ABSTRACT: Interstate 90 over Snoqualmie Pass, WA is affected by numerous avalanche paths that disrupt travel and threaten the safety of travelers. The most active paths affecting Interstate 90 had a snow shed to protect travelers, but highway expansion in the 1960’s added two lanes alongside the snow shed exposing eastbound vehicles to avalanches, leaving only the westbound lanes protected. An avalanche forecasting and control program has been in place since the early 1970’s to further protect travelers. Up to 40 avalanche control missions may occur at the snow shed site each winter. Increasing traffic volumes and commerce have made traffic delays less acceptable as avalanche delays and closures have an economic impact that often exceeds several million (USD), depending on the length of the closures.

The existing snow shed is being replaced with two bridges as part of a $550 million (USD) highway expansion project. The snow shed was removed in 2014 to prepare the site for construction of twin avalanche bridges as part of a $550 million (USD) highway expansion project. In addition to the bridges, approximately 1500m of snow supporting structures will be installed in adjacent avalanche 1208

INTRODUCTION

Snoqualmie Pass, WA (921m) is located in the Central Cascade Mountains, in a maritime snow climate, and receives an average of 1100 cm of snowfall and 2500mm of precipitation annually. Interstate 90 over Snoqualmie Pass is the major highway through the Cascade Mountains of Washington State, with traffic volumes averaging nearly 30,000 vehicles per day and peak volumes exceeding 50,000. Numerous avalanche paths affect I-90 near Snoqualmie Pass.

Avalanche delays and closures have an economic impact that often exceeds several million dollars (USD), depending on the length of the closures. The area with the most active avalanche paths, known as the East Shed area, had a two-lane snow shed, but for the majority of its 65 years of service the shed only protected the westbound lanes; eastbound lanes were fully exposed. Up to 40 avalanche control missions may occur at this site each winter.

The existing two-lane snow shed was removed in 2014 to prepare the site for construction of twin avalanche bridges as part of a $550 million (USD) highway expansion project. In addition to the bridges, approximately 1500m of snow supporting structures will be installed in adjacent avalanche 1209
zones. The construction season runs from May through October and is suspended during the winter due to snowfall and avalanche hazards. The 6-month construction season did not allow enough time for construction of the replacement structures to be completed in one season, thus the affected area was left without avalanche defensive structures for two winters. In 2012, the author examined the background of the East Shed location and preparations that were being considered for the two winters without the snowshed’s replacement (Stimberis, 2012). This paper and subsequent poster look at those two winters and how expectations were either met or not met. In addition, we will look at what the future holds for this active avalanche area.

OPERATIONAL CONCERNS

Highway construction in general will have a number of factors affecting work schedules. These factors may include operational needs of the highway, local terrain, and seasonal snowfall in mountainous regions. The construction schedule for I-90 Snoqualmie Pass, WA is affected in a number of ways. The highway is the major mountain pass for commerce and thus must remain operational throughout the construction season. Terrain is a big factor, especially near the East Shed where the avalanche bridges will be located, as the highway is being expanded and realigned between a steep hillside and a reservoir. Finally, seasonal snowfall of 1100cm annually, along with avalanche risk, brings construction to a halt from November through April.

A variety of scenarios were discussed internally at the WSDOT and with our primary stakeholders (State Patrol, County Sheriff, Fire/EMS, local ski areas, etc.). The primary concern about operating the highway without the old shed revolved around increased avalanche risk. Although this appeared to be a valid concern the highway was operated without protecting the eastbound (EB) lanes for decades, thus the risk was mainly being shifted from EB traffic to the westbound (WB) traffic. The planned winter configuration also provided some catchment along the WB shoulder which would offer a slight decrease in risk, especially from small slides.

The main operational concern centered on snow removal following avalanche control. When the snowshed was in place avalanche debris only accumulated in the EB lanes. With the shed no longer protecting the WB lanes avalanche debris would be expected to accumulate in both EB and WB lanes. Additionally there was concern that the center concrete barrier would be displaced when impacted by an avalanche. Both snow removal and a displaced concrete barrier would likely increase the cleanup time and lead to longer traffic delays.

Longer traffic delays result in two main issues for WSDOT Maintenance; stopped traffic doesn’t allow plowing and treatment of the highway and growing traffic queues eventually back up to the summit grade leading to an increased likelihood for collisions and loss of traction.

2014-2015: WINTER I

Anticipation was high going into the first winter without the shed. The seasonal outlook called for El Niño conditions, which mean a trend towards drier and warmer conditions in the Pacific Northwest. The winter could not have been better in terms of managing avalanche risk in a construction site. Although the winter was not a particularly dry one, the temperatures were warmer. Snoqualmie Pass saw the least amount of snow on record with a scant 264 cm of snowfall from October through May. The 2014-2015 winter was the first time that avalanche control was not performed at the East Shed site since the formation of the Avalanche Forecast and Control program in the 1970’s.

During the summer of 2015, the first of two bridges was nearly completed. Autumn rain and a rising reservoir put work to a close on the east egress of the bridge. We would not get to use the bridge to escape the avalanche hazard. Traffic was moved closer to the hillside this year as well so we had to go through the winter with a narrower catchment and snow storage on the westbound lanes. Once again, the forecast was for El Niño conditions, and
much to the chagrin of all in the snow industry, the WSDOT again hoped for a mild winter.

2015-2016: WINTER II

The 2014-2015 season would be noted for its record low snowfall, but December 2015 would not be outshone as a record holder. These records were much the opposite though. When the month ended, we had recorded the most snowfall for December (491 cm) as well as the most snowfall for a 7-day period (284cm). I-90 over Snoqualmie Pass closed numerous times during this period with the longest closure nearing 28 hours.

Avalanche closures were manageable at the outset mainly due to storm timing; much of our avalanche work took place in the early morning hours when traffic volumes were low. As the snowpack increased and the tracks filled in the frequency of avalanche closures increased. Additional demands such as holiday traffic, as well as increased skier and recreation visits, contributed to closure times. By December 23, 2015, the amount of new snow and the height of the existing snowpack led to widespread avalanche hazard and Snoqualmie Pass closed for an extended period. Avalanche debris removal in the construction area at East Shed 4 was becoming an overwhelming project. The debris pile against the hillside had not been managed and was now presenting a 6+ meter drop-off to the highway. The lack of snow storage, a large drop-off, and a full avalanche track would all contribute to further problems.

January 2016 did not present as many problems from new snow avalanches. The storms did not arrive with the frequency or large amounts of new snow as seen in December, but one key element was missing from December that is common to a maritime climate: rain. The snowpack experienced 1 meter of settlement from the peak height in late December to early January without the benefit of rain or significant warming. Snow levels remained relatively low and consistent throughout December and early January.

Snoqualmie Pass experienced the first significant rain-on-snow events of the winter around mid-late January. The rain and subsequent warming contributed to several problems in the construction zone. Many of the steep rock cuts developed a covering of snow and ice during December and were now shedding snow and ice onto the highway due to a lack of catchment. A similar situation was developing in the most active avalanche path, ESS-4. Here ice and snow from the edges of the path were becoming a real problem as there wasn’t a catchment in this location either. Triggers were both rain/frontal warming, diurnal warming and solar input, and tree bombs.

By the end of January, these problems ended as a series of rain-on-snow events had cleared all steep slopes and trees of snow and ice buildup. February was a wet month but with 117mm SWE and 257mm rain it wasn’t an active month for new snow avalanche control. The existing snowpack in the avalanche paths affecting the construction zone were well settled and only two additional avalanche control missions would happen for the remainder of the season. The final mission occurred on March 15, 2016. This particular mission is noteworthy in that it may very well be the last time that avalanches are artificially released to protect the highway in the East Shed location.

Following a 40+ year history in which avalanches were artificially released to protect the highway, the WSDOT will move into an era in which avalanches occur naturally in the East Shed area. This presents a rare opportunity for what has historically been a very active avalanche control area. The WSDOT Highway Avalanche Forecasting and Control program will have the opportunity to record naturally occurring avalanches and eventually compare the frequency of these avalanches against artificially controlled avalanches. The outcome will be a rare chance to evaluate the effectiveness of a control program.

CONCLUSION

The downside of a winter like 2014-2015 is the complacency that can follow. The planning, anticipation, and public outreach are quickly forgotten once the problem, or lack thereof, has
passed. Reminding the interested parties (related agencies, stakeholders, and the travelling public) can feel a bit like the boy who cried wolf; one too many dire warnings and the message gets lost.

Another issue that can and will arise is keeping the stakeholders, both internal and external, on the same track. It can be a challenge to maintain consistency and follow the plans and related contingencies established prior to the winter operating season. Developing plans based on future weather patterns is a difficult and often fruitless endeavor, but it is necessary. It is important to establish a common vision and be sure to keep the stakeholders aligned to that vision for the duration of the project.

REFERENCES