Highway Activity Reports. Data can be queried based on date and location; however, icefall may not be explicitly indicated.	
4	1953	As-Built Plans	U.S. Dept. of Commerce, Bureau of Public Roads/Division No. 10	Proj. No. 11817; Seward - Anchorage Highway, Moose Creek to Mile 58; Primarily shows roadway elevation grades (no slope info.)	
5	7/10/1998	As-Built Plans	AKDOT&PF	Proj. No. 51069; Seward Highway, MP53 to MP59.3; Grading, Drainage, Paving, Bridge Replacement, Retaining Walls, Signing, Striping, Illumination	Sheet 8 of 217 (Rock slope cut details)
6	7/1/1998	As-Built Plans	AKDOT&PF	Proj. No. 52820; Seward Highway, Bertha Creek to Ingram Creek; Rehabilitation, Paving, Striping, and Guardrail (no slope info.)	
7	8/19/1993	As-Built Plans	AKDOT&PF	Proj. No. 57328; Seward Highway, Rock Slope Stability, Ditch Widening & Slope Flattening; MP16.5 to 31.4 and MP106.1 to 113.9	Sheet 21 of 26 (Site 16, MP113.2); Sheet 22 of 26 (Site 17, MP113.9); Sheet 26 (Site 16)
8	10/1/1995	As-Built Plans	AKDOT&PF	Proj. No. 59956; Seward Highway, MP50 to MP53; Lower Summit Lake to Wibel; Grading, Drainage, Paving, Signing, Striping	Sheets 8 and 9 of 73
9	11/20/1999	As-Built Plans	AKDOT&PF	Proj. No. 67032; Richardson Highway, MP6 to MP14 Rehabilitation (no slope info.)	
10	8/2/2001	As-Built Plans	AKDOT&PF	Proj. No. 67034; Richardson Highway, MP14 to MP26, Proposed Highway Project (no slope info.)	
11	4/4/1986	As-Built Plans	AKDOT&PF	Proj. No. 76783; Richardson Highway, MP6 to MP14 Rehabilitation; Grading, Drainage, Pavement	Sheet 2 of 28 (Catchment Ditch Details); Sheets 6/7 of 28 ("Rock Slide" areas)
12	2/12/1953	Proposed Road Layout	AKDOT&PF	Richardson Highway, Section G, Plan and Profile of Proposed Highway; No MP indicated (no slope info.)	
13	9/10/1985	As-Built Plans	AKDOT&PF	Proj. No. RF-F-071-1(44); Richardson Highway, MP35 to MP 40, Grading, Paving, Drainage and Bridge	Sheet 2 of 50 (Typical Roadway Section/Cut Slopes)
14	10/17/2013	Memorandum	D. Scarpato (when with Haley & Aldrich, Inc.)	Statement of Technical Opinion, 6 April 2012 Icefall Event at MP113; Case Document On-File with AK. Dept. of Law	Page 15 of 15 (Ref. Cited)
15	3/31/2015	Memorandum	Landslide Technology	Use of GAM Asset Location Map	Page 3 of 3 (Asset Inventory Map)
16	9/15/2014	User Guide	Landslide Technology	USMP Rating Category Descriptions	
17	3/29/2015	GAM Data	Landslide Technology	USMP Detailed Rating Summary, Seward Highway to Postage Road	Pages 172 - 201 of 547 (Pg. 176 for 4/6/12 Icefall Event at MP113); Pages 341 - 348 (MP 52); Pages 368 - 399 (MP56 to MP58)
18	3/29/2015	GAM Data	Landslide Technology	USMP Detailed Rating Summary, Richardson Highway	Pages 49 - 55 of 584 (MP13); Pages 430 - 437 (MP38)
19	Various	LiDAR/Topo.	AKDOT&PF	CR and NR have some LiDAR/Topo. Data. NR was flown in winter and summer so we could establish contrasts. (Part of Phase 2)	

TABLE 6 - ALASKA-SPECIFIC ONLINE/WEB-BASED SYSTEMS FOR ICEFALL EVALUATION			
Item No.	**Origin**	**Description**	**Web Link**
1	AKDOT&PF/RWIS	Road Weather Information System, with site-specific meteorological data and cameras for photo sharing	http://www.dot.state.ak.us/iways/roadweather/forms/IndexForm.html
2	NOAA/NWS	National Weather Service; Real time/recent weather conditon data	http://www.weather.gov/
3	NOAA/NCDC	National Climate Data Center; Queries for historical climate data	https://www.ncdc.noaa.gov/
4	NOAA/CPC	National Weather Service; Climate Prediction Center/Alaska	http://www.cpc.ncep.noaa.gov/products/partnerships/alaska.php
5	Google	Google Earth	https://www.google.com/earth/
6	AKDOT&PF/TDP	Traffic data, maps and reports	http://www.dot.alaska.gov/stwdplng/transdata/traffic_maps_home.shtml
7	Alaska DNR/P&R	Maps/info. for trails in vicinity of Seward Highway	http://dnr.alaska.gov/parks/brochures/turnagainarmtrails.pdf

TABLE 7 - POTENTIAL SOFTWARE FOR USE WITH ICEFALL ANALYSES		
Item No.	**Product Description**	**Web Link**
1	Rocscience Suite - Range of rock engineering software products that could be applied to icefall analysis from rock slopes, with modified input assumptions. Includes analysis of sliding, toppling, and falling.	https://www.rocscience.com/rocscience/products
2	Colorado Rockfall Simulation Program (CRSP) - 2-D analysis of rockfall trajectory, bounce height, velocity, and kinetic energy for roadside ditch and barrier design. Has been successfully used to complete initial icefall evaluations.	https://www.codot.gov/programs/geotech/rockfall
3	RAMMS (Rapid Analysis of Mass Movements) for Rockfall, Debris Flows, and Avalanches. 3-D Rockfall Module.	http://ramms.slf.ch/ramms/downloads/RAMMS_ROCK_Manual.pdf
4	Itasca Numerical Modeing for Geotechnical Applications, including surface, underground, natural/geologic hazards. Finite and Distinct Element methods, for advanced modeling.	http://www.itascacg.com/software
5	Hy-Stone Rockfall Modeling Software (Italy) - GIS/DEM based 3-D rockfall modeling. Very powerful but steep learning curve.	http://www.geo.unimib.it/index.php?option=com_content&view=article&id=206&Itemid=153&lang=en

APPENDIX NO. 2

Question & Response Log

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NO.	QUESTION & RESPONSE LOG
1	On the activity reports (CR), it shows an event on 2/27/14 indicating "INSTALL TRAFFIC CONTROL/ DETOUR FOR ICE FALLING AT M.P. 113 SEWARD HIGHWAY". Is this precaution due to ice build-up, or was there another icefall event on this date?
	RESPONSE: (1) Precautionary. At traffic section request (C. Boeckman, 12/18/15); (2) My understanding is the Anchorage MMS report is everything regarding activity at 113. May want to check with Scott Thomas, but I don't believe Anchorage M&O coordinates with him every time a detour is installed. It's also my understanding that the detour is installed when ice or rockfall in the area is noticed and/or forecast is for weather events that seem to promote such events. (B. Nickeson, 12/22/15); (3) This was a precaution is my understanding due to visual observations that were similar to the previous. (A. Bosin, 01/05/16); (4) Response is based on field crews on the ground. Traffic staff advises when requested on message board use and detours. M&O fully enabled/authorized to choose messages and traffic control with the guidance already provided to date. Primarily for extreme thaws, rain events, spring events. (S. Thomas, 01/22/16)
2	Has there been any other documentation of monitoring at vicinity of MP113 since 2012 icefall?
	RESPONSE: (1) No indication of any further (C. Boeckman, 12/18/15); (2) Check with Scott Thomas or Craig Boeckman. MMS report is everything Anchorage M&O has. (B. Nickeson, 12/22/15); (3) The documentation would have been covered in the MMS excel spreadsheet from M&O. (A. Bosin, 01/05/16); (4) Field crew observation as weather changes to extreme thaws, rains, spring events (S.Thomas, 01/22/16)
3	The CR activity reports don't seem to indicate the 4/6/12 icefall event on Seward (or at least listing I have).
	RESPONSE: It is listed under MP113 (C. Boeckman, 12/18/15)
4	Seward MP75.5 As-Built Plans?
	RESPONSE: That would be the as-built 52820 Seward Highway Bertha to Ingram creek. (A. Bosin, 01/05/16)
5	Activity Reports for NR and SCR?
	RESPONSE: Based on 7 January 2016 call with Jason Sakalaskas and Bob Dunning, there is no info from MMS for NR relative to icefall, and the MMS reporting is general and does not capture all of the rockfall clean-up that may take place. (D. Scarpato, 01/07/16)
6	Do we have access to photos for AB Plans Proj. No. 57328; Seward Highway, Rock Slope Stability, Ditch Widening & Slope Flattening; MP16.5 to 31.4 and MP106.1 to 113.9?
	RESPONSE: (1) Photos taken during construction? None that I am aware of. I can pull current photo logs from our pavement software but it won't capture more than the ditch area. Maybe Craig's staff could take some? (A. Bosin, 01/05/16); (2) There were photos in the DSR and the Design planset included into the planset. Should be in Central Files. (S. Thomas, 01/22/16)
7	Topo or flown LiDAR plans for 7 key sites (so we can assess upslope watershed area)?
	RESPONSE: (1) NR has LiDAR data flown in winter and summer for the 3 sites on Richardson Highway (J. Sakalaskas, 01/07/16); (2) I will look into this for phase II. (A. Bosin, 01/05/16)
8	I was with different company in my role as expert for AK Dept. of Law re: Lawton case. We can reach out to them via FOIA (if needed) for doc release during Phase II.
	RESPONSE: Yes, could probably get information from the event from AK Dept. of Law. Don't think the case is sealed as it was settled, but could do FOIA request if needed. (D. Scarpato, 01/13/16)
9	AB Plans for Richardson Hwy., MP38 area? MP20-21?
	RESPONSE: Anna sent what she could find for as-builts in both these areas. See table for "AK Specific Info." (D. Scarpato, 01/13/16)

NO.	QUESTION & RESPONSE LOG (CONTINUED)
10	Title for AB says: "67032 As Builts Richardson MP 10-19.5", but Title Sheets says: "MP6 to MP14 Rehabilitation; Plan and Profile"
	RESPONSE: I don't know the area well enough to know why there is the difference with these two plan sets. I will ask someone from NR. (A. Bosin, 01/05/16)
11	Two sets of plans for "Keystone Bypass" within AB Plan set: As-Built_Rich Hwy MP 6-14 Richardson Highway Flooding Permanent Repairs (Oct 06) 76783.
	RESPONSE: See above (response). (A. Bosin, 01/05/16)
12	Richardson MP20 and 38 AB Plans?
	RESPONSE: I could not find any other asbuilts for MP 20 or any AB for MP 38. I will ask NR to help. (A. Bosin, 01/05/16)
13	I'm archiving photos, journal articles. Maybe I can put on CD and send to AKDOT?
	RESPONSE: Yes (A. Bosin, C. Boeckman, 12/18/15)
14	From looking at Google Earth and my recollection driving thru this area in past, what is signifacnce of MP 75.5 and 52 SB on Seward? Cannot see any large slope features.
	RESPONSE: (1) Unknown. No rock slope at MP75.5. Seward Highway MP 52 is a low rock slope (C. Boeckman, 12/18/15); (2) I don't know to what "significance" you refer….? In the USMP, I see a record for a rock slope at MP 74.82/CDS Milept 73.95. Also, I see a record for an unstable soil slope at MP 74.87/CDS Milept 74. And I see four records for rock slopes between Mileposts 52 and 53 on the Seward. (B. Benko, 01/04/16); (3) The slope as you begin climbing into the pass on the right should be visible around MP 75-ish. 52 SB I believe a rock fall happened last spring time from the NB side that cross into the SB lane. (A. Bosin, 01/05/16)
15	USMP shows 4/6/12 icefall event at CDS MP112.65 - should update this for CDS MP112.25. But its closeby!
	RESPONSE: Sent to C. Boeckman and B. Benko for review (D. Scarpato, 01/13/16)
16	Are the 7 key sites indicated by CDS MP or Hwy. MP?
	RESPONSE: (1) USMP refers to both Mile Post and Mile Point. Maybe just indicate what you are referring to (C. Boeckman, 12/18/15); (2) How to minimize the confounding MP/MP confusion? Suggestion: reserve "MP" for the physical milepost only…and use milepoint [no MP] for the CDS location. (B. Benko, 01/04/16)
17	Other than the MP113 area site, how did the other 6 sites come to be? By direct observation of ice build-up?
	RESPONSE: When scoping this project, I queried the other regions for rock and icefall historical locations. Then I aksed Barry and Craig to vet those locations just for ICEFALL historical buildup or freeze/thaw issues that might have caused rock fall from winter ice buildup behind slopes. (A. Bosin, 01/05/16)
18	MP 75.5+/- along Seward is not contained within the USMP data set? Closest is Hwy. MP 74.87.
	RESPONSE: No rock slope at MP75.5 (C. Boeckman, 12/18/15)
19	Is the "MP52 SB" site indicated in the Scope of Work actually Highway MP51.93?
	RESPONSE: Low rock slope (C. Boeckman, 12/18/15)
20	Cannot find MP20 slopes in USMP data along Richardson. There is a MP19.7 based on CDS MP's - is this it? Low slope.
	RESPONSE: Confirmed…I think---the USMP record to which you refer is for CDS Milept 19.7 on the Richardson, yes?... (B. Benko, 01/04/16)