FIFTY YEARS OF BC MINISTRY OF TRANSPORTATION AND TRANSIT AVALANCHE AND WEATHER PROGRAMS: FROM THEN TO NOW

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ABSTRACT: British Columbia's provincial highways traverse steep mountainous terrain and are exposed to snow avalanche hazards at numerous locations, creating an ongoing challenge to maintain safe and reliable winter transportation. Established following the 1974 North Route Café avalanche near Terrace, the British Columbia Ministry of Transportation and Transit (MOTT) Avalanche and Weather Program has evolved from localized operations based on manual observations and helicopter-based explosive control into an integrated, risk-based management system. Today, the program manages avalanche risk across 63 avalanche areas encompassing approximately 1,400 active avalanche paths. Major developments include the expansion of automated weather and avalanche monitoring networks, adoption of Remote Avalanche Control Systems (RACS), development of the Snow Avalanche and Weather System (SAWS) and SAWSx, and deployment of automated avalanche detection technologies. These advances have improved worker safety, reduced highway closures, and strengthened operational decision making, demonstrating the value of sustained investment in people, infrastructure, and technology.

KEYWORDS: Operations and Program Management.

1. INTRODUCTION

In 2026, the BC Ministry of Transportation and Transit's Avalanche and Weather Program marks its fiftieth year of operation. Established in the aftermath of the 1974 North Route Café avalanche, the program has grown from a small group of avalanche practitioners working in a handful of high-hazard corridors into a province-wide organization responsible for managing avalanche and weather-related risks across British Columbia's transportation network. (Avalanche Task Force, 1974)

Over five decades, the program has continually adapted to changing operational requirements, new technologies, and increasing expectations for public safety and transportation reliability. Advances in avalanche forecasting, monitoring infrastructure, explosive control systems, decision-support tools, and environmental sensing have fundamentally changed how avalanche and weather hazards are managed on provincial highways.

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The evolution of the program reflects a broader shift from reactive hazard management toward proactive, risk-based decision making supported by integrated monitoring networks, remote-control technologies, and centralized information systems. This paper traces the progression from the recommendations of the 1974 Avalanche Task Force through to the modern Avalanche and Weather Program, highlighting key developments in operations, infrastructure, technology, and organizational learning.

2. ORIGINS OF THE PROGRAM

Transportation through British Columbia's mountainous regions has long been affected by avalanche hazards. As highway development expanded throughout the twentieth century, so too did the exposure of motorists, maintenance personnel, and infrastructure to avalanche risk.

By the early 1970s, Ministry maintenance personnel in several districts had begun collecting weather, snowpack, and avalanche occurrence information while attending avalanche training programs. These efforts, however, remained localized and lacked a coordinated provincial framework.

A defining event occurred on January 22, 1974, when a large destructive avalanche struck the North Route Café on Highway 16 west of Terrace, killing seven people. The disaster prompted the Minister of Highways and Public

https://doi.org/10.15788/1790099070

Works, Grahm Lea, to establish the Avalanche Task Force and direct it to examine hazards affecting public highways and adjacent infrastructure. (Avalanche Task Force, 1974)

The Task Force included leading avalanche specialists, notably Peter Schaerer of the National Research Council and Geoff Freer, who later became head of the Ministry's Snow Avalanche Section. The resulting report, completed in September 1974, became the foundation of today's Avalanche and Weather Program. (Avalanche Task Force, 1974)

The report recommended:

- Systematic avalanche hazard evaluation and mapping;
- Snow stability assessment and avalanche forecasting;
- Enhanced weather and snowpack monitoring;
- Development of avalanche atlases;
- Public education and warning programs;
- Rescue planning and worker protection measures;
- Avalanche control programs;
- Structural mitigation options including snow sheds, deflection structures, and reforestation; and
- A formal weather-information partnership with Environment Canada's Atmospheric Environment Service.

Many of these recommendations remain core components of the program today. (Avalanche Task Force, 1974) including the relationship with Environment Canada. The Ministries weather network provides valuable data on a 24/7 basis to Environment Canada’s systems to improve weather forecasting.

3. ESTABLISHMENT AND EXPANSION OF OPERATIONAL PROGRAMS

Under the leadership of Geoff Freer, the Ministry's Snow Avalanche Section was established in 1974 to implement the recommendations of the Avalanche Task Force. Freer, Janice Johnson, and Bill Moffatt formed the core of the Section's Victoria office.

The Ministry's first operational avalanche forecasting programs were established during the winter of 1975-1976 in the highway corridors identified by the Task Force as having the highest Avalanche Hazard Index ratings: Kootenay Pass, Terrace, Hope, and Stewart. (Cooper, 2024) These early programs were staffed and monitored by Ministry district personnel who volunteered to assume avalanche forecasting responsibilities. Most had little or no previous avalanche experience and typically held seasonal summer positions in activities such as surveying, construction inspection, or paving operations.

Despite these limitations, snow stability assessment and avalanche forecasting were initiated on a provincial scale. Avalanche control using explosives was conducted on a limited basis, extensive avalanche training programs were delivered to maintenance crews, weather stations were established, avalanche mapping and atlases were developed, and warning signs were installed throughout high-hazard corridors. These signs included *"No Stopping in Avalanche Area"* warnings for highway users. More than five decades later, this message remains one of the Ministry's most important and enduring public safety tools and continues to serve as a primary means of communicating avalanche hazard to highway users.

The development of these early programs was greatly assisted by expertise from outside the Ministry. Significant support was provided by the National Research Council of Canada, Parks Canada, Environment Canada, and avalanche professionals from the United States. Individuals who contributed knowledge, training, operational guidance, and technical expertise during this formative period included Willi Pfisterer, Fred Schleiss, Walter Schleiss, Peter Schaerer, Paul Anhorn, Stewart Thompson, Norm Wilson, Dale Gallagher, Mark Moore, and Rich Marriott. Their contributions helped establish many of the forecasting, control, training, and safety practices that became foundational to the Ministry's Avalanche and Weather Program.

On January 17, 1976, another significant avalanche accident occurred on Highway 3 at Kootenay Pass when a vehicle was swept from the highway, resulting in three fatalities (Stetham, 1979). The tragedy reinforced the Avalanche Task Force work and the need to continue with the new Ministry approach to avalanche risk management and formal establishment of local avalanche programs across the province.

A remarkable aspect of the incident was the survival of an infant passenger who was found unresponsive in the avalanche debris. Members of the Creston Fire Department successfully revived the child using cardiopulmonary resuscitation (CPR), a technique they had only recently been trained to perform.

As the operational programs matured, the Ministry recognized the increasing need for dedicated avalanche professionals with specialized mountain experience. In 1975, Mike Zylicz was hired as the first Snow Avalanche Technician in Terrace. Ed Campbell was hired full-time in Hope in 1979, followed by John

Tweedy at Kootenay Pass in 1980. These positions represented the first full-time dedicated Avalanche Technician roles within the Ministry. To support continued growth, Freer began recruiting personnel from ski areas, mountain guiding operations, and other sectors of the emerging avalanche industry. The addition of Jack Bennetto to the Snow Avalanche Section in 1984 marked the beginning of a period of continued program development and innovation that extended through the 1990s.

Over the following decade, avalanche operations expanded to additional corridors including Revelstoke, Kicking Horse Canyon, Pine Pass, Red Pass, Bella Coola, Duffey Lake Road, and numerous locations throughout the East and West Kootenays.

Early programs relied heavily on manual weather observations, snowpack assessments, avalanche occurrence tracking, and localized forecasting. Field observations formed the basis of operational decision making, while forecasting procedures evolved through practical experience, research, and organizational learning.

As the program expanded, standardized operating procedures, training requirements, and safety practices were developed to support increasingly complex avalanche operations across the province. This period established many of the technical and professional foundations that continue to guide avalanche forecasting, hazard assessment, and risk management activities today.

Over time, what began as several localized programs evolved into a coordinated provincial network. Today, eight operational avalanche programs manage avalanche risk across 63 avalanche areas and approximately 1,400 active avalanche paths throughout British Columbia.

4. EVOLUTION OF AVALANCHE CONTROL OPERATIONS

Explosive avalanche control became a cornerstone of operational risk management throughout the program's development. (McClung & Schaerer, 2006) Early control methods included hand-deployed explosives, case charges, helicopter-deployed charges, Avalaunchers, recoilless rifles and a Howitzer. Helicopter-based explosive delivery, first used in British Columbia during avalanche mitigation associated with the 1965 Granduc Mine rescue operation, remains an important operational tool today.

Beginning in the 1990s, the Avalanche and Weather Program transitioned from a primary focus on hazard management toward a broader strategy of systematic risk reduction. This shift was driven by targeted investments in control infrastructure, environmental monitoring, communications systems, and operational decision-support tools. The objective was not only to manage avalanche hazards, but also to improve worker safety, reduce highway closure durations, and increase overall corridor reliability.

An early milestone in this evolution occurred with the opening of the Coquihalla Highway in 1986. A key factor in the success of the Coquihalla project was the involvement of avalanche specialists during the planning and design stages. Avalanche terrain was evaluated prior to highway construction, and avalanche practitioners worked closely with engineers and designers to locate the highway, where practical, away from avalanche hazard areas. The corridor also introduced the Ministry's first Remote Avalanche Control Systems (RACS) in the form of two bomb-tram installations. By allowing explosive charges to be delivered remotely into avalanche start zones, these systems reduced personnel exposure and improved operational flexibility during avalanche-control programs.

Randy Stevens of Rossland played an important role in the design, installation, and early operation of the bomb-tram systems. Stevens subsequently became the first District Avalanche Technician for the Duffey Lake Road program. Building on this experience, a significant technological advancement followed in 1992 when the Duffey Lake Road became one of the first transportation corridors in North America to deploy Gazex technology. Additional Gazex installations were subsequently introduced at Kootenay Pass. These fixed systems use remotely operated propane-oxygen detonations to trigger avalanches under controlled conditions. Unlike conventional explosive control methods, Gazex systems can be operated during periods of poor visibility, severe weather, and darkness, significantly reducing operational constraints and worker exposure.

Over subsequent decades, RACS technology expanded to additional corridors including the Revelstoke-to-Glacier section of the Trans-Canada Highway, Three Valley Gap, and Highway 16 west of Terrace. Remote avalanche control systems have become a central component of the Ministry's avalanche risk-management strategy.

The expansion of RACS occurred alongside significant growth in environmental monitoring infrastructure. What began as a small network of manually operated weather stations evolved into a province-wide system of approximately 325

avalanche, weather, road-weather, and highway-condition monitoring stations. Together, these investments improved spatial coverage, increased the availability of near-real-time environmental information, and strengthened operational coordination between field programs and headquarters staff.

The combined effect of enhanced monitoring, remote control technology, and improved operational procedures has been substantial. At Kootenay Pass, advances in avalanche-control infrastructure and operational practice have reduced typical highway closure durations from twelve hours or more to generally two hours or less, with extended closures now comparatively uncommon. Similar improvements in operational efficiency and worker safety have been realized across many of the province's avalanche programs.

5. DEVELOPMENT OF THE WEATHER MONITORING PROGRAM

While the remote avalanche control systems transformed how avalanche hazards were managed, their effectiveness depended on timely and accurate environmental information. Weather observation and forecasting have therefor remained fundamental components of the Avalanche and Weather Program since its inception. (Avalanche Task Force, 1974; McClung & Schaerer, 2006)

The earliest weather networks consisted of manually operated stations where observations were recorded in field books and communicated by telephone or radio. Weather, snowpack, and avalanche occurrence data were painstakingly documented and archived on hand-drawn time-profile graphs. These records formed the program's original forecasting database and were routinely consulted when evaluating avalanche conditions and identifying historical analogues. Avalanche technicians relied on these observations to assess avalanche likelihood, expected magnitude, spatial extent, and potential impacts on transportation corridors.

The transition from paper-based records to digital systems began in the late 1970s and accelerated during the 1980s under the leadership of Bill Moffatt, with significant contributions from Gordon Bonwick and Janice Johnson. At the same time, advances in automated weather-station technology made it possible to collect continuous observations from remote mountain environments. In 1977, the Ministry installed its first Remote Automated Weather Station (RAWS) at Kootenay Pass, providing temperature observations from the Stagleap area. As technology improved, additional stations were deployed throughout avalanche corridors across the province, expanding the ability to monitor temperature, precipitation, wind, and snow depth in near real time.

Unlike many transportation agencies, much of this infrastructure was designed, assembled, installed, and maintained internally. Early stations were often located in exposed alpine environments, powered by solar panels, and connected through dedicated radio communication networks. The development of in-house technical expertise allowed the Ministry to expand monitoring capabilities while adapting equipment to the demanding conditions of British Columbia's mountain regions.

Over subsequent decades, incremental advances in sensors, communications, and data management transformed a relatively small network of avalanche weather stations into a comprehensive environmental monitoring system. The growth of this network provided the foundation for improved forecasting, more effective avalanche control operations, enhanced highway maintenance decision making, and the development of modern decision-support platforms. Today, the monitoring network forms a critical component of the Ministry's broader risk-management strategy, supporting avalanche forecasting, winter maintenance operations, traveler information services, and climate-monitoring initiatives throughout British Columbia.

This evolution from manual observations recorded in notebooks to a province-wide network of automated stations represents one of the most significant technological advancements in the history of the Avalanche and Weather Program and laid the groundwork for the digital systems and operational tools that followed. Road Weather information systems and highway operations

During the mid-1990s, advances in pavement-sensing technology broadened the role of environmental monitoring beyond avalanche forecasting.

Under the leadership of Maintenance Weather Technician Art McClean, pavement temperature, salinity, and surface-condition sensors were integrated into existing weather-station infrastructure, establishing the foundation of British Columbia's Road Weather Information System (RWIS). The ability to monitor and forecast roadway conditions significantly improved winter maintenance decision making and enhanced highway safety.

In 2004, highway webcams were added at selected stations, marking the beginning of the

Highway Cam Program and providing visual verification of road and weather conditions throughout the transportation network.

In 2011, weather-station-controlled Variable Message Signs (VMS) were introduced. These systems automatically activated warning messages and flashing beacons based on observed environmental conditions, providing real-time information to motorists and contributing to reductions in weather-related collisions.

6. DIGITAL TRANSFORMATION AND DECISION SUPPORT

As environmental monitoring networks expanded, the need for centralized data management and operational decision-support tools became increasingly important.

The Snow Avalanche and Weather System (SAWS), developed during the early 1990s, provided a centralized platform for managing observations and supporting avalanche forecasting operations. SAWS significantly improved information accessibility and replaced many paper-based workflows.

As operational requirements grew, multiple software applications were developed to support business functions. Recognizing the limitations of independent systems, the Ministry initiated the SAWSx modernization project, formally advancing it as a major initiative in 2016.

SAWSx consolidated numerous legacy applications into a single web-based platform supporting forecasting, mapping, hazard assessment, observation management, and operational coordination across approximately 1,400 active avalanche paths throughout the province.

Automated avalanche detection and emerging technologies

Recent years have seen the deployment of technologies that further enhance operational awareness and decision making.

Automated Avalanche Detection Systems (AADS) use radar and other sensing technologies to detect avalanche occurrences and provide information regarding avalanche size, movement, and runout extent. These systems are particularly valuable during darkness, poor visibility, and severe weather.

Initial deployments at Bear Pass and Ningunsaw Pass have demonstrated the benefits of continuous avalanche monitoring, reducing uncertainty in hazard evaluations and supporting more efficient operational decisions.

Additional modernization efforts have included deployment of high-definition camera systems and expanded remote monitoring capabilities that provide continuous situational awareness at selected locations.

7. CLIMATE MONITORING AND ENVIRONMENTAL ADAPTATION

The responsibilities of the Avalanche and Weather Program have expanded considerably beyond avalanche forecasting and winter maintenance support.

In 2003, the program assumed responsibility for the provincial Frost Probe Network, which supports Seasonal Strength Loss programs and informs roadway load restriction decisions.

Beginning in 2007, the Ministry became a participant in British Columbia's Climate Related Monitoring Program. (British Columbia Minsitry of Environment and Parks, 2026) Through partnerships with the Pacific Climate Impacts Consortium, Environment and Climate Change Canada, BC Hydro, regional governments, and industry partners, the program contributes to a provincial climate-monitoring dataset.

More recently, specialized monitoring stations have been installed to support climate adaptation initiatives related to atmospheric rivers, post-wildfire hydrology, debris flows, and landslide hazards.

8. LESSONS LEARNED FROM FIFTY YEARS OF PROGRAM DEVELOPMENT

Several key lessons emerge from fifty years of Avalanche and Weather Program development.

First, major incidents can create the institutional momentum necessary to establish long-term risk-management programs. The North Route Café disaster provided the catalyst for a coordinated provincial approach to avalanche safety, leading to the creation of the Avalanche Task Force and the implementation of many of the core elements that continue to define the program today. (Avalanche Task Force, 1974)

Second, sustained investment in monitoring and control infrastructure forms the foundation of effective operational decision making. The combined development of weather-monitoring networks, remote avalanche control systems, automated detection technologies, and decision-support tools has dramatically improved situational awareness, forecasting capability, and operational efficiency. These investments have enabled a shift from reactive hazard

management toward proactive, risk-based management of transportation corridors.

Third, technological innovation has consistently improved both worker safety and transportation reliability. The adoption of remote avalanche control systems reduced personnel exposure during avalanche-control operations, while modern monitoring and detection systems have improved confidence in operational decisions and reduced the duration of highway closures.

Fourth, organizational learning and knowledge transfer have been critical to the program's success. The expertise developed by generations of avalanche practitioners, technicians, forecasters, and managers has allowed the program to adapt to changing technologies, evolving operational requirements, and emerging environmental challenges while maintaining continuity in professional practice.

Finally, maintaining strong internal technical expertise has enabled continuous innovation. The Ministry's ability to design, install, maintain, and adapt specialized monitoring and communications infrastructure has supported long-term program resilience and allowed new technologies to be integrated efficiently into operations.

Collectively, these lessons demonstrate that effective avalanche risk management requires more than forecasting and avalanche control alone. Long-term success depends on sustained investment in people, infrastructure, technology, and organizational capacity, supported by a commitment to continuous improvement and adaptation.

ACKNOWLEDGEMENTS

The authors would like to thank the following contributors for their help in preparing and reviewing the paper: Simon Walker, Geoff Freer, John Tweedy, and John Buffery.

We also acknowledge the many avalanche professionals, industry pioneers, visionaries, and Ministry staff who contributed to the establishment, growth, and modernization of the BC Ministry of Transportation and Transit's Avalanche and Weather Program. In particular, we recognize the contributions of individuals including, but not limited to, Peter Schaerer, Ted Weick, Paul Anhorn, Janice Johnson, Pat Johnson, Bill Moffatt, Gordon Bonwick, Mike Zylicz, Art McClean, Randy Stevens, Ed Campbell, Nic Seaton, Jack Bennetto, Mike Boissonneault, Doug Wilson, Alan Dennis, Bruce Allan, Tony Moore, David Smith, and John Bolleman. Their efforts, together with those of many others not named here, helped build the foundation of avalanche and weather risk management on British Columbia's transportation corridors.

Historical information regarding program development, infrastructure deployment, and operational evolution was compiled from BC Ministry of Transportation and Transit archival records, annual reports, technical reports, operational documentation, and institutional knowledge maintained within the Avalanche and Weather Program.

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