

THE WHITE PASS AND YUKON ROUTE AVALANCHE PROGRAM, FORECASTING AND RISK MANAGEMENT FOR A HISTORICAL RAILROAD

Bill Glude

Alaska Avalanche Specialists, Juneau, AK

The White Pass and Yukon Route (WPYR) is a narrow gauge railroad built in 1898 during the Klondike Gold Rush. Considered impossible to build by many who studied the route, it was blasted through the Coast Range from Skagway, Alaska to Whitehorse, Yukon Territory in only 26 months, and is a designated International Historic Civil Engineering Landmark.

The WPYR suspended operations in 1982 when the Yukon's mining industry collapsed due to low mineral prices. The railway was reopened in 1988 as a seasonal tourism operation and today is Alaska's most popular shore excursion, carrying over 390,000 cruise ship passengers during the tourism season.

The route to the White Pass goes through 17 major avalanche paths and numerous minor zones. In the early days, as was typical for the time, there was no avalanche program beyond relying on the experience and historical knowledge of the crews. Crews now begin snow-clearing operations at the end of March, and summer passenger operations begin with the arrival of the first ships in late April, while avalanche season runs through through mid-May, and can run into June.

In 2007, Alaska Avalanche Specialists was called in to do an annual springtime snowpack evaluation. In 2015, as part of a system-wide risk management upgrade, operations transitioned to a modern avalanche program with crew training, daily forecasts and observations, regular fieldwork, closures and work area restrictions, and helicopter and hand blasting as necessary.

KEYWORDS: railroad, avalanche program, Alaska, Yukon.

## 1. HISTORY

The White Pass and Yukon Route (WPYR) is a narrow gauge railroad built in 1898 during the Klondike Gold Rush. Considered impossible to build by many who studied the route, it was blasted through the Coast Range from Skagway, Alaska to Whitehorse, Yukon Territory in only 26 months, and is a designated International Historic Civil Engineering Landmark.

The Klondike Highway, crossing the White Pass on the opposite side of the valley, opened in 1978. The WPYR suspended operations in 1982 when the Yukon's mining industry collapsed due to low mineral prices, and trucks now haul the ore. The railway reopened in 1988 as a seasonal tourism operation and today is Alaska's most popular shore excursion, carrying over 390,000 cruise ship passengers during the tourism season.



*A WPYR train awaits cruise ship passengers on the Railroad Dock. Most tours use these diesel-electric locomotives*

---

*\* Corresponding author address:*

Bill Glude, Alaska Avalanche Specialists,  
PO Box 22316, Juneau, Alaska, 99802 USA;  
tel: 206-617-7703;  
email: aas07@me.com



*The WPYR maintains two steam locomotives that run several trips weekly.*

## 2. AVALANCHE ISSUES



*A bulldozer begins clearing fresh avalanche debris from the 15.2 Mile Path in May 2015.*

The route to the White Pass summit goes through about 17 major paths, and numerous minor zones. The first and most active zone, with the largest and by far the most active paths, is from 12 Mile to 16 Mile (19 to 26 km), in the Glacier area. After the 16 Mile (26 km) Tunnel, there is a short stretch with minimal avalanche terrain, and then from Inspiration at 17 Mile (27 km) to the White Pass summit at Mile 20.4 (39 km) there are many short banks and rocky areas that send avalanches onto the tracks.

The avalanche program and its fieldwork currently are limited to the United States side of the border, which lies at the summit of the pass. This has been workable in the recent low and moderate-snow years, but we are seeking international work permits for heavier-snow years or longer seasons.

The railroad currently operates only during the summer tourist season. The avalanche program begins in late March or early April, when crews begin clearing the tracks. The railroad opens for summer business in late April with the arrival of the first cruise ships. Avalanche season ends when the snowpack at starting zone elevations thaws and makes the transition to settled early summer conditions that no longer produce large avalanches. This typically happens in mid-May, but avalanches have reached the tracks as late as June when snows are heavy and spring is late.

## 3. AVALANCHE PROGRAM

In 2007, Alaska Avalanche Specialists was called in to do an annual springtime snowpack evaluation. In 2015, as part of a system-wide risk management upgrade after a trainload of passengers was caught between two slides in the spring of



*Snowpit for field snow studies, with snow profile, temperature, and density set up for measurement.*

2013, we went to a modern avalanche program with crew training, daily forecasts and observations, regular fieldwork, closures and work area restrictions, and helicopter and hand blasting as necessary.

We evaluated a full range of avalanche mitigation techniques, but a combination of closures, work protocols, and explosives delivery by helicopter, with limited use of sled charges lowered on a rope, proved to be the practical solutions for seasonal operations.

We are looking into adding a portable mortar system for the Slippery Rock Path, which is too steep and icy for helicopter or sled charges; and are considering a deflection berm for the late-running South Glacier Gully path.

Staffing is minimal: one AAS lead avalanche forecaster (minimum of 10 years of experience and

training), supplemented with experienced local backcountry travelers as seconds for field days. Our forecaster is stationed in Skagway and uses train, road, and helicopter access, plus ski and splitboard, for snowpack evaluation and avalanche mitigation.



#### 4. ROUTE MAP

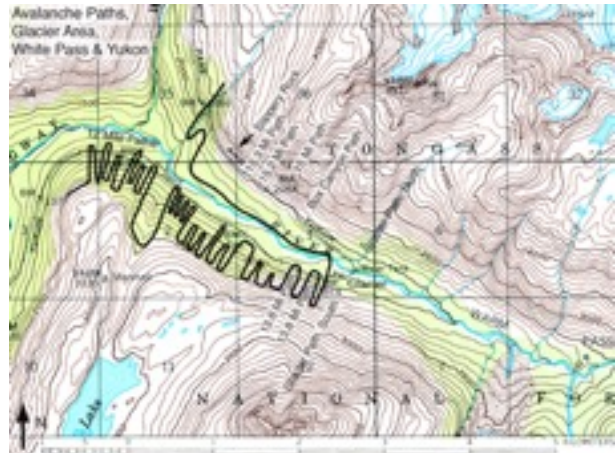
The currently active WPYR route from Skagway, Alaska to Carcross, Yukon Territory, with major avalanche areas identified. Trains are not currently operating on the Carcross to Whitehorse portion of the railroad. Apple Maps base.

#### 5. AVALANCHE HISTORY

Doug Fesler generously contributed a database of 899 avalanche occurrences compiled from WPYR maintenance records over the 83 year period of operation from 1899 through 1982. Records are most complete on the US side, and are known to underrepresent activity on the Canadian side. Carcross maintenance foreman Willy Scheffler verbally contributed his 55 years of knowledge of paths on the Lake Bennett section.

#### 6. AVALANCHE MAPS AND PHOTOS

##### 6.1. Glacier Paths Map



The Glacier area paths are the largest and most active along the route. The 12 Mile paths have only been recorded as reaching the tracks once, in a very snowy winter, and are not a problem in the spring. The main Glacier Area paths at 13.6 and 13.8 Mile, South Glacier Gully, Box Canyon, 15, 15.2 and 15.3 Mile, and Slippery Rock are the largest and most active group. USGS base map.

##### 6.2. South Glacier Paths Photomap



The South Glacier area has the largest paths on the route, but they hit the tracks far less often than the North Glacier paths. They have only 5 hits in the historical database. Facing north, they run later into the season than those on the opposite side of the valley. 13.6 Mile, 13.8 Mile, and the West Apron Slabs all have large granite rock slabs that produce an annual cycle of glide avalanches in the spring. The nearly 1800 m high, steep, and shaded starting zones above the Main Gully have hit the tracks with big debris as late as June.

### 6.3. North Glacier Paths Photomap



The North Glacier paths are by far the most active paths on the route, with 674 occurrences in the historical database, peaking at 258 in April, and active through May, with 82 slides recorded. They are steep, with high starting zones, but due to their south aspect, they wet out and finish their spring cycles earlier than the paths across the valley. The tracks cross them high in the runout zones, so even moderate size avalanches put snow and rocks from the steep hillside on the tracks.

The Glacier North path is less frequent than the others, but can hit the tracks. Going north (left), the whole hillside can produce slides, but the prin-

cipal and most active paths are labeled. Box Canyon regularly hits the tracks, with 43 slides in the database, and the path group that includes 15.0, 15.2, and 15.3 Mile is the most active on the route, with 467 slides in the database. Slippery Rock is a big, frequent-running granite slab with 148 slides in the database. It releases snow and ice directly onto the tracks, and is difficult to hit with helicopter-delivered charges due to its steepness and proximity to the tracks.

### 6.4. Hannon Shed Area Paths



There are many banks that produce avalanches onto the tracks between Inspiration and White Pass, with 205 slides recorded in the area, and peak activity in March, April, and May. The Hannon Shed Path is a notable producer of large slides with the consequence of a steep drop into Dead-horse Gulch below. The prevailing southerly storm winds (right to left in the photo) build cornices on the right side and load the slopes below. Pieces of cornice falling off are the usual triggers, and the broad gully holds substantial snow volume. The name comes from a wooden snowshed that used to help protect the tracks here.

### 6.5. Lake Bennett Paths Map

The avalanche program does not currently cover the paths on the Canadian side. This is a lower-snow area than the coastal side of the White Pass, and the paths have generally all run and stabilized by the time track crews reach them in the spring, but they merit caution in heavy snow or late springs, and if winter operations ever resume.

The paths named on this map are the ones with known avalanche history. Other paths that usually stop above the tracks, but may have potential to hit them, are indicated by their outlines.



6.6. Bennett Paths



This path in the yard just south of Bennett, and its twin just to the north, have a history of hitting the tracks and moving whatever is parked in their way. The 5 slides recorded probably underrepresent activity there, according to WPYR crews.

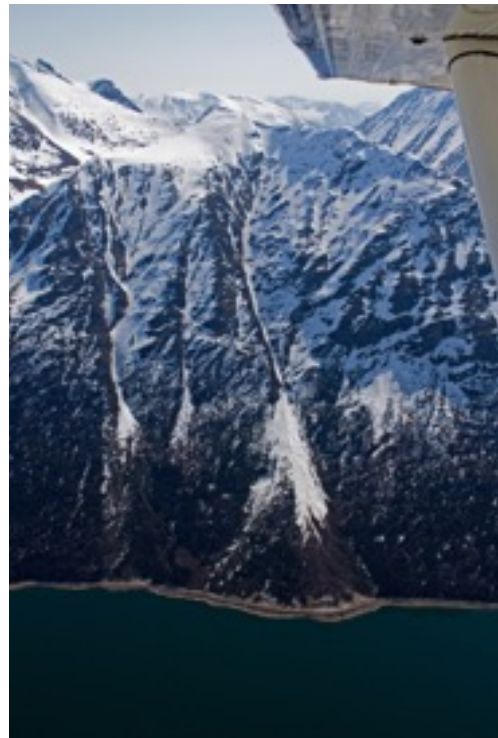
6.7. 42 Mile Path



This path is not large, but has one slide in the database and is known to the maintenance crew for putting slide debris on the tracks.

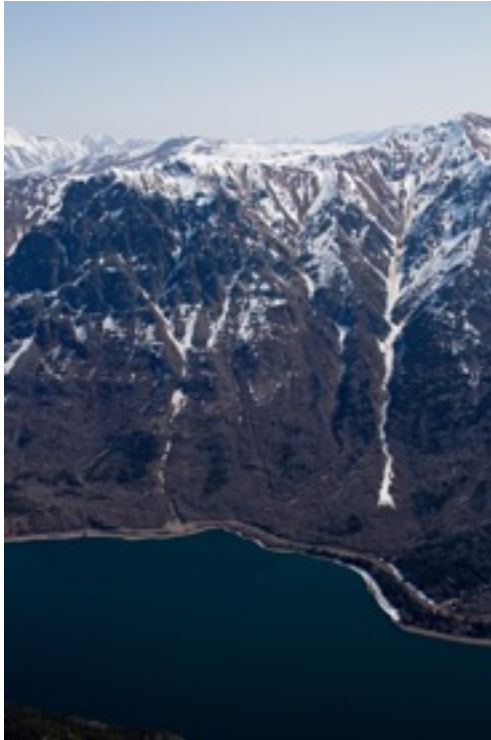
6.8. 44 Mile Path

This is the most active path on the Lake Bennett section of the route. It only has three slides in the



database, but maintenance crews say large slides on it are annual events. Both branches of the main path just right of center have a history of frequent large avalanches hitting the tracks. The path on the left is not known to hit the tracks, but appears to have the potential.

#### 6.9. Scheffler and 50 Mile Paths



The Scheffler Path on the right has two recorded hits, the 50 Mile Path on the left has four, and maintenance crews know both as producers. The smaller drainages between have no record of reaching the track, but may do so in big years.

#### 6.10. Pennington Path

This path just south of Pennington has a long runoff to reach the tracks, but has one recorded



hit and is known to maintenance crews for slides. It is the northernmost avalanche path on the route.

### 7. STAFF TRAINING

A key component of the avalanche program is annual training for the track clearing crews in late March, for the office and management staff in early April, and for summer train crews as they arrive in late April.

### 8. AVALANCHE FORECASTING PROGRAM

#### 8.1. Forecast Program Overview

The daily forecasting program is the heart of the WPYR Avalanche Program. Observations are daily; fieldwork daily when conditions are active, every second or occasionally third day when not. Forecasting is the basis for setting work protocols, closures, and best timing for avalanche blasting.



*One of our standard burlap-bagged 12.5 kg ANFO charge, with 2m double cap and fuse, drops from the helicopter.*

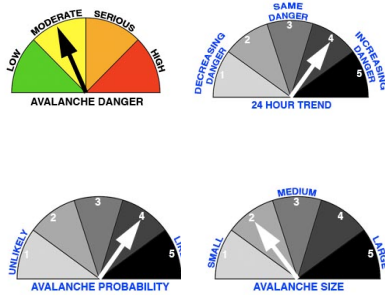
The avalanche program has two distinct phases. The first is during the track-clearing season, an industrial program for a small crew of WPYR employees, generally beginning around April 1. The second is during the operating season, when we carry the general public in addition to our own crews. Passenger trains begin with the arrival of the first cruise ship, generally around the last week of April, with only one or two days of trains in the first two weeks, then multiple trains six to seven days a week, beginning in the first week of May.

The avalanche program usually wraps up by mid-May, but the 1800 m, north-facing Glacier South Gully path has put snow on the tracks in June, so the program continues as long as there is a threat.

**WPYR Avalanche Forecast**

Issued 0600 Tuesday, April 14, 2016  
 by Bill Glude 206-617-7703  
 Valid through 0600 Wednesday, April 14, 2016

**WEATHER:** We have +2" breaking skies, and wind S 3-5 m/s in town this morning. The SOT station on the pass reports -3" with S5-8 m/s; Summit Creek has -4", and Fraser has -4" with S4-6 m/s and mostly clear skies on the webcam. We expect continued clearing today, with thawing conditions in the afternoon, and moderate south winds in the 5-8 m/s range.



**AVALANCHE:** We are on Moderate today, with an increasing trend in the afternoon as the snow thaws on solar aspects. Watch for the usual spring bank stuffs between Inspiration and the pass, glide avalanches on the slopes above Glacier, and ongoing small were stuffs on the slopes above Glacier. Slides are not expected to reach the tracks, except for bank stuffs above Inspiration.

**PLAN:** We will be taking the work train for fieldwork above Inspiration today, monitoring the progress of the spring thaw.

*Sample forecast front page.*

The avalanche forecast goes out by 06:30 each day, and the forecaster briefs crews during the morning meeting. Forecasts are e-mailed to a distribution list. The format is intended to offer some education on weather analysis, avalanche behavior, and the thinking behind the forecast; in addition to being a simple summary.

The format we have been using is:

- Front page summary
  - weather outlook
  - snow stability and likely effect of predicted weather; work protocols if any
  - “speedometer” icons for danger level, probability, size, and trend
  - avalanche crew plan for the day
- Detailed analysis on following pages
  - current weather, in town and on the pass
  - summary of previous day’s observations and fieldwork, if any
  - summary and discussion of National Weather Service (NWS) zone forecast for today and tomorrow

- US Navy GFS weather model images and discussion for today and tomorrow
- discussion of other forecast model and tool results; our best value-added forecast

Forecasts can also be broken out by the main zones: South of Glacier, North of Glacier, Hannon Shed Area, and Cutbanks from Inspiration to Summit, as needed.

**8.2. *Weather Data Sources***

We are fortunate to have a good existing network of weather stations and webcams already operating in the area, saving us from the need to install and maintain our own:

- White Pass ADOT&PF RWIS weather station
- Summit Creek Yukon Avalanche Center weather station
- Fraser Yukon Avalanche Center weather station
- Fraser highway weather station and webcam.
- Moore Creek SNOTEL weather station.
- Skagway Airport observations.
- We also share information with a network of avalanche forecasters working in the area
  - Alaska DPT&PF forecaster.
  - Yukon Avalanche Center forecasters.
  - Yukon Highways forecaster.
  - Yukon Heliski.
  - Alaska Heliskiing, in Haines.
  - SEABA Heliskiing, in Haines.

**9. REFERENCES**

Fesler, D.: White Pass and Yukon Route entries from Alaska Historical Avalanche Database; personal communication..

Glude, Bill, Alaska Avalanche Specialists, Operations Plan, White Pass and Yukon Route Avalanche Program, 2016, internal document.

Scheffler, Willy, White Pass and Yukon Route Carcross maintenance supervisor for 55 years; oral communications, 2016

White Pass and Yukon Route website history; <http://wpyr.com>

**10. MITIGATION OPTIONS CONSIDERED**

The table on the next page summarizes the other mitigation options that were evaluated, with the two that most merit further consideration, a mortar for the Slippery Rock path, and a diversion berm for the South Glacier Main Gully path, in bold.

Mitigation	Capital Cost (rough estimate)	Operating Cost/yr	Comments	Most cost-effective	Worth Study
Relocation and Bridges	very high	same as normal maintenance	Not likely to be worth the disruption and cost. Probably within right of way; might require adjustment.		
Support Structures	very high	moderate	Unlikely to be worth cost; land use permits required.		
<b>Earthworks, S Glacier main Gully Diversion</b>	<b>\$1.5 million</b>	<b>Low but substantial</b>	<b>Would shorten avalanche season; further study might be merited. Land use permits required.</b>		<b>x</b>
Earthworks, S Glacier W Apron and 15 Mile	Less than berm	Low but substantial	Probably not worth the risk reduction. Land use permits required.		
Snowsheds	\$8.4 to \$25 million just for S Glacier Main Gully	Low but substantial	Effective but prohibitively costly. Probably inside right of way; might require land use permits for backfill.		
Warning Systems	\$150,000 to \$300,000	moderate	Worth communicating with developer. Would require land use permits, but impact is minimal.		x
Closure	none	lost revenue; crew time	In use; effective but can stop trains in season. No land use permits.	x	
Helicopter and Hand Blasting	\$10,000 for magazine	\$17802.00	In use; relatively cheap and effective despite weather delays; reduces train stoppage and risk. Have land use permission.	x	
Daisy Bell	\$150,000.00	\$3,500.00	Not effective for spring operations; wet snow and deep weak layers. Have land use permission.		
Remote Exploders	\$1.2 million for S Glacier Main Gully; \$4.95 million for all	\$6,000 to \$20,000 (spring only)	Effective but too costly for spring-only operations; some terrain is difficult for exploder placement. Land use permits required.		
Bomb Trams	\$50,000	\$1,000.00	Possible for Slippery Rock. Land use permits required.		x
<b>Mortar</b>	<b>\$15,000 plus firing mount</b>	<b>\$2,500.00</b>	<b>Might be best cost and benefit for Slippery Rock. Have land use permission.</b>		<b>x</b>
Avalauncher	\$70,000 with shipping, mounts, blast shields	\$2,500.00	Too expensive for Slippery Rock, range too short for most paths, better to share with ADOT&PF. Have land use permission.		x
105 mm Howitzer	\$32,000.00	\$13,000.00	Effective but probably not available for seasonal operations. Have land use permission.		